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FOREWORD

It is an established tradition in universities all over the world to invite lecturers, on elevation to the professorial position, to deliver inaugural lectures in which they either summarize their research achievements or proffer to the academia and the nation critical views and recommendations on matters they consider to be of strategic importance. The University of Ibadan had in the past ensured that such lectures were promptly published and widely distributed by the Ibadan University Press.

Paul Christopherson, a professor of English, was the first in this university to give an inaugural lecture. The lecture, titled "Bilingualism", was given on Foundation Day, 17 November 1948 and was promptly published in 1949. Since then, many professors from various departments have delivered inaugural lectures, which the University promptly published. However, the practice became stalled as from 1992 owing to a severe scarcity of funds. As a result, some inaugural lecturers published their lectures by themselves. However, many inaugural lectures have been "awaiting publication" without hope of ever seeing the light of day.

Inaugural lectures have critical roles to play in the universities and the nation at large. They often contain highlights of research findings that may be of great value to the academic world, budding entrepreneurs, industrialists and even governments. Such lectures can also showcase to the outside world the academic attainments of individual lecturers and the entire university.

It is against this background that I heartily welcome the financial intervention of the National Universities Commission, through the Direct Teaching and Laboratory costs allocation, that has enabled the publication of the backlog of inaugural lectures. For handiness and cost-effectiveness, we have decided to compile the lectures that emanated from one decade (1992-2002) in two volumes. We thank the NUC for the grant and warmly commend the volumes to research libraries and the reading public at large.

University of Ibadan
Ibadan
April 2005

Professor Ayodele Falase
Vice-Chancellor

1

IN SEARCH OF THE ORIGINAL JESUS

S. Oyin Abogunrin

Department of Religious Studies

Introduction

This is the third inaugural lecture from the Department of Religious Studies. The first lecture titled: "Religious Studies In An African University" was given by Professor James Welch on the University's Foundation Day, November 17, 1950. The second lecture, "The Obituary of God", was delivered by Professor Bolaji Idowu in February 1976, a few weeks before he left the University on retirement. In the first lecture Professor Welch put across the philosophy of the then new Department of Religious Studies, its aims, objectives and goals. In the second lecture, Professor Idowu discussed the reality of God and His active presence in the universe.

My area of research within the large field of Religious Studies is New Testament Literature and Theology, focusing attention on the Historical Criticism of the Gospels and Pauline Studies. What has engaged my attention in the last twenty-four years or so is the contextualization of Biblical Theology in Africa. As a biblical scholar, living and practising in Africa, my main concern has been how to combine Africanness with sound biblical scholarship such that Jesus, the Eternal Word, can become incarnate in the life and thought of the peoples of Africa. Thus the Bible is made to speak in local rather than, in foreign idioms. Today's lecture is in the area of the historical criticism of the Gospels, focusing on one of the thorny issues in Gospel Studies, namely, the 'Historical Jesus'.

The Nature of the Problem

Men throughout the ages have been divided over the question: "Who is Jesus of Nazareth?" This raises the other relevant issues such as: Why so much interest and conflict over an individual? Why is it that His name, more than that of any other religious leader, either causes irritation or attracts worship and adoration? For more than two centuries, the life of Jesus has remained a matter of supreme interest in New Testament research. During the last fifty years the number of

books written on the subject in the English language alone has swollen to fantastic proportions. Indeed, it will be a very difficult task today for any full-time reviewer to keep track of books appearing about Jesus. These are books written not only by Christians of different persuasions, but also by Jews, Muslims, Communists, etc., each of whom has his own reasons for being interested in Jesus. Jesus of Nazareth continues to fascinate people from many cultural and religious backgrounds. For example, many modern Jewish biblical scholars have a keen interest in Jesus, some of them believing that Jesus was a highly unconventional teacher from Galilee and was probably a Pharisee.¹

And back to the main questions we intend to deal with in this lecture: Was Jesus a real person, or a mythological figure? Did Jesus ever live? And if He did live, what are the real events of His life? The most unifying element in the New Testament writings is the common concern for Jesus Christ. The presentation of Jesus Christ in the New Testament begins with the Gospels, though they are not the earliest writings. The arrangement, which puts the Gospels at the beginning of the New Testament, was certainly not an accident, but a deliberate confirmation of the fact that the Christian faith has to do, first and foremost, with the person of Jesus Christ. The starting point in the New Testament, therefore, is Jesus of Nazareth, His advent, life, teaching, deeds, death, resurrection, exaltation and His significance as an historical figure.

However, some people will be surprised that for more than two hundred years, the very existence of Jesus has been challenged. Jesus' pre-eminent position in religious history the world over has led to a great deal of interest in the historical investigation of His own person and such questions as the following are asked: In what sense are the four Gospels historical? Are they true stories in every aspect, or are they mere historical novels? From where did the traditions which found their way into the Gospels come? What do we know of the origins of those traditions? Are the Evangelists trained historians? What was Jesus really like as seen by unbiased observers? What is the significance and correct interpretation of His life? Can Jesus be really accorded a place in history as a significantly influential figure?

Since the 18th century scholars have claimed that the Gospels were written between A.D 100 and 150 or much later, because, according to them, it was only then that the early Christians invented Jesus as a historical figure. Many scholars have argued that the alleged controversies between Jesus and His Jewish opponents actually reflected the debates which arose within the early Christian community, rather than during the life time of Jesus. Of course, the primitive Christian community would be expected to try to recall what Jesus had said or done on certain occasions in order to resolve certain contemporary problems among members. It is true that to some extent these early concerns would have determined some of the traditions preserved in the four Gospels. Also, until very recently, official Soviet Union encyclopaedia and reference works referred to Jesus as a mere invention of the early Church.

For our knowledge of Jesus we depend, for all practical purposes, on the writings of the early Christians. The Gospels were written by men who believed that Jesus was the Messiah and Lord. He was regarded as the Supreme

Representative of God and as the One possessing the key to human destiny. They were committed men who gave religious veneration to Jesus. What are the implications of this for the historicity of what they wrote? If they wrote as committed Christians, does this not call into question the impartiality with which they wrote their Gospels? If some of the Evangelists were dependent on the work of other Evangelist(s) for their information, would not the same consideration apply to these intermediaries? How can we be sure that the whole story has not been coloured by the pious imagination of the earliest Christians who saw the story of Jesus in the light of the religious position which they ascribed to Him after His death?

Until the 18th and 19th centuries, most biblical scholars still regarded the Gospels as biographic or accurate historical records of the life of Jesus. Several scholars attempted to stitch together pieces from the four Gospels in order to write a modern biography of Jesus. Gaps in our knowledge of Jesus' life were often filled with imaginative reconstruction by adding guess work, especially about Jesus' early hidden years. Attempts were also made to reconcile contradictions.

Modern critics argue that if the Evangelists had been scientific historians, disinterested recorders of what actually happened, then there is some chance that they might have avoided such bias. But this is not what they were. What they wrote was meant to convert outsiders and strengthen believers. Critics, therefore, conclude that the Evangelists were not writing the history of Jesus' life, but rather religious propaganda. Other questions often asked are the following: Did they check their sources to ensure that these were reliable? Did they cross-examine those who told them about Jesus? Or did they simply believe what they were told, whatever was interesting and edifying? How can we be sure that they made efforts to tell the story with any degree of accuracy?

The effects of these considerations have led many to seek the 'historical Jesus' in the sense of what they call "the un-interpreted Jesus". The common cry on the lips of critics is: "Let us get away from the Christ of dogma, as painted by credulous early Christians and their successors. Let us go back to Jesus as He really was." Implicit in this idea is that the Gospels were not written by the Apostles or their disciples, but are products of a later period, variously dated between AD 100 and 200. In the opinion of these radical scholars, the real Jesus must have been an ordinary human being and was not responsible for the rise of the Christian faith. Much of the 19th and 20th centuries research was also based on the assumption that the original event was an ordinary human life and it should therefore be possible through careful probing of records to uncover the ordinary life of Jesus as a historical figure. Hence, the term "historical" is used in a technical sense which may trap the unwary. It does not simply refer to Jesus as He really was, but to Jesus as an ordinary man that He must have been.²

The liberal scholars are no longer ready to accept things like the virgin birth, the miracles, death for the sin which Jesus did not commit, the resurrection and the ascension. For them, the original Jesus is not directly accessible to history. They, therefore, conclude that it is fruitless to try to place Jesus within a process of historical development. What we know about Him now is not what He really

was, but what was revealed to the disciples through stories invented by some of them. They further argue that no chronological sketch of Jesus' life is available, except for the unconnected stories put together in the Gospels. What exactly gave rise to this negative development?

The Rise of Modern Biblical Scholarship

The critical approach to the study of the Scriptures arose in Europe as the old order crumbled with the Reformation and as a result of the rise of the Enlightenment in the 17th and 18th centuries. The terrible consequences of religious division in Europe had so succeeded in discrediting religious authorities that the intellectual avant-garde felt free to investigate the church's title deeds, among other issues. The old religious order had centred around an unquestioned acceptance of Judaeo-Christian understanding of God, which was losing its self-evident character under the pressure of rationalists' criticism. The enlightened authority of religious tradition began to raise questions about church dogma. People were no longer ready to assume uncritically that the Bible spoke reliably about God and the universe. Natural science began to challenge the biblical picture of the world. The Bible was now regarded as a fallible human record which spoke unevenly about man, religion and history.

Historical criticism created the most serious crisis for faith, and this has not yet been completely overcome. The 19th century began with historical criticism of traditions and legends about the church and state. The unmasking of the Donation of Constantine as the legend of the foundation of the church-state relationship was only the beginning. Historical biblical scholarship developed within Protestantism. It launched a vicious attack on the doctrine of verbal inspiration which had declared the Scripture as infallible, self-sufficient, free of all contradictions and, thus, the absolute authority in all questions of faith and life. In the Roman Catholic circle, the assertion of the infallibility of the church's *magisterium*, as well as its incorruptibility and impartiality, was shown to be historically conditioned and was, therefore, questioned by critics.³ Critics in Europe regarded the historical critical approach to the Bible and Church traditions as the foundation of freedom. Historical criticism not only undermined religious authorities, but also all other values and ethos of the society. The feeling then was that historical criticism had liberated men from the tutelage of the traditions and finally broken the last chains which philosophy and natural science had been unable to break.

History was no longer endured passively as a destiny or providence. Life was no longer oriented on what is derived from tradition. Personal and social life was no longer ordered in harmony with the eternal laws of the cosmos, but on the basis of natural law. The meaning of history was no longer sought in the past made present by traditions or in eternity made present by religion, but in the open invitation to the future. Also, since the beginning of the Renaissance the sciences have liberated themselves from the limitations and the laws of theological metaphysics. Theology ceased to be the 'queen' of all sciences and the church was no longer regarded as the 'crown' of the society. It was argued that it was not possible for someone to accept the natural laws of nature in the context of

technology during the week and turn round on Sunday to believe in supernatural miracles.

The main focus of historical criticism is not the relationship between the Bible and church tradition, but between the Bible and Christ. The historical critical investigation of the Bible since the 18th century has been guided by an interest in getting to know Jesus Himself and to understand Him as He really was. This, it is believed, would liberate Jesus of Nazareth from the dogma of the Christ of faith and the liberation of faith from dogma. Furthermore, critics argue that the christological dogma of Chalcedon had to be overturned so that people could seek the historical Jesus, and that only through the search for the real historical Jesus could christological dogma be overturned. It is only by doing this that one can encounter the real Jesus.

Many believing Christians are yet to make their peace with the current development. They have been unable to see how the critical approach can be compatible with revelation and faith in the Word of God, which the biblical text demands. Here the conservative Christians have a serious point. Christianity is a historical faith whose fundamental affirmations are expressed in the past tense. Also since we are dependent upon the New Testament writings for access to those past events which are the objectives of faith, we must accept that a distinction between what the Bible tells us and what "really" happened definitely poses a big threat to faith.

However, if the historian of Christian origins is to be faithful to his task, he must steer a course between the uncritical acceptance of biblical narrative demanded by fundamentalism and theologically motivated scepticism whose hypercritical approach ignores the rules of historical probability and is uncritical of its own approach as the opposite extreme. A critical reading of the sources is the only one possible way for the historian, if he is to use the New Testament writings, to reconstruct the past.

New Testament writings are a proclamation in history, the history of Jesus as the saving act of God. They are proclamations of Jesus in concrete historical situations of the past. If we are to understand the authors, therefore, we must first understand the historical situation in which the books were first written.⁴ Biblical criticism in its grammatical sense means no more than the exercise of judgement. Used in this neutral sense, biblical criticism is not only permissible but commendable, if pursued in a scholarly and reverent manner. The critical study of the Bible has indeed been undertaken by scholars, the majority of whom are fully persuaded of the divine authority of the Scriptures. It is neither destructive nor faultfinding with the Bible, but objectively researches to find out the truth and nothing but the truth. It is not we criticizing the Bible, but the Bible criticizing us in our daily lives. Genuine biblical criticism does not affect the uniqueness of the Bible. Nevertheless, we must admit that some of the old ways of stating facts are no longer adequate for today and for the people of Africa. A new reformation is taking place, both within and outside Africa, so much new thinking and reasoning is going on in the continent.⁵

The Life of Jesus

The research into the life of Jesus focused on the historicity of the Gospels through the investigation of the order of the gospels, their sources and the use they made of those sources. Lessing in his work composed in 1778 and published in 1784, proposed the existence of the "Gospel of the Nazarenes" or the "Gospel of the Hebrews", written in Aramaic soon after the death of Jesus, as the source of the Synoptic Gospels.⁶ J.J. Griesbach in 1783 said that Mark wrote after Matthew and Luke.⁷ J.G. proposed a plurality of sources and that the four Gospels were based on four revised editions of an original Aramaic Gospel, with each Evangelist making use of a different edition of it.⁸ But Marsh thought that there must have been an Ur-Marcus which formed the major source.⁹ 'Schleiermacher claimed that Matthew drew upon the Papias' Logia and Luke drew upon Matthew and that Mark was a later Gospel, with close affinity to Apocryphal Gospels.¹⁰ In 1818 J.K.L. Gieseler claimed that the Apostolic preaching must have taken some concrete forms, structured into Aramaic Gospel of the Nazarenes between AD 35-40, and later translated into Greek in order to meet the needs of the Gentile churches. He concluded that it is this Greek version that the Evangelists variously modified.¹¹ C. Lachmann claimed that Mark was basic and was followed by Matthew and Luke.¹² B.H. Streeter proposed a four-document source, claiming that both Matthew and Luke drew upon Mark. He further proposed a common source used by Matthew and Luke to explain the material common to both Gospels. This common source, he labelled *Quelle*. Furthermore, for materials peculiar to each of Matthew and Luke, Streeter opines that they both derived these from two different sources. Therefore, he labelled as *M* the material special to Matthew and *L* for material peculiar to Luke. This means that $Mark + Q + M = \text{Matthew}$ and $Mark + Q + L = \text{Luke}$.¹³

For nearly a century the majority of scholars have accepted this hypothesis that Mark is the first Gospel, and that Matthew and Luke, and also John, to some extent, copied from Mark. Thus the rationalists abandoned the traditions dating back to the second century that Matthew, followed by Luke were the first Gospels to be written, and thereafter Mark and John. Accepting the ancient traditions about the origins of the Gospels and the Gospel order would render many of the rationalists' hypothetical sources of the Gospels unnecessary. However, during the last forty years many scholars have been calling for a return to tradition about the Gospel order. Also, the multiplication of hypothetical sources such as the Ur-Gospel, Greek and Aramaic Versions of the Gospel of the Nazarenes, the Oral Gospel, Ur-Marcus, Ur-Matthew, the Proto-Luke, the Logia, Q, Qa, Qb, Qc, Qd, the M source, the L source, the priority of Mark, the recensions of the various Gospels, mutilated Gospels etc, all these have failed to provide a satisfactory solution to the Synoptic problem.¹⁴ The supreme task of New Testament scholarship in Africa, therefore, is not to further complicate an already confused and confusing situation by making its own addition to the number of hypothetical sources of the Gospels, but to make Christ crucified, a living reality in the thought of our time and to renew in it, once again, the awe and wonder of the Christian faith. This is not to say that African Christianity is not interested in the present critical probing and debate. If African Christianity

should neglect this aspect, how can it be well equipped to face the challenges of today and of the new millennium? Moreover, if the Christian faith is to be rational, it cannot avoid philosophical probing, and the evidence it uses in support of its biblical interpretation must be convincing. The appeal for faith and commitment cannot ultimately be separated from historical literary investigation.¹⁵

The critical scholars having concluded that Mark was the first Gospel, the next step was to investigate the historicity of Mark. If Mark is not historical, then most of what we have in the other Gospels, which was allegedly copied from Mark, must *ipso facto* be false.

The first major work, *The Life of Jesus* by D.F. Strauss, a junior lecturer at the Protestant Seminary of Tübingen University, was published in 1835. He argued that the Gospels must be judged to be unhistorical, both on the account of internal contradictions and because the modern scientific world no longer believes in angels, demons, voices from heaven, walking on water and other interferences with the laws of nature. Strauss argued further that the traditional belief in the historicity of the Gospels has become untenable to many and that biblical accounts have come into direct collision with modern scientific apprehension of truth and reality. He concluded that there were no such things as miracles because the closed system of nature brooked no such divine intervention. Strauss and his disciples conceded that Jesus performed some psychosomatic healings, but these could not be called miracles, which involved the suspension of the laws of nature. Strauss rejected outright the historicity of the Gospels, arguing that the real Jesus must have been an ordinary person whose life could be explained in human terms, and that if the Gospels were critically examined such picture of Jesus would emerge.¹⁶

At that time, however, Christianity still commanded sufficient respect for such an attack on its title deeds to be considered an outrage. As a result, Strauss lost his post at Tübingen. When, indeed, in 1839, a liberal government in Zurich offered him a professorship, the people rebelled and that government fell. The young lecturer was pensioned before he arrived at the new post.¹⁷

J. Weis in his work, *Jesus' Proclamation of the Kingdom of God* published in 1892, stated that Jesus meant to set up a rule in the immediate future. He was more like a fanatical preacher, warning people that the world might come to a sudden end at any time.¹⁸

Also in 1892 W. Wrede in his work, *The Messianic Secret*, argued that Mark, on which the other Evangelists supposedly depended, was riddled with contradictions and wild improbabilities. He submitted that Jesus never claimed to be the Messiah and that the Gospels were not historical reports, but theological fantasies from which history could be extracted with great difficulty. Mark was only painting a theological picture of Jesus under the guise of history. Mark imposed his own theological theory on the available material which he rewrote and interpreted, not in accordance with what happened, but in accordance with his own ideas. Wrede concluded that the supernatural features in Jesus' ministry were created by Mark, the creative theologian.¹⁹

Albert Schweitzer in his work, *A History of Research Upon the Life of Jesus*, with the sub-title, *The Quest of the Historical Jesus (1906)*, tried to relate the research of scholars during the 19th century on the life of Jesus. He argued that rather than rejecting the miracles of Jesus, they can be explained. The following are some of his explanations:

The walking on the water was an illusion of the disciples. Jesus walked along the shore in a mist and they took him for a ghost. When Jesus disclosed His identity Peter jumped into the water and was drawn to the shore by Jesus when he was sinking. Jesus entered the boat and they doubled headland and drew clear of the storm centre. They, therefore, thought that He had calmed the sea.

Similarly, when He was asleep and the boat was about to sink, his disciples waked Him and He taught them about the wind and weather. At that moment they gained the centre of a hill which protected them and they marvelled among themselves, that even the winds obeyed Him.

The feeding of the 5000 is explained thus: "When Jesus saw the multitude an hungered. He said to the disciples, we will set the rich people among them a good example". And Jesus began to distribute His own supplies and those of the disciples. The example had its effects, and soon there was plenty for everyone because the rich among the crowd similarly distributed their own supplies.

According to Schweitzer, the various raisings from the dead should actually be called deliverance from premature burials. They were all cases of coma. In Judea interment took place three hours after death and how many would have returned to consciousness in their graves and thereafter perished miserably.

On the transfiguration, Schweitzer posited that at night when Jesus was in the mountainous district, He had an interview with two dignified looking men whom His three companions took for Moses and Elijah.

Form Criticism

The arguments so far against the historicity of the Gospels are based on source criticism which deals with written documents alone; but this did not resolve the phenomenon of the Gospels. Scholars, therefore, feel that they must get behind the Gospels to know what was happening at the oral stage before the writing of the Gospels began. How did the stories about Jesus circulate during the first 20 to 40 years before any Gospel was written? How did these stories take concrete forms? This, therefore, led to the rise of form criticism.

Form criticism, which arose in Germany, was devised by Hermann Gunkel to study the individual stories in the Pentateuch.²⁰ Martin Dibelius²¹ and Rudolf Bultmann²² were the leading scholars who applied the method to the study of the Gospels. Form criticism is not an alternative to source criticism, but a supplement to it. For example, source criticism, among several other theories, proposed a four-document hypothesis as the sources of the Synoptic Gospels. But it could not push the study beyond the written documents. Form criticism is an attempt to fill this gap. Secondly, form criticism arose from the challenge to historicity by W. Wrede who argued that the framework of Mark was the author's own creation based on what were originally independently circulating units. The third reason for the rise of form criticism is the attempt to modernize the Gospels in the light

of scientific revelations. The fourth reason is the quest of the historical Jesus aimed at rediscovering the original Jesus as He really was and to free Him, once and for all, from the chains of Church dogma.²³

The form critics argued that the gospel stories first circulated in form of sermons and that some narratives were aimed at showing Jesus as a wonder worker. Such stories were created by story tellers in the early Church. According to Dibelius, there were also legends of the infancy story, as well as myths. For Bultmann, Jesus does not need any historical demonstration. What is important is the Jesus of faith, since little is known of the historical Jesus. The general feeling among the form critics is that it is not possible to know the historical Jesus because it is impossible to find reliable historical evidence about Him. The form critics claim further that 'form' is neither something accidental nor the result of the literary genius of an individual. Rather, it is a record of the spontaneous reactions of a community which grew out of a typical recurring situation to various issues and controversies which arose within the members and with outsiders. Each form had a function in the life of the community and reveals the concern which brought it into being. We, therefore, see that the thrust of form criticism is largely sociological.²⁴

Both Dibelius and Bultmann classify their material according to a variety of 'forms', although they differ in their terminology for them. The form critics believe that by observing certain laws which govern the transmission of material as illustrated by different Synoptic accounts of the same story, it is possible to arrive at the earliest recoverable form of the community's earliest renditions ever before the first Gospel was written. These forms constitute a function of life for the early Christian community and reveal the concerns which led to the creation of those traditions, as well as the nature of life in the early Church. Although Bultmann agrees that the traditions in the Synoptic Gospels pre-supposed the preaching of Jesus, it is impossible to determine how much of this is traceable to Him.

Rudolf Bultmann reacted vigorously against the scholars of the 19th century who made a reconstructed biographical account of the life and personality of Jesus the sole aim of their research. This is because Bultmann felt that it was a waste of time trying to investigate the accounts of Jesus' life since very little or nothing at all can be known about the historical Jesus. For Bultmann, what is central to the Christian message is not Jesus meek and mild, nor indeed the historical Jesus at all, but the Risen Christ. For a long time nearly all the form critics stated confidently that the Gospels were not biographies and that these books were concerned almost entirely with the significance, rather than the life history of Jesus. They further argued that the Evangelists were not concerned with any precise chronology; nor with the description of Jesus' personal appearance, and further, that no attempt was made to unravel the development of His personality, nor set Jesus in the historical context of His own day.²⁵

Bultmann adopted, for his study of the Synoptic Gospels, the method of analyzing the small units of tradition which Gunkel had used in the analysis of the materials in Genesis and the Psalms. In his view, the literary analysis of typical forms in which traditions were preserved would show how they had been

used in early communities. Attention was turned from reported events to anonymous teachers, preachers, worshippers, collectors, editors, redactors etc. who were allegedly responsible for the stories in the Gospels and this led to historical scepticism about the Gospels. Form criticism had by now taken firm root in Germany because its presuppositions were already present in the German History of Religions and of its research traditions. This is why Bultmann thought that comparative study of folk literature would explain the laws governing the transmission of the Synoptic traditions.²⁶ Bultmann vigorously opposed scholars who made the reconstruction of biographical accounts of the life and personality of Jesus the very centre of the Christian message. For him, it is the Risen Christ that was central to the Christian faith. He insisted that the early Church in its missionary preaching was only concerned with the fact that Jesus of Nazareth had once lived on the earth.²⁷

Of course, these may be the expectations of many modern readers of a biography. But a careful, open-minded reading will reveal that some of the issues raised by the form-critics are assumed in the Gospels. Their problem is that they have come to the Gospels with a preconceived notion that most of the accounts in the Gospels are unhistorical, hence their failure to see those facts which they claim to be looking for, but which are conspicuously present in the Gospels. Moreover, the Gospels must be set against the backdrop of their own times. When this is faithfully done, the Gospels will emerge both as the full-fledged biographies of Jesus and as the true story about His actual life and deeds and the significance of His life.

A careful study of the Graeco-Roman biographies reveals that they rarely trace the character development of personalities. They allow the actions and words of persons to speak for themselves. This method was commonly used in sophisticated ancient biographical writings with long literary tradition. Therefore, if we find that the Gospels appear to portray the character of Jesus by reporting His actions and teachings, we are certainly not misunderstanding their intention, as the form critics would want us to think. Of course, ancient biographies are themselves diverse in forms and this does not make direct comparison with the Gospels easy.

Several scholars have insisted that the early Church did incorporate Jewish teaching, as well as its own teaching, into the Gospels. They have therefore proceeded to argue that only materials which have no parallels in either the first-century Judaism or in early Christianity can be considered authentic or as coming from Jesus Himself.²⁸ Such a view not only leads to a distorted picture of the life and times of Jesus, but amounts to separating Jesus from the religious tradition and culture to which He belonged. Jesus was born a Jew, raised up as one, lived as a Jew and, naturally, observed some of the Jewish customs. To agree with the form critics is like saying, concerning the late Dr. Nnamdi Azikiwe of Nigeria, for example, that only things which could not be traced to the Igbo religion and culture, and to the political ideas of 1940s and 50s can be said to be authentic about Dr. Azikiwe. Or that anything that could be traced to the Yoruba religion and culture, and to the politics of the 1940s and 50s could not be true about the

late Chief Obafemi Awolowo and that only the ideas belonging to the year 2000 and thereafter could be true of Awolowo and of Azikiwe.

In response to the form critics, Christ as a teacher was greater than the Christian community which He founded and it must be expected that He had His stamp on the form and content of the oral tradition which circulated about Him. Also, variation in tradition may not mean that a particular record of events is unhistorical since Jesus Himself might have on different occasions and in various places repeated some of His teachings in different forms, depending on the situation. Again, some of the variations among the Gospels might be additional information, rather than contradiction. Also, no form critical hypothesis which ignores the presence of the eyewitnesses is justified. The uniqueness of Jesus in whom the Christian faith is centred and for whom the early Christians were prepared even to suffer death must be noted. Would the early Christians have been prepared to die in defence of falsehood and what they know to be products of their own imagination?²⁹

Also, the historian's acceptance of the pre-suppositions of the form critics would amount to abandoning Jesus as a possible subject of investigation, and reducing Him, who is the main subject of the Church's proclamation, to a mythological figure, with the consequent danger of depriving that proclamation of all historical content. Christianity would then become a sort of myth. The argument of the form critics — that only materials that have no parallel in contemporary Judaism of the first century AD to the post-Easter Christian Church could be attributed to Jesus — is faulty because of the limitation of our knowledge of the first century Judaism, based on available Jewish sources. Furthermore, it is difficult to accurately date those Jewish sources and be definite about how much of these Jewish sources go back to the first century. Moreover, form critics set the beginning of the gospel tradition at Easter, but this is quite arbitrary. Form critics cannot dispute the fact that during Jesus' ministry, He was surrounded by a group of disciples who later constituted the earliest Christian community. The origins of the Jesus traditions, therefore, were in the Pre-Easter period. It can, therefore, be legitimately assumed that there was something about the historical Jesus which explains how He came to be the object of the Church's faith and preaching. Attempts to explain the origins of the synoptic materials in terms of collective creativity of the early Christian community rests upon an unproved assumption. Even if the Gospels were written to meet the contemporary needs of the primitive Church, the Evangelists appeared to have drawn upon the actual life stories about Jesus' teachings and deeds. What kept the early Christian community together was not just the Easter experience, but what they knew of Jesus before the Easter event and it is evident that this knowledge of Jesus' teaching and deeds was adequate enough to keep the Church going.

The Church was interested in Jesus because it came into being as a result of the activities of Jesus and not as a result of invented stories after His death. Any theory which explains the contents of the Gospels as the creation of the early Church is ridiculous. Equally false is the theory that only a very tiny amount of information was handed over to the Church. The theories of the form critics are too weak to explain the rise of the early Church and faith in Jesus Christ.

Assuming that it was the resurrection that brought the church into being, this must have carried with it some personal knowledge of who Jesus was. What the early Church taught about Jesus would be inexplicable unless there existed some previous knowledge of Jesus.

The early church did not just esteem Jesus as a wonderful teacher and prophet; it regarded Him as the Messiah, the Son of God, Redeemer, Saviour and Lord. The Jesus of the form critics could not have been elevated to the status of the Jesus that we have in the New Testament. All the form critics agree that Jesus had disciples who survived Him. If so, did the disciples all forget all that Jesus ever did and taught and, therefore, need to create stories about Jesus? Had they no memory of what Jesus said in the course of His ministry which they must have told and retold over some period of time? Did they distort tradition so thoroughly that next to nothing of what Jesus actually said and did survived? If the form critics were all Jesus' disciples and were eyewitnesses, what would they have done or written after His death?

Furthermore, the argument by form critics that the gospel materials lack the characteristics which are usually found in accounts given by eyewitnesses and, further, that our present Gospels look more like oral traditions, preserved and transmitted by communities rather than eyewitness testimonies of individuals; is untenable. The gospel traditions played an important part in the faith and life of the early Christian communities which preserved them. The eyewitnesses must have been responsible for the vivid details in the Gospels and must have exercised some control over the development and transmission of the traditions about the life of Jesus. If Jesus was proclaimed as a mythical figure for about seventy years and the gospel message still spread so fast, and churches were firmly established in different parts of the Roman Empire, why would the Church at that stage need the proclamation of Jesus as an historical person to assist it in evangelism when it had succeeded without it for seven decades? If the historical Jesus was invented after A.D. 100, why would it be necessary to create so many detailed traditions? All the early Christian opponents agreed that Jesus once lived, had disciples, taught and performed miracles and was put to death on the cross by the Romans. Today nearly all historians accept that Jesus once lived and that the Gospels contain valuable materials about His life.

The gospel stories indeed reflect Jesus' own time and situation rather than the time and situation of the early Church and, therefore, they cannot be the early-Christian inventions. Bultmann's claim that the gospel stories reflect the life situation in the rabbinic traditions cannot stand. We do not possess any evidence that similar debates existed within the Judaism of the day which would necessitate the creation of such scenes in Jesus' ministry. Also we have no account of such debates within the early Christian communities. Equally untenable is the argument which regards Jesus' sayings recorded in the Gospels as inspired utterances of early Christian preachers and prophets. It is true that the New Testament recorded some occasions when some sayings are attributed to the risen Jesus or to the Holy Spirit or to a prophet, but when such occurs, it is usually made clear in the passage. On most occasions when neither the content

nor the context of gospel records points to a situation after Easter, the authenticity of such materials should be assumed.

However, H. Riesenfeld,³⁰ and his student Gerhadson, both of whom were Scandinavian scholars, proposed an alternative to the presuppositions of the form critics. They postulated the existence of a community for the transmission of Jesus' tradition within the early Church, a situation where the transmission of tradition becomes a technical act of instruction. This reflects the method of the oral transmission of the Torah in Judaism. In Rabbinic Judaism there existed a methodically controlled transmission of the tradition of the fathers. Gerhadson sees a parallel in the ministry exercised by the Twelve in Jerusalem. Like in Jewish tradition, a group of official repeaters (the ministers of the word) could be responsible for the oral transmission of the Jesus tradition. Paul told the Corinthians: "For I delivered unto you what I also received" (I Cor. 11:23; 15:3). The words 'delivered' and 'received' parallel the technical terminologies used for the control of the oral transmission of the Torah. Obviously, the Twelve must have exercised influence, if not control, over the way and manner the Jesus tradition was transmitted at the early period. There may be some elements of truth in this because it was in this manner that most prophetic oracles, which were first deposited with the disciples or the 'sons' of the prophets, were first preserved in poetic forms and were kept for some time before being committed into writing in ancient Israel. But this cannot fully explain the phenomenon of the relationship between the Gospels.³¹

To some extent, this has a parallel in the *Odu Ifa* system of divination among the Yoruba of West Africa and the related groups. The *Ifa Corpus* contains sixteen major divisions or "books" and 256 "chapters". It takes at least seven years of full-time apprenticeship to learn the art and scriptures by heart, and also to know the various myths connected with each chapter, as well as their meaning. It is in the *Ifa Corpus* that we have the most ancient and purest traditions of the Yoruba people. The Yoruba ancient scriptures are memorized and recited in the way Quranic students memorize and recite the Quran. In spite of the fact that many of the experts of *Ifa* divination system today are literate and well-informed, the old system of memorization and recitation remains the only approved method of learning and practising the art.³²

The New Quest of the Historical Jesus

This was a new development during the 1950s and 1960s in consequence of the failure of the old quest and form criticism. J.N. Robinson argued that the old quest of the historical Jesus was both impossible and illegitimate. The new quest, unlike the old, was ready to accept that some historical information about Jesus survived in the Gospels or in the Kerygma. Of course, it is not that the exponents were seriously interested in the historical Jesus. Robinson underlined the illegitimacy of trying to work back to pure history since what we have in the Gospels are interpreted stories and sayings. He too believed that not very much could be traced back to the lifetime of Jesus. According to him, the task of the historian is to recognize the intention behind past historical records, since history is a matter of interpretation in which the interpreter may find himself being

interpreted. He concludes that the Gospels are therefore an interpretation of facts and it is illegitimate to go behind them since the historical Christ remains inaccessible.³⁵

The rise of the new quest was also due to Bultmann's theological hostility to the liberals' quest for the historical Jesus. He had argued that faith must be bolstered by rational arguments, lest its sufficiency for salvation be undermined. He stated further that faith must not be exposed to the risk of the historicity of the Gospels and, that they should be severed from historical claims. Also, he argued that faith is directed towards God Who cannot be identified with a bit of worldly reality. Finally, he advocated a new understanding of the incarnation against the position of liberal Protestantism which denies the historicity of the Gospels altogether.

The new questers were in broad agreement with Bultmann on the above points, but they realized at the same time that since Christianity is centred on the crucified and risen Jesus Christ as the decisive revelation from God, objective investigators must at least be interested in what can be known about him by rational enquiry. The denial of the resurrection of Jesus and the substitution of an anti-theological explanation for this event cuts the thread of legitimacy which joins the faith of the early Church to the historical figure of Jesus. The Christian claim that 'Jesus is Lord' would therefore be false. Evading the "risk of history" by showing no interest in the historical reality of Jesus is therefore unsatisfactory. Since the claims of Christianity are open to challenge, it must be ready always to meet this challenge with rational historical arguments. Abandoning the historical quest would be to break with something that has from the start remained the cornerstone of the Christian faith.³⁴

A disciple of Bultmann who broke away from him in October 1953, was E. Kasemann who insisted that we cannot separate the Christ of faith from the Jesus history, nor do away with the identity between the exalted Lord Jesus and the earthly Jesus without falling into docetism. Another disciple of Bultmann, who also broke away, is G. Bornkamm who admits that Jesus is the only reality of God who confronts men and calls them to a decision.³⁵ Thus we see that the new quest admits that the Gospels contain some historical facts about Jesus, though they have been interpreted.

Christ and Mythology

There is another vital issue relating to our subject which needs to be discussed briefly. This is the issue of myths in the New Testament, first examined by Rudolf Bultmann and in the recent works edited by John Hick and others.³⁶ Bultmann wrote his essay on mythology in the New Testament in 1941. Bultmann was a professor of New Testament, who before then, had served as a chaplain in the army. He had been very concerned about the growing agnosticism in Europe and in the army. He believed that the major cause was that the modern man could no longer accept the myths contained in the New Testament. He was convinced that an undemythologized New Testament Christianity was no longer alive and could not make sense to the modern man. He argued that both the Old and New Testaments were obsolete and were unable to tackle the problem of

man in this age. It is the reason man has fallen into agnosticism. Moreover, he argued further that the New Testament is unscientific and too elementary for the modern scientific minds. It must, therefore, be purged of these elements that make it unacceptable to the present scientific age. Bultmann regarded the resurrection and miracles as impossible. He went further to say that not very much is known about Jesus as a historical figure, and His contributions to the thoughts of the New Testament are almost impossible to identify. He also submitted that Christ is neither the main figure of the New Testament nor is He responsible for all that is attributed to Him. Bultmann considered the Old Testament more embarrassing than helpful. In his view, the myth of God's saving act in Jesus was derived from gnosticism and Jewish apocalyptic. The idea of sacrifice is an anachronism rather than the essence of the Christian faith. He argued further that, today, nobody would interpret a case of epilepsy or mental illness as demonic possession. The modern man would take these as illness and go to a doctor. Cholera epidemic would be seen in terms of germs, rather than as divine visitation. Moreover, in Bultmann's view, it is impossible to use electric light, radio, television etc. and, in case of illness, consult a medical doctor and at the same time believe in the existence of demons and miracles. Bultmann's radical criticism of the New Testament notwithstanding, he maintains that God has done something decisive in Jesus Christ and that Christianity is a Gospel. Unlike many scholars before him, Bultmann believes that the myths should not be eliminated from the New Testament but must, rather be interpreted, and also that Christianity is an event rather than an invention. Yet he did not accept the supernatural in the life of Jesus, such as the virgin birth, miracles, and the resurrection. He accepted only the interpretation of these. For him, faith does not depend on the resurrection appearances, but on being crucified with Christ.³⁷

Bultmann, who was greatly influenced by such existentialist philosophers as Heidegger and Kierkegaard, opined that if all the stories in the Bible could be interpreted existentially, there would no longer be conflict between religion and science. For him, Religion would cease to make statements about the material universe, and the field would be left entirely to science. The problem with Bultmann's position, however, is that Christianity cannot make such a wholesale withdrawal from the world and still remain true to itself. Also what man believes about creation, providence, prayer and miracles implies that God is not only the Lord of the individual life, but of the material universe. The early Church did not create the miracle and resurrection stories, as suggested by Bultmann, but merely responded to them. Christianity cannot dispense with the Gospel traditions about Jesus and still remain the true Christian faith.

The latest major debate on the issue can be found in the book, *The Myth of God Incarnate* edited by John Hick and published in 1977. The volume contains articles by various scholars who are no longer persuaded by the fundamentals of the Christian faith. This gave birth to a series of articles written in reaction to this strong challenge to the authenticity and historicity of the Christian faith. These were published in 1977 in the volume titled: *The Truth of God Incarnate* edited by Michael Green. The two sides were brought together and academic papers on the subject were presented and discussed. This resulted in another volume titled:

The Myth of God Incarnate: *The Debate Continued*, edited by Michael Goulder and published in 1979.

The first volume, *The Myth of God Incarnate*, is an attempt to rethink christological beliefs and the primacy of soteriology. The main arguments of some of the authors go thus: the Christians in the early Church lived in a world in which supernatural causation was accepted without question and in which divine visitations were not unexcepted. Such assumptions, they argue, have become foreign to our situation. It is further claimed that in the West today, both popular culture and the culture of the intelligentsia have come to be determined by human and natural sciences to such an extent that the supernatural causation of, or intervention in, the affairs of the world has become incredible. Therefore, they have maintained that, Jesus could not have been a real man and at the same time be unique in a sense different from that in which each of us is a unique individual. A literal incarnation, no matter how sophisticated the arguments in its support, cannot avoid the elements of docetism and it requires the believer to accept a claim for Jesus' uniqueness in a way not acceptable to the majority of our contemporaries. They are of the view that Christianity, as traditionally conceived, is alien to the present climate. Also, that it is notoriously difficult, to the point of impossibility, to prove the sinlessness of Jesus. How, for example, could even the most consistent companion of Jesus have been sure that He remained unbrokenly true to His own principle and never, for example, "looked on a woman to lust after her", in the sense of Mathew 5:28? They, therefore, conclude that everything in the four Gospels would have occupied only some three weeks; meaning that the overwhelmingly greater part of Jesus' life and deeds remains unrecorded.

John Hick and his colleagues are not saying anything very new, although they have been able to strengthen and perfect arguments on the belief that the Bible cannot be more than a compilation of myths in the light of the present Western culture and the development of science.

Most of what we have considered so far deals with the historicity of the Christian faith. Therefore, before concluding, it is necessary to consider the nature of history, the modern understanding of what history is and how much that has influenced many Biblical scholars and theologians.

History and Faith

The task of the modern historian is often described as aiming at an objective reconstruction of the past. He is expected to determine and understand what has happened in the past. But since he has no direct access to the past, he has to make use of the various kinds of evidence by means of which the past events have left traces of themselves for the historian. He has to work back to the facts which underlie them, and interpret them. He must possess the skill and talent to draw up creative hypotheses, where and when required, for a critical analysis of the evidence. The word 'history' is derived from the Greek word *historia* meaning "enquiry". The noun *historia* comes from the verb *historeo*, meaning 'to inquire' 'to visit for the purpose of coming to know someone or something', 'to get information from'.

Modern historiography has its origin in the 19th century, which is regarded as the great age of facts and enquiry. The 19th century was occupied with names, dates, places, occurrences, sequences, causes and effects. It found the idea of objectivity in the natural scientist's investigation of the physical phenomena. But since the historian often stands within the history which he is investigating, total objectivity is apparently unattainable. The historian must know how to select the right facts, in other words, those which shed light on the historical phenomenon which he is investigating. His task consists mainly of material selection, collation, ordering and evaluation of the historical data. This means that the reconstruction of the past ultimately depends on the historian's judgment.³⁸

But the ancient historians did not view their task in the same way as their modern counterparts. Their criteria of significance were quite different. They were mostly concerned about transmitting to their readers what they considered important, useful and edifying in their reconstruction of the past. Pedagogical example, whether good or bad was the aim of ancient historiographers. The ancient historiographer did not share our scruples about passing judgements on the past personalities or events. He freely composed speeches, slating his own perception of the significance of past events and placing them on the lips of the actors in the historical drama. Attention was focused on prominent persons and political changes which they brought about. The biographical genre is therefore no guarantee that the events took place precisely as reported. Also, the scope of investigation by ancient historians were restricted to what was considered appropriate.

The sources for the investigation of the Christian movement during the first century are the New Testament writings. Archaeologists have investigated the various sites mentioned in the New Testament, and this has given us valuable insights into the historical context of Jesus' ministry and the world in which Christianity arose. But archaeological finds have not shed light on some important areas of the historical Jesus. This is because during the first century, Christians did not construct places of worship and prayers, but assembled in private homes. Their simple worship required no distinctive ritual objects and the Scriptures they used were those of the Synagogues. We, therefore, depend largely on the four Gospels for our information on the historical Jesus.

We have tried to demonstrate that in spite of the difficulties raised by critical scholars, the Gospels contain reliable material about the Jesus of history. The problem of the historical Jesus is part of the problem of studying ancient history and has to be studied, to a large extent, essentially by the same methods. Therefore, the quest of the historical Jesus faces the same difficulties as any other historical study of the same period. The historical study is not aimed at denying the truth contained in the Gospels, but rather, at applying the method of historical science as the basis of assessing the historical worth of the Gospels. When this is done with an open mind, the historical value of the Gospels can never be in doubt.

Furthermore, the historical phenomenon that we are dealing with is not just the life of Jesus Christ, but also the church which was triggered off by His life. The Christian understanding of history is that of a God who reveals Himself and

acts in history. The God about Whom Jesus spoke is the God Who stoops down to seek out and to save man. But if Jesus is not more than a mere prophet and teacher, then the Christian message is false. The Biblical concept of God is that of a God Who not only seeks and saves, but expresses Himself in the incarnation by coming to dwell among men in some tangible way. Otherwise, God will remain unknowable. The Christian conception of history is that of a history which finds its centre and climax in the coming of Jesus. The death and resurrection of Jesus are the basis of the hope for the future. This has rescued history from being a cyclical process, in which something continually happens, and makes it into a goal. But to accept the Christian view of history is to affirm that Jesus is more than an ordinary man who discovered the truth or to whom the truth about God was revealed. By this statement we are asserting that God has done something decisive in Jesus Christ and this is a proof that Jesus Christ is related to God in a unique way.³⁹

We must be careful not to move away from the Gospel roots in history. There is no doubt that in spite of some problems identified in the gospel records concerning the life, deeds and sayings of Jesus, there is a personal originality, combined with profundity of insight. He is not just the greatest reformer that ever existed and a martyr of whom religion cannot be said to have made a bad choice in pitching on Him as an ideal representative and guide of humanity. Jesus is more than all these. Indeed, the Christian faith is about the act of God in Jesus Christ. Hence, Christianity affirms that there is no other way to God and that the relation is both complete and continuing in Jesus only. What took place in Jesus is decisive and the Christian faith does not expect any future revelation of God to supplement, supersede, or correct the one already given in Jesus Christ. Henceforth, the relationship between God and man is once and for all defined by the relationship with God in Jesus Christ. What God has accomplished for humankind in Christ Jesus, is accomplished once and for all. It is finished, and it is of decisive significance. The reconciliation between God and man is once and for all achieved. It is God in Christ reconciling the world to Himself (II Cor: 5:19).

Historical evidence may sometimes appear contradictory, and with immense gaps in it. Quite often the material may be so vast and the questions that can be asked so endless as to make some process of selection inevitable with different possible pictures of the same event thereby emerging. This is one serious and valid observation that critical scholars have always made about the Gospels. But nobody can write history and conclude, as a result of some apparent contradictions, for example, that Karl Marx or Bishop Ajayi Crowther, the first African bishop in the 19th century, never lived. It is not purely 'accidental' that the four canonical Gospels have survived. Perhaps the most notable phenomenon is the re-emergence of the historical Jesus from the midst of critical uncertainties resulting from critical historical research.

A large number of believing Christians have yet to make their peace with critically historical approach to the Scriptures. They could not see how the critical approach can be compatible with the reverence which the biblical text demands. One can appreciate this deep concern. But Christianity is a historical

religion, that is, it is a faith whose credal affirmations are expressed in the past tense. Also the problem is compounded because the critical approach is a challenge to the ancient ecclesiastical dogma of the verbal inspiration and inerrancy of the Bible, which appears to rule out, *a priori* a critical approach to the Scriptures.

Interest in Jesus of faith to the almost total neglect of the Jesus of history almost naturally leads to historical scepticism and flight from history. But the reconstruction of the past, in order to be meaningful, must remain relevant to faith. The Gospels are not just a form of the Kerygma, but sources of what actually happened. If the historian of Christian origins is to be faithful to his task, he must steer a course between the uncritical acceptance of biblical narratives demanded by fundamentalism and a theologically motivated criticism, whose hypercritical approach ignores the rules of historical probability; and is itself as uncritical of its own way as the opposite extreme. A critical reading of the sources is the only one possible for the historian, if he is to use the New Testament writings to reconstruct the past. He has no other option, but to ask whether or not these things really happened in the way in which they are presented in the available records. However, before the historian accurately evaluates the evidence, he must first identify the historical material contained in his sources. It is a fact that the New Testament, being a collection of religious writings, contains certain affirmations about which the historian is not competent to pass a judgement. Nevertheless, this does not mean that the historical method and religious beliefs are incompatible.

Consequently, there is no need for the historian to deny the existence of God or God's activity in the world. Faith affirmations and historical affirmations often differ in their content, but not all the time. For example, with the statement: "Christ died for our sins in accordance with the Scriptures", the first part "Jesus died" is a historical fact, but the second part, "for our sins" belongs to the dogmatic interpretation of the passion story; yet this does not make the second part unhistorical. The Easter event gives credence to such an interpretation of Jesus' death.

Jesus Christ has remained the most remarkable phenomenon in human history. Jesus Christ was and is different from everyone else. What makes Jesus universally significant? Is the human race one? If so, what effects does this have on the human race? Scientists assume that the universe is one; this cannot be proved. But since without a single consistent universe they could not do what they do; scientists find this a convenient assumption to make. And empirically, there must be somewhere a central point where the universe is located. Nobody has any idea about its location. If it can be proved that the human race has a single history, then there is the possibility that there could be a central point at which all human threads converge and from which all threads diverge. It would, therefore, mean that a theology of history is possible. In Christian theology of history, the death and resurrection of Christ are the central point of history. This is the point where all roads of the past converge and all roads of the future diverge. The biblical concept of history is that of narrowing down to a point. Human history begins with Adam who is the father of us all, and ends with Jesus

Christ, the last Adam, Who in His person won victory over sin and death for humankind. The Gospels present Jesus as constituting Himself the true Israel and the One in Whom the whole destiny of Israel is realized. From the point at which He supremely tasted death for sin through obedience, He was supremely vindicated through the resurrection. It is at this point that the proclamation of the Gospel begins, and is to be preached as long as the world lasts.

The African Perspective

The above leads us to the following pertinent questions: Of what value to Africa is the current debate on the historicity of the Gospels, as well as the question of the historical Jesus? What can African Christianity benefit from the critical study of the Gospels, which has dominated the West for more than two centuries? Is it possible to pursue the question of the sequential order and the literature of the Gospels purely from the academic point of view, quite unrelated to the attested primitive traditions of the immediate generations after the Apostolic age? Can African biblical scholars brush aside the age-long accepted traditions and convictions of the church from the beginning before we can explain the phenomena of the Gospels? In the light of the African experience is the multiplication of hypothetical sources the solution to the problem of the sources of the Evangelists? Can we completely remove the Gospels from their cultural milieu and the conditions obtaining in first-century Palestine and impose Western cultural understanding of the 20th century upon their texts as if the Gospels actually originated from the West in the 20th century? What effects has the imposition of modern understanding of the nature of history on the cherished traditions of the Church? Can African biblical scholars brush aside the age-long accepted traditions and convictions of both Judaism and the Church because Western culture no longer has room for the supernatural? In the light of African experience, can the current Western approach be the best for African Christianity?

African Christianity has benefited tremendously from the cumulative labours of Western scholars. These scholars have kept African theologians aware of the questions being raised about the Bible which are pertinent to serious biblical research. At the same time, the increasing efforts in Africa to make biblical scholarship relevant should similarly be seen as contributing to the history of the enquiry.

But as far as Christianity in Africa, is concerned, the concern for the truth is still whole and unfragmented. The liberal scholars' approach to the question of the origin of the Gospels has not always been the best or the right way to understand the milieu out of which the Gospels emerged. One of the major reasons for this is the fact that there is a wide gap between the thought-world of the Bible and of that of Western critics today. The majority of Africans still live in the world of the New Testament, where belief in demons and a host of unseen supernatural powers is still potent and real. A Jesus emptied of all such supernaturalism as is contained in the Gospels would therefore be meaningless in the African setting.

In Africa today, the primary source of history is still largely oral tradition. Ancient traditions are still much cherished. Even now the history of most African peoples is still unwritten, and still lives on in the form of oral traditions, songs, family eulogies and genealogies, most of which have taken definite forms over the centuries or for countless generations. The fact that modern investigators into African history are often confronted with apparently conflicting traditions does not necessarily impugn the validity of such historical facts. Therefore, it cannot be concluded on that basis that the people of Africa have no history, and that everything about them is false. It is often left to such investigators to scientifically analyse their collections and decide whether the contradictions are real or only apparent. To return to our major concern, it is significant that all ancient evidence is generally unanimous about the origins of our four canonical Gospels. The concern for the truth and objectivity by serious scholars should not mean the rejection of the old tradition. Instead, it should lead to commitment to a thorough investigation of such information without preconceived ideas. It is important to note that our ideas about what could have happened about two thousand years ago may not actually reflect the position of things then. Furthermore, it is a very dangerous procedure to brush aside external evidence, which is basic to any serious historical research.

The modern approach to history is, as we have argued, quite alien to the approach of the ancient historians. It is, therefore, unacademic and unscientific to impose our present Western understanding and interpretation of history on the ancient people. The Gospels are essentially a product of faith and of the experiences of committed individuals and the community of believers. The Gospels, therefore, require some kind of special treatment and understanding.

Undoubtedly, before the written Gospels appeared, many of Jesus' traditions had taken definite forms at the time the majority of the eyewitnesses were still around. This would mean that correspondence among the Synoptic Gospels must not be traced to some hypothetical written sources alone, but also to the forms of oral tradition before the first written Gospel appeared. The stories of Jesus' sayings, parables, healings, miracles, etc must have been told and retold at various centres in the early church. Within a period of twenty to thirty years of oral transmission, those traditions must have assumed some definite concrete forms. Many forms of Jesus' sayings must have been memorized and some translated into Church hymns, as is the case within the churches in Africa today. The constant appeal to hypothetical sources to explain the origins of the Gospels gives the impression that the Evangelists were so ignorant and uninformed about the tradition of Jesus before they began to write and that they had to resort to copying from existing written documents or written stories created to glorify Jesus in the second century A.D. in composing their Gospels. But the Evangelists, whether they were apostles or not, were prominent and well-informed members of the early church where the tradition about Jesus took definite forms, and they were quite familiar with these.

But what is the state of contemporary Christian theology in the West today? Is theology speaking to the contemporary society, any longer? Who, is it that, fired what can be described as the fatal shot at Christian orthodoxy in the West?

The modern Christian theologian it is that fired the shot, and in so doing, he killed himself by eliminating the Bible, the sole reason for his existence and has, therefore, in effect committed suicide.⁴⁰ Contemporary liberal Western theology is incapable of offering any firm advice to modern secular society. The present secular dilemma of uncertainty is matched by an equal, if not greater, religious uncertainty of the modern theologian. Philosophical objectors to historic Christianity have succeeded in establishing a new religion — naturalistic Deism. They fought vigorously to eliminate the miraculous claims of the Scriptures. But the foundation of this teaching is the denial of the historicity of the Gospels by scholars of the Age of Reason and their successors, some of whom now live and practise in Africa. Biblical studies must not be divorced from the world of reality and practicability and the world of daily living, if it is to continue to speak to human needs. Modern Biblical studies are becoming more and more theoretical and speculative because of the attempt to equate them with abstract philosophy. Christianity did not begin as speculative thought, nor as speculative systematic theology. It began as a way of life, not based on intellectual speculative presuppositions, but on a faith which was in fact, founded on absolute trust in Jesus Christ and loyalty to Him as the Lord of all.

In a situation where biblical scholars are failing to reach the Church, and in a world where communication has broken down between it and theologians, as well as between them and the Church, theologians need to reexamine their methodology and vocabulary and they must be honest about this. They should ask themselves whether they are being bogged down by modernism, or they are being actuated by the living, dynamic incarnate Christ. In a changing world, the Christian affirmation is that God is unchanging. However, there is need to recognize that our world is changing. There are epoch-making discoveries. Man's knowledge about himself, the physical universe and culture does undergo constant changes. Biblical scholarship must serve the society, the Church, and the changing world. Biblical scholars must not allow the findings of science and history of religion to become a snare in their confrontation with the world. As long as the source of the message is the living God, it cannot be out of date. The biblical scholar must see himself, first and foremost, as an apostle of Him who is the Truth and must, therefore, face all the facts about the Bible as we have them today. The Bible is a speaking book and where it has ceased to be such a book, the scholar is no longer communicating, because he has lost touch with both the word and the world.

The sum total of the Christian message is this: that God became incarnate in the historic Man, Jesus Christ. The New Testament world, which is said to be alien to the West of today, is not strange to the present African world. A Jesus emptied of all the supernaturalism that is associated with Him in the Gospels and with his disciples in the Acts of the Apostles will be meaningless and irrelevant in the African context. The concern for the truth and objectivity by scholars must not translate to the rejection of the Bible story and the inherited traditions of the Church.

Conclusion

In Conclusion, it is clear from all we have said above that the original Jesus is the One we read of in the Gospels and in the New Testament and Whose coming had been predicted by several prophets centuries before He was born. The Jesus of most of the various critics is fake. The Jesus they speak about has never lived. He exists only in the various hypotheses, classrooms and in their imagination. Their kind of Jesus is too weak and powerless to be the Jesus of Nazareth Who commands respect, worship and adoration. The original Jesus is the One proclaimed as the Redeemer and Saviour of mankind. He came to proclaim the gospel of freedom and "to preach the good news to the poor, to proclaim release to the captives ... and recovery of sight to the blind, to set at liberty those who are oppressed and to proclaim the acceptable year of the Lord" (Luke 4:16-19). It was for this reason that Jesus went to the cross. Through His death and resurrection, Jesus became triumphant over the power of sin, death and the forces of evil.

What does Jesus as the Redeemer mean in the context of Africa? We are quite familiar with wars, famine, political oppression, suppression and murders in Africa today. Not less than 40% of the annual budget of many African nations is spent on the purchase of arms, while education, agriculture and health receive much less emphasis. The arms are not meant for fighting external aggressors, but to suppress, maim and kill political opponents. Consequently, more than half of the total population of refugees in the world is Africans. In addition, all African countries are price takers. We have to sell at the price dictated to us for all our exported raw materials, and when these are turned to finished products, we buy at the price dictated. All these have combined with greed, mismanagement of national resources and avarice by most African leaders to impoverish the continent and cause economic decay. Oppression and political unrest have turned highly educated Africans to refugees in foreign lands, while the poor die helplessly in their thousands daily. The currencies have been heavily devalued in most African countries — in several places by well over 1,000%. Africa is fast becoming desolate and her children are fleeing their mother-land in their thousands on a daily basis to Europe, America and Asia, either as refugees or in search of comfort, security, peace and livelihood.

The ready-made Jesus, encased in a statue of wood or gold, enshrined in Cathedrals, endorsed by the Church doctrines, is quite often, not the real Jesus. The real Jesus is the love of God that creates the miracle of redemption and life in abundance in the midst of hopelessness. The real Jesus is the pain of God mingled with the pain of humanity, as clearly demonstrated on the cross. The real Jesus is the hope of redemption in places where people live in despair in the midst of death. The challenge of the incarnate Son of God proclaimed in the Gospels, in this multi-religious world, is that biblical scholars in Africa should look more deeply into the multi-religious, multicultural, multi-political and multi-colonial experience of Africa in order to see how Jesus can become incarnated as the life-giving Redeemer once again as it were, in the suffering of the peoples of the crisis-laden Africa, an Africa in serious agony.

How can we affirm in Africa and elsewhere that Jesus is the Redeemer in every sense of the word in the midst of growing affluence by far less than one percent of the population: where millions are deprived of the basic necessities of life like food, shelter, health care delivery, good drinking water, equal opportunity to education and the right to ancestral land through structural injustice and violence? Life that is abundantly given by God is being regularly diminished, distorted and destroyed by fellow citizens who constitute the ruling oligarchies in Africa. Millions are marginalized and oppressed politically and economically, and have become outcasts politically from their God-given land — millions to whom life seems to be a curse, rather than a blessing. But we are urged all the time to accept murder, injustice, oppression and political persecution as the will of God. Unless we have rapid changes and there is genuine repentance and a complete change of attitude by all concerned in and outside Africa, we may not, in many African nations, be too far away from a bloody revolution. People are hungry and angry. When the people rise up, all the arms in the world may not be able to suppress them.

The effective witness of the Church's faith in God is her tireless efforts in proclaiming the Gospel of freedom in Christ to all men for the transformation of the world through social change and by helping man to become his best. The confession of Jesus as Lord and Saviour ought to lead the confessors to work for the freedom of all men from poverty, ignorance, disease, and for liberation from all kinds of dehumanizing conditions of life, which are the griefs and anxieties of Africa. Jesus of Nazareth is where the poor and oppressed are, and wherever Jesus is, the Church ought to be found actively involved there. Biblical studies in Africa must emphasize the presence of Christ with the people who are struggling for a better life against the forces of injustice and oppression. Our scholarship must also show that Jesus continues to participate in the people's struggle to attain full humanity. Biblical studies in Africa must be at the service of the Church, the peoples of Africa, and humanity as a whole while, at the same time, serving as the motivating force for the mobilization of all who profess faith in Jesus Christ in the on-going struggles in Africa for freedom, self-identity and human dignity. Moreover, Christianity cannot be expected to think of abandoning to the powers of evil the great human society for which Christ died. Jesus loves and expects His followers to love humanity and seek to serve it as He did. The alleviation of human suffering and the achievement of abundant life for all have a primary claim on Christianity in Africa and elsewhere. This is why it is incumbent on every Christian to strive hard towards the elimination of all causes of suffering and deprivation, and achieve liberation for all victims of social injustice and misfortunes.

The woes of Africa are due to the selfishness, greediness, visionlessness and planlessness of our leaders, especially in a situation where the self-interest of the leaders has become the national interest. In collusion with foreign partners, our leaders divert most of the money made from our export into their private accounts, which money directly aids the economy of the receiving nations, while the continent becomes poorer and poorer by the day. Can it be true that some of the loans given to the Third World' countries are from the ill-gotten gains of their

leaders stacked away in their secret accounts in Asia, Europe and America? Some of the loans themselves are fictitious and are sometimes shared by the officials of the creditors and borrowing nations. When the economy is totally ruined, citizens are called upon by political leaders who are living in plenty, through the stolen wealth, to bear the pains of structural adjustment programmes and of regular currency devaluation as dictated by foreign creditors. What the present African leaders are doing is worse than what the chiefs who sold their brothers and sisters into slavery did in the 18th and 19th centuries. The current leaders are actually destroying the African soul and mortgaging Africa's future. Today, a large number of Africans and Asians are migrating to the West and this is putting untold pressure on the economy and labour market of those countries. Of course, they are partly responsible for the plight of Africans today because of the policy which allows ill-gotten wealth from the 'Third-World' leaders to be kept in their banks without question. This is likely to get worse as the economic and political situation saving deteriorates in Africa and Asia. And will this not amount to an indirect revival of the old slavery in Africa? Laws should be made to allow courts to investigate those suspected to have looted their nations' wealth, and if they are found guilty the money so looted should be repatriated to the accounts of those nations. This is more meaningful and practicable than the current campaign for reparation in Africa. Also, the Christian nations in the West must not only support the law against international fraud in order to support the poor nations in Africa and Asia, but must fight for the cancellation of current debts owed by the Third World countries. This will help those nations to begin life afresh. This will also reduce the unnecessary pressure on the economy of the Western nations. At the end, both sides will benefit.

Jesus knew what it is to be rejected by one's own people. He knew what it is to be arrested, brutally beaten, tried, condemned to death, and cruelly crucified. Jesus says: "I came that they may have life and that they may have it more abundantly". Theologians must see themselves as God's mouthpiece and agents of this abundant life. What we are saying is that the essence of the message of Jesus is as stated in 1902 by Dr. Mojola Agbebi: "The great essentials of Christian religion are that the lame walk, the lepers are cleansed, the deaf hear, the dead are raised up and the poor have the Gospel preached to them."⁴¹ Those are the words of the original Jesus who is the same yesterday, today and forever more.

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2

FROM GATEKEEPER TO GATEWAY: ASSESSMENT IN EDUCATION

'Wole Falayajo

Institute of Education

This is the fifth inaugural lecture from the Institute of Education. The first was given almost twenty years ago, (in 1979 to be precise) by Professor Yoloye. Others have been given by Professors Obayan, Bajah and Obemeata in 1982, 1988 and 1992 respectively. What an inaugural from the Institute of Education is going to focus on, is not easily given away like an inaugural from any of the other departments in the Faculty of Education. For example, an inaugural from the department of Educational Management will more likely than not address some issues in the planning and or administration of education. An inaugural from the Institute of education can address any of the areas of education which an inaugural from the Faculty of Education will address. In a sense, this is simply obvious, after all, whether from the Institute or the Faculty, we will still be talking about education. But the point I want to make is that the Institute of Education, being both an organized research and service unit in education, attracts staff with specialization in all the sub-fields of education. I do not intend to talk about what the Institute of Education is and what it does in this lecture but I will have cause much later on to put forward some views about how education (*Faculty and Institute*) should be structured in the Universities in the country.

Whenever I am in the midst of colleagues in the field of education. I always state that my field of specialization is Measurement and Evaluation without the prefix '*educational*', in the midst of a mixed group however, the need for that prefix is compelling lest I be taken for some kind of surveyor or something even worse!

The Nigerian educational enterprise is like a gigantic beast, which on close examination displays some healthy tissue, some diseased tissue, and some scare tissue. There is room for controversy about how healthy or sick the creature really is.

Pessimists will say that the creature's death is imminent and unavoidable. Optimists will say that the creature is not dying any faster than is natural, and will foresee a long and useful life for it. It is possible that the creature is not well enough understood for us to know how healthy or sick it is, however, it must be cherished for its contribution to Nigerian society. There is great need to help it to stay alive and improve its health, in order that those contributions may continue. Aware that the creature has trampled and destroyed as well as built, its virulent pathologies must be diagnosed and excised as quickly as possible. (Adopted from Cooley and Lohnes 1976).

This quotation very aptly provides a justification for the subspeciality in education referred to as educational evaluation. This lecture is focused on an area of educational evaluation — educational assessment. By way of preliminary remark, let me clarify the link between three commonly occurring terms in this field viz Measurement, Assessment and Evaluation. Measurement is the unidimensional operation of assigning numbers to the properties or characteristics of an object or entity; it is a quantification procedure. Assessment on the other hand is the process of collecting information on anything of interest for the purpose of taking decision on that thing. Evaluation on the other hand uses the information obtained from assessment and measurement to place a value or worth on an entity. This is the sense in which both assessment and measurement are subsumed under evaluation. I will therefore like to begin this lecture by a discussion of some issues in educational evaluation.

All public institutions providing one kind of social service or the other are usually expected to provide '**proof**' of their legitimacy or effectiveness in order to continue to receive public support. The intensity of demand for proof and what will constitute acceptable proof will depend on the nature of the relationship between society and the public institution. In the words of Suchman (1963) "*In general, a balance will be struck between faith and fact, reflecting the degree of man's respect for authority and tradition within the particular system versus his scepticism and desire for tangible "proofs of work"*".

What is Educational Evaluation?

There are as many definitions of evaluation as there are people who care to attempt a definition. Some will offer a conceptual definition by saying that evaluation is the process of determining the value or amount of success in achieving a predetermined objective; or the procedures of fact-finding about the results of planned social action (*Hyman, Herbert H 1982*). If one goes further to state that this process includes formulation of objective, identification of proper criteria to be used for measuring success, determination and explanation of the degree of success and recommendations for further programme activity, then one would have provided an operational definition of evaluation (*Suchman op cit*). The range or variation in these definitions is captured in the comprehensive characterization of 'evaluation as **the determination** (whether based on opinions,

records, subjective or objective data) of **the results** (whether desirable or undesirable, transient or permanent; immediate or delayed) **attained by some activity** (whether a programme, or part of a programme) designed to accomplish **some valued goal or objective** (whether immediate, intermediate or ultimate).

The key elements in this characterization are: determination which represents the process; results which are the criteria; activity which is the social intervention and value which stands for the objective. From the above characterization of evaluation, it would appear fairly obvious why there should be such a field as evaluation of social intervention programmes. But in reality, educational evaluation did not come to its own as a field of scholarly discipline until very recently when compared with other sub-disciplines in education. For example, courses in educational evaluation and testing (*a component of evaluation*) were introduced into pre-service teacher education programmes in this country only in the early seventies.

Approaches to Evaluation otherwise known as Models of Evaluation

Different approaches (*which are complementary rather than competing*) have been adopted by evaluators in carrying out their assignments. The first approach which was spearheaded by Tyler (1950) was that which saw evaluation as a way of finding out the extent to which programme objectives are being achieved. In its original formulation this approach was considered rather static. Later improvements to the Tyler's model such as the Stake (1967) model introduced some important components. These components were such as to make it possible not only to document the attainment or nonattainment of the programme objectives but also to be able to **explain** why the objectives were or were not achieved. Scriven (1967) observed that decisions about a programme can be taken not only at the completion of the programme but also while the programme is still in progress; this gave rise to his famous formative and summative evaluation model. Stufflebeam (1971) and Dave (1973) introduced the idea of context or environment in which programmes are operated into the components which evaluators have to take into account in the evaluation of programmes.

All these models have been summarized as falling into one of two categories — the Engineering model as typified by all the input-output models and their variants and the Medical model as exemplified by the Scriven's (1967) formative-summative evaluation model. On a lighter mood, we have been able to identify some '**Home-grown**' models variously referred to as the '**Firebrigade**' model, the '**panic**' model, the '**kiakia-bus**' model and the '**push me I push you**' model. The label of '**firebrigade**' captures the essence of what typifies these so-called models: An educational crisis occurs, a group is mobilized to put down (this crisis and investigate both the immediate and remote causes and suggest remedies. As you may have guessed, what I am talking about here are the various commissions of inquiry, investigation panels and national conferences (*both sovereign and non-sovereign*) which are usually set up whenever some malfunctioning or inadequacy is observed in our educational system. Such gatherings are usually followed by **blue**-prints and **white**-papers and **green**-lights for implementation. This seems to be our own '**home grown**' approach to

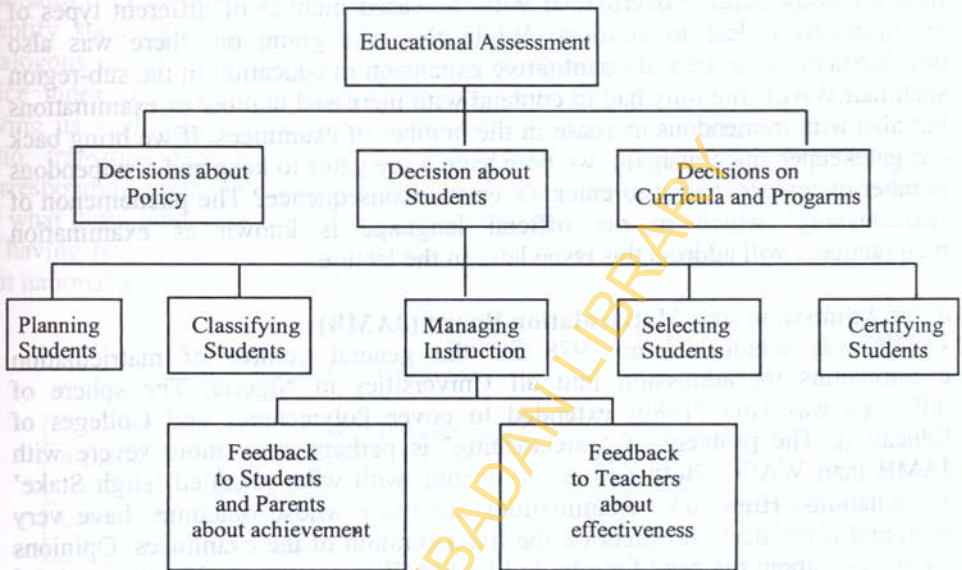
educational evaluation. I have now provided the general background for this lecture on assessment in education.

My Excursion into Educational Assessment

In 1977, I made a presentation to the conference of Principals of Secondary Schools in the old Bendel State. In that presentation, I argued on how the practice of continuous assessment can promote more meaningful learning and also how it can potentially minimize the problem of examination malpractice. Most of us will recall that the year 1977 witnessed an unprecedented scale of examination leakages which necessitated the setting up of the *Sogbetun Tribunal*. The use of continuous assessment in schools was one of the recommendations of that *Tribunal*. Also the National Policy on Education which was published that same year specifically had the use of continuous assessment in schools as a matter of policy. Part of the implementation strategy of the then new education policy was a programme to popularize the new approach to assessment of students. A Committee was set up under the auspices of the Evaluation unit of the Federal Ministry of Education. This committee produced a handbook and my contribution to that handbook was a chapter on "*Operating the System*" (Falayajo 1983). This chapter was later elaborated upon at a seminar given at the monthly seminar of the West African Examinations Council (WAEC). That presentation took the form of a formal proposal for the initiation of a National Assessment of Educational Achievement programme as the national equivalent of operating continuous assessment at the classroom level. To my mind, establishing a National Assessment programme in the country then, would have been the educational analogue of the call for a maintenance culture in the country at that time. Several attempts were made to sell the idea of National Assessment of Educational Achievement in Nigeria from 1983 with virtually no success. Then suddenly in 1994, I was invited by UNICEF Lagos to lead a technical committee to propose and execute a project on Monitoring of Learning Achievement (*MLA*). Not only did I regard this invitation as a unique opportunity but also as 'an important landmark in my career. The greater part of this lecture will be on National Assessment of Educational Achievement or Monitoring of Learning Achievement, to call it by its new (UNESCO/UNICEF) name. But before I do this, let us recall what we may regard as the working definition of assessment given at the beginning of this lecture: the process of collecting information for the purpose of taking decision. The following figure shows the kind of educational decisions which can be supported by educational assessment.

As the Figure shows, there are three categories of decisions which can be influenced by assessment data - decisions about policy issues, students and curriculum/programmes. The main reason why the figure was only extended beyond the decisions about students is to underscore my main concern about using assessments to positively influence students' learning. Assessments can and do act as gatekeepers to learning.

EDUCATIONAL DECISIONS SUPPORTED BY EDUCATIONAL ASSESSMENT

**Institutions which use Assessment as Gatekeeper in Nigeria**

The normal function of a gate is to keep out 'intruders' or uninvited persons from a restricted area. We do quite often put a person at the gate (a *gatekeeper*) to enforce the restriction order. The two commonest uses of assessment in this are country for selection and certification of students. For certification purposes, there seems to be an unwritten law that all students cannot pass, hence, only those who qualify to pass will be allowed in by the gatekeeper. Similarly, in selection, there is always a limited number of places to which people can be selected; again there is a fierce looking gatekeeper who does not allow the 'weaklings' to pass through. As of now, there are four officially designated 'gatekeepers' stationed at different strategic locations in the Nigerian educational estate: The Joint Admissions and Matriculation Board (*JAMB*), the West African Examinations Council (*WAEC*), the National Business and Technical Examinations Board (*NABTEB*) and the National Board for Educational Measurement (*NBEM*). *JAMB* deals with selection at the tertiary level, *WAEC* deals with certification at the secondary level, it also does aptitude testing for some establishments for job selection. *NABTEB* deals with selection and certification at the secondary level and *NBEM* deals with selection from primary level and certification at the junior secondary level. A few comments about these organizations might be in place at this point.

West African Examinations Council (WAEC)

This is the oldest examinations body in the country. It was established in 1952. It was charged with the responsibility of conducting examinations required in the

public interest in West Africa and to award certificates equivalent in standard to those of similar examination Boards in the United Kingdom. In the course of time the body became overloaded with increased number of different types of examinations it had to conduct. While this was going on, there was also development in the area of quantitative expansion in education in the sub-region such that WAEC not only had to contend with increased number of examinations but also with tremendous increase in the number of examinees. If we bring back our gatekeeper analogy again, we now have more gates to keep and a stupendous number of 'guests' trying to enter the estate. Consequence? The phenomenon of 'gatecrashing' which in the official language is known as examination malpractice. I will address this issue later in the lecture.

Joint Admissions and Matriculation Board (JAMB)

JAMB was established in 1978 for the general control of matriculation examinations for admission into all Universities in Nigeria. The sphere of influence was later (1989) extended to cover Polytechnics and Colleges of Education. The problem of 'gatecrashing' is perhaps even more severe with JAMB than WAEC. Both bodies are dealing with what is called 'High Stake' examinations. High stake examinations are those whose outcomes have very profound if not decisive effect on the life aspiration of the examinees. Opinions are divided about the need for a body like JAMB in a country which is supposed to be a Federation. My own opinion is that JAMB should not have been created in the first place.

Apart from its role being likened to that of a gatekeeper, it is also an unnecessary bottleneck in transition to the tertiary level of education. But having been created, I will say do not scrap it as I can think of a more educationally useful job for it to do than what it is doing now. I will suggest *this* later.

Educational outcomes as measured by the performance of students in public examinations have remained the main source of information about the performance of the Nigerian educational systems for a long time. It is on the information from this source that the public usually makes such comments as "*the standard of education is falling*" or "*the performance in this year is better or worse than that of last year*". We know that the main purpose of public examinations is to assess the performance of individual students out of a population of students from a given cohort. There are a number of reasons which I will go into presently why the kind of comments mentioned above may be quite misleading. Public examinations are not designed to warrant such comments. The point of view I want to argue for in this lecture is that there is an alternative approach to the assessment of educational outcomes which is specifically designed to warrant such comments. This alternative approach is referred to as **National Assessment**. While public examinations are concerned with measuring the knowledge and skills of individual students, national assessment is a form of parameter estimation for a whole education system or part of it (*for example, a state or a local government area*). Such a parameter is aimed at providing information about the nature and extent of existing conditions in the educational system. It may be the conditions of the inputs, the process and/or the outputs. If

national assessment involves parameter estimation, the monitoring of these parameters is a logical extension. In other words, following the trends in the estimates over time is a necessary part of national assessment. The index used to identify such trends is quite often referred to as an educational indicator - analogous to such economic indicators as gross national product or consumer price index. Educational Management has, for a long-time, concentrated on giving us such educational macro indicators as enrolment ratio, pupil/teacher ratio, transition rate etc. There has been little or no effort at establishing corresponding micro indicators for education. Such micro indicators will report on what those who have passed through the educational system can do as a result of having been exposed to say x number of years of education. This is the gap that national assessment has to fill.

Table 1
Differences between national assessment and examination

	National Assessment	Examinations
Administered to	A sample of students	Population of students
Level of Report	School, Local, State or Nation	Individual students
Frequency	Every 2 or 3 years per subject	Every year
Subjects tested	Math (Numeracy) Marking, Writing (Literacy) Science	All in Curriculum
Administered at	Usually one class per cycle (e.g. Primary 4, JSS2, SS3)	End of schooling cycle

Source: Adapted from 'Testing to Learn - Learning to Test' by Joanne Capper 1996

Assessments of any type, even at the best of times and with the best of intentions put people in a very stressful position. The amount of stress seems to be directly proportional to the value of what is at stake. National examinations (*which are all high stake examinations*) are very stressful to the examinees. I have a friend who fears three things -soldiers (*for obvious reasons*), water (*he cannot swim*) and examinations (he is always afraid he might fail particularly if there are figures involved). Can you then imagine the state of stress he was under when he was being interviewed by a naval officer - a symbolic figure for all the three objects of his fear!!

It is always doubtful whether a student can give a good account of what he/she knows and can do under this stressful condition. National examinations are also not known for being concerned with the improvement of learning among students. Infact, on the contrary, they are better known for restricting students learning to just those things that are examined which usually fall short of all that students are expected to know. It is as if the message being passed on to the students by the examining bodies is "*If you want to give yourself a chance of passing through our narrow gate, you better shed all excess baggage!*"

National assessment which is a policy oriented approach to assessment of students, is focused on the improvement of learning among students. In the first place, the detailed specification of what students are expected to know and how these will be assessed give a sharp focus to the efforts of both teachers and students; also national assessment covers all that have been specified as expected competencies during any cycle of administration. It does this by using the matrix sampling technique. Most important of all, national assessment results are reported in such a way that guides instructional improvement. This is why we will like to claim that the national assessment approach to evaluation of the performance of an educational system serves as a gateway to giving proper education to our students and not just preparing them to be allowed into the educational estate by the gatekeepers.

We will now address the efforts we have made to introduce the adoption of national assessment in the country. In the first place, there was no financial grant, to execute a national programme and so what we did was to adopt a piecemeal approach. The first study was not actually designed by us. It came as a result of the membership of our Institute of Education in the International Association for the Evaluation of Educational Achievement (IEA). There was a survey of the level of achievement of form three students in Mathematics in about twenty countries which included Nigeria. The Nigerian participation was coordinated by me (Falayajo 1983). This study covered only ten states in the Southern part of Nigeria. An extension of the study to form five (*last year of Secondary education*) was carried out for Oyo State by one of my doctoral students (Osafehinti 1984). This study was carried out to demonstrate the fact that in a Federal System as we have in Nigeria, just as we can have a national assessment programme so also can we have State assessment programmes going on concurrently. There were other IEA studies which were all co-ordinated from the Institute. I also got another doctoral student of mine to carry out a longitudinal study of achievement in mathematics i.e. following a group of form one students through form two to form three in some selected schools in Ondo State (Faparusi 1987). Since instrumentation is one of the critical issues in national assessment, some I.C.E.E. students have developed cognitive instruments for different levels of senior secondary schools in mathematics and science subjects (see Farombi 1990, Onwuakpa 1990, Abdulraifu 1991, for their masters degree projects).

Some Results and Observations

The analyses used in these studies vary quite considerably. They range from purely descriptive accounts to some fairly sophisticated multivariate analyses. Our intention here is not to go into the details of such analyses but rather to highlight some of the types of reporting which were done. In this approach to assessment which we are trying to illustrate, this wide range of analytic procedures is to be expected. Reports are made to different groups of audience. The results we want to show here are the type that will be easily meaningful to teachers, administrators, and policy makers. It is also important to bear in mind that the sort of things we will be reporting on are those features of schools,

teachers and students which tend to change over time and for which reason the trends of such changes should be monitored.

Some Demographic Information about Schools and Students

A systematic monitoring system of an educational system provides an opportunity for collecting demographic data on the system. Information like age, distribution of students and teachers, parents, level of education and occupation, distribution of schools in urban and rural areas etc. can easily be collected under a non-politicized atmosphere thus ensuring more reliable and valid data. For example in the IEA study, the age range of students in form 3 was found to be between about 12 years and 20 years with a mean of 16.4 years and standard deviation of 1.8. In the longitudinal study, the modal age was 13 for form 1 and 14 for form 2. But there were 10 year-olds in form 1 (3.2%) and also 16 year-olds (4.4%) in the same class. The same pattern was noticeable in form 2. Our IEA study sample contained 70.6% boys and 26.4% girls while the longitudinal study sample contained 52.3% boys and 47.7% girls. The rate of women participation in education is certainly a very important issue which any nation should keep under constant observation. Students' home background is an important variable which affects their achievement – parents, level of education, parents, occupation etc. are also important. Suppose we take a survey today of the level of education of parents of children in our primary schools; will there be a noticeable difference across the states of the Federation? In the IEA study we did not carry out such a state by state analysis, but we did gather information on this variable for the whole sample and the finding is as shown below.

Parents' Level of Education

Level of Education	% Fathers		% Mothers	
	IEA	Longitudinal	IEA	Longitudinal
Little or none	17.6	25.0	28.6	29.8
Primary	25.8	28.2	31.7	31.3
Secondary	23.9	21.8	21.9	22.4
University	28.8	25.0	13.6	16.5

The occupational categories of these parents were also obtained. The result of the IEA and the longitudinal are given here separately because of differences in categorization. The longitudinal one is of more interest to us.

PARENTS' OCCUPATION (IEA STUDY)		
Category	% Fathers	% Mothers
Unskilled	12.0	2.6
Semi-Skilled	7.9	3.7
Skilled Lower	12.5	10.9
Skilled upper	1.2	2.0
Clerical lower	20.1	5.0
Clerical upper	4.3	1.6
Managerial lower	27.1	38.3
Managerial Upper	5.3	1.2

PARENTS' OCCUPATION (LONGITUDINAL STUDY)				
Category	FORM 1		FORM 2	
	% Fathers	% Mothers	% Fathers	% Mothers
Unskilled	1.2	1.9	0.1	1.3
Semi-Skilled	10.7	8.6	9.3	8.9
Skilled	1.0	0.5	4.0	2.4
Traders	10.0	56.7	10.0	56.9
Farmers	54.3	18.6	49.7	15.0
Professional	22.8	13.7	26.8	15.2

The kind of information that one can get out of survey of the type we have in the longitudinal study should be of particular interest to a society that claims to be or aspires to become egalitarian. Imagine what could be revealed if this kind of break down of students by parental education and occupation is carried out for our unity schools! We shouldn't be surprised if it happens to be the children of a class of Nigerians who are being united. Trend may not be noticeable yet in the two years covered by our longitudinal study; but notice that the percentage of farmers children moving from form 1 to 2 has dropped by 4% while those of professionals has increased by about the same amount. In the form five study which was carried out in Oyo State, the percentage of students with fathers having post secondary or University education was 47.7, while those with fathers who are upper clerical to upper managerial i.e. mainly professional, the percentage was 48.4 but remember that Nigeria is a predominantly an agrarian country.

Report on How Much Has Been Learnt at School

Recall that a central aim of the assessment programme we are advocating is to be able to say how much of a certain content area of the school curriculum has been learnt by how many of the students. Mathematics is the content area used in all the studies we carried out. What we will like to show here is the level of the detailed analysis possible. In all the studies, the summary answer to the central question of how much mathematics Nigerian students know is fairly unequivocal -very little. This itself is no news since WAEC tells us that much every year judging from the failure rate in the subject. But we will start getting alarmed

when we come to the details of the tasks these students cannot perform after about 10 years of exposure to mathematics. For example in the form 5 study in Oyo State, students were asked to find the value of $0.213+4.001-2.1$ and only 3.4% of the sampled students could answer this correctly. In 11 of the 40 sampled schools, no student could give a correct solution. This item could easily appear in a national or state common entrance examination for admission into secondary schools.

The concept of prime members and prime factors comes up in primary schools and it is also encountered in the early forms of secondary schools. Yet at the end of form five when students were asked to find the prime factors of 84, only 0.6% of the sampled students could do so. In 33 out of the 40 schools not one single student could give a correct answer.

The following table shows the kind of summary result we obtained in the IEA study.

Subtest	Number of Items	Mean	S.D.	Average Difficulty	Reliability
Arithmetic	46	17.7(38.5)	7.5	38	83
Algebra	40	12.5(31.3)	5.5	31	72
Geometry	48	13.2(27.5)	5.4	27	68
Measurement	24	13.2(28.8)	2.9	28	45
Statistics	18	6.0(33.3)	2.4	32	30
TOTAL	176	56.4(32.0)	23.8	32	94

By way of comparison, the other country whose results are as bad as the above is Swaziland - another developing country.

We also produce below some items with different levels of difficulty.

- 1054 865	% Responses
A 189	*A 78.6
B 199	B 6.1
C 211	C 3.6
D 289	D 1.9
E 299	E 1.7

168 x 45 is equal to	
A 1378	A 0.8
B 1458	B 0.6
C 5890	C 1.1
D 6290	D 8.1
E 7290	*E 87.7

What is the capacity of a cubic container 10cm by 10 cm ²	
A 1 Litre	*A 5.7
B 10 Litres	B 9.1
C 100 Litres	C 15.4
D 1000 Litres	D 24.0
E 10000 Litres	E 41.1

These three items are not likely to be included in a regular examination paper because the first two will be considered too easy and the third too difficult. In national assessment, they are very informative; we want to know those tasks which almost everybody can perform as well as those only few can perform.

In deciding on the subdivisions of mathematics to use for analysis, we have used the conventional ones for our IEA study analysis. But others are possible; for instance in the form V study we grouped items into “worded” and “non-worded” and found that performance on worded items was much poorer. We also correlated scores on worded items with the amount of English spoken at home and obtained a correlation of .72. These results clearly show a language component in the problem of poor performance in mathematics. This problem was discussed in Falayajo (1986) and it has surfaced again quite glaringly in Nigeria's first national assessment study as reported by Falayajo *et al* (1997).

Prototype of National Assessment for Nigeria

I have just described some of the piecemeal efforts which some of my colleagues and I have made to demonstrate the possibilities from a national assessment programme. In 1994, as I reported earlier, I had the good fortune of being asked to lead a team to propose and execute Nigeria's first national assessment of educational achievement exercise; it is this exercise that I am referring to as a prototype of national assessment for Nigeria. I have already discussed the following: the continuous assessment policy, our participation in the different IEA studies and the various studies referred to in the last section. These may be regarded as the national antecedents to the exercise. There are some international antecedents also which I do not want to go into here.

It is to be noted however that apart from the participation of the ICEE of our Institute of Education in the IEA studies, it is doubtful whether there are any African or indeed any developing country in which there is any programme of national assessment before the nineties. One can then understand the need for the workshop organized by the IAEA and World Bank on national assessment in Sub-Saharan Africa held in Nairobi, Kenya in January 1993.

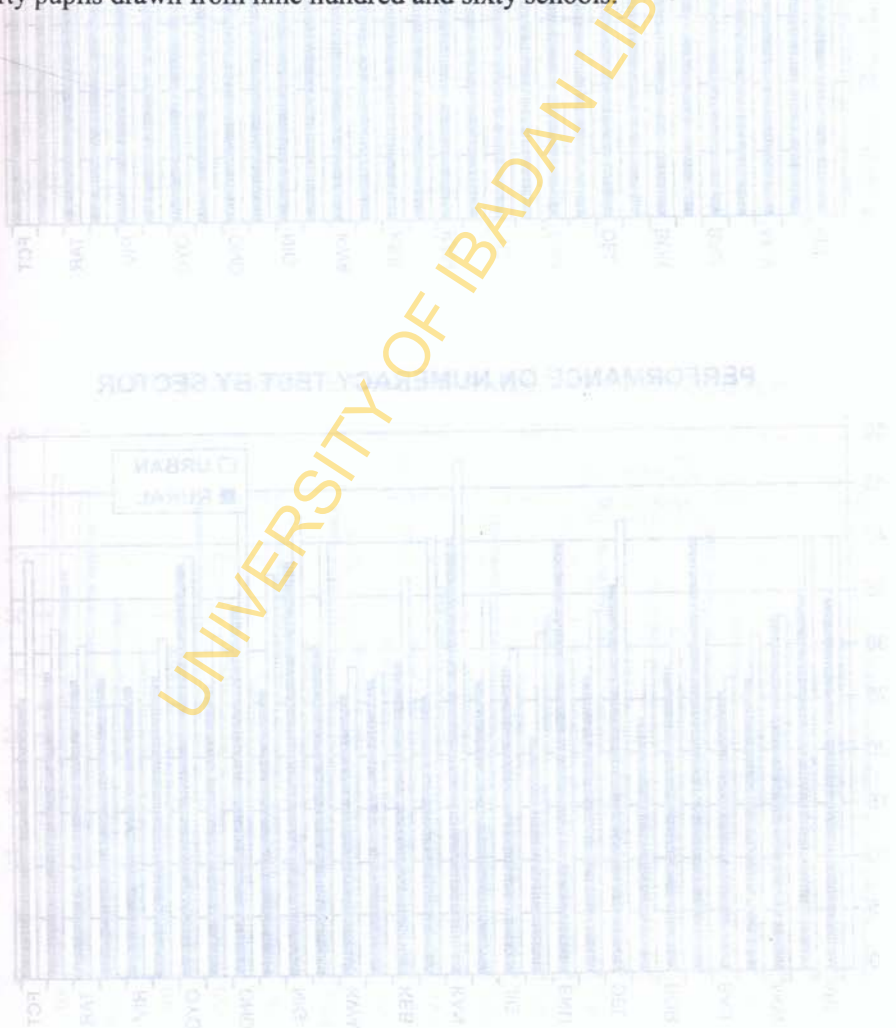
It is in the light of all the observations above that we will like to see the exercise which is being reported here as a prototype of a national assessment programme for Nigeria.

The objectives of the exercise were to:

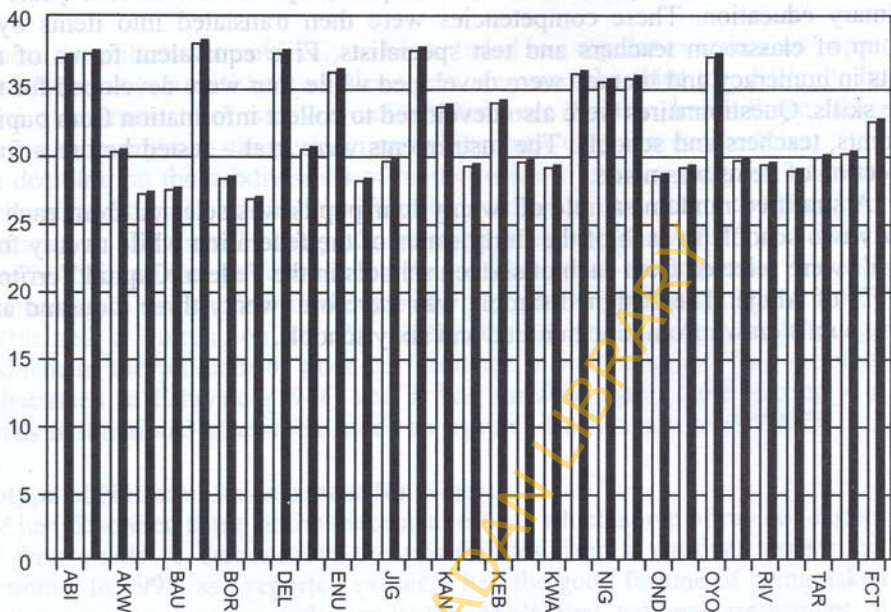
- assess the level of competency of primary four pupils in certain skills: numeracy, literacy and life skills.
- report on the competency by aggregating the pupils into subgroups: urban/rural, public/private and male/female
- collect information on contextual variables that may be used as explanatory variables for the level of competency acquired in the various skill areas.
- use the execution of the project to build capacity for monitoring of learning achievement or national assessment.

The national curriculum was used as guideline for drawing up the expected competencies which pupils should have acquired by the end of four years of primary education. These competencies were then translated into items by a group of classroom teachers and test specialists. Five equivalent forms of the tests in numeracy and literacy were developed while four were developed for the life skills. Questionnaires were also developed to collect information from pupils, parents, teachers and schools. The instruments were trial – tested before a final selection of items was made.

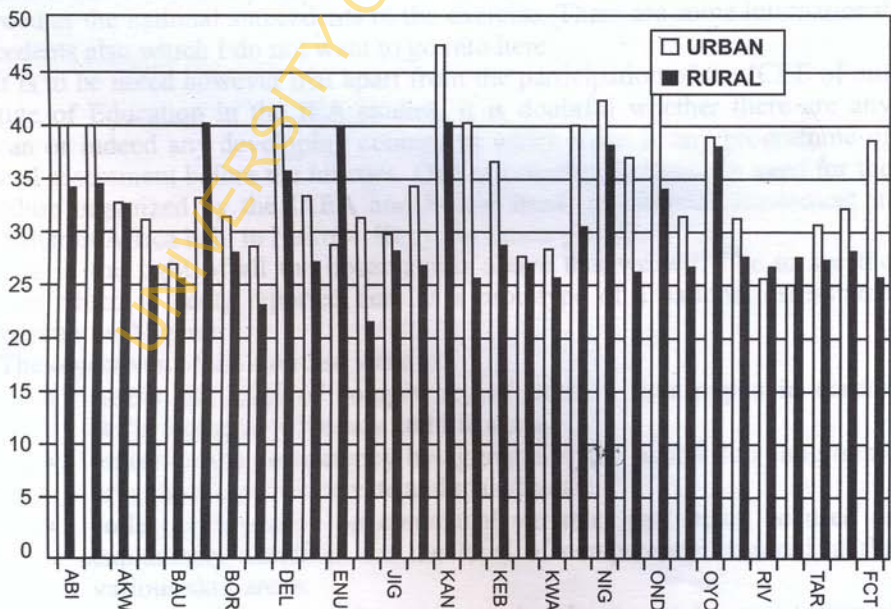
A stratified random sample of twenty four pupils was selected from each of thirty two schools in each of the thirty states of the federation while twenty four pupils were selected from each of sixteen schools in the Federal Capital Territory (FCT) of Abuja. The designed sample was therefore twenty three thousand and forty pupils drawn from nine hundred and sixty schools.



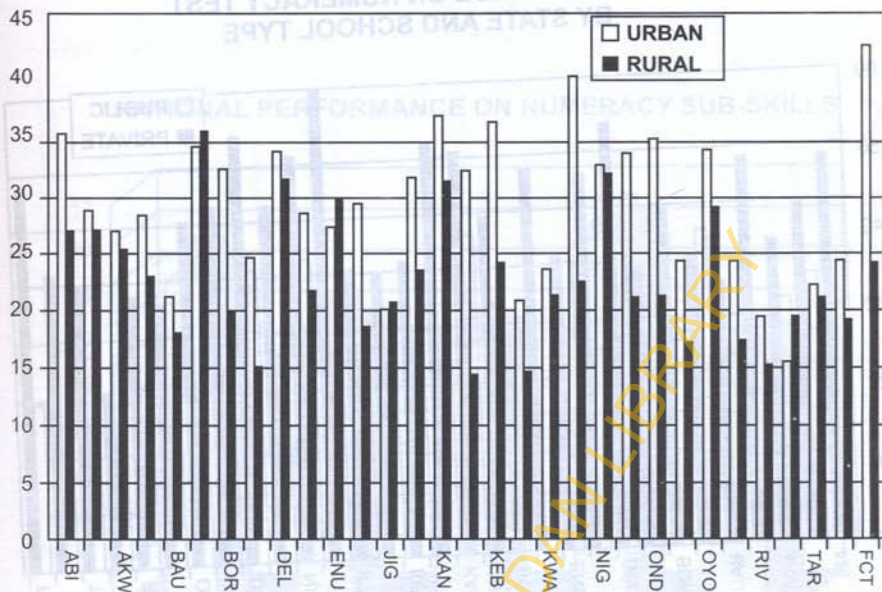
PERFORMANCE ON LIFE SKILLS TEST BY STATES



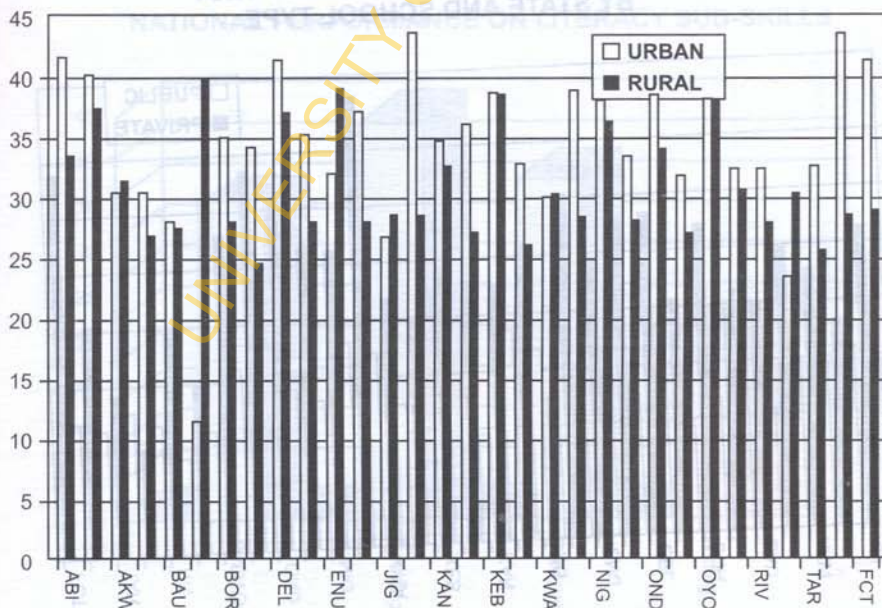
PERFORMANCE ON NUMERACY TEST BY SECTOR



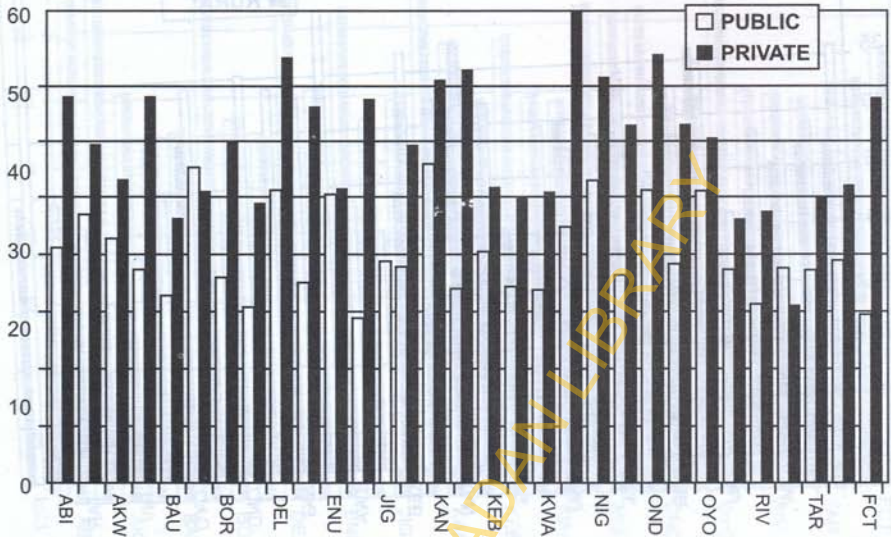
PERFORMANCE ON LITERACY TEST BY SECTOR



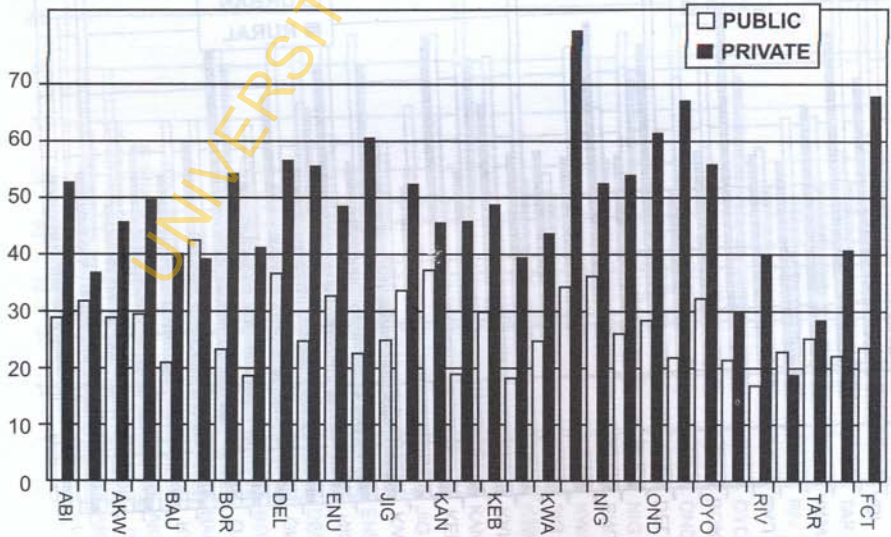
PERFORMANCE ON LIFE SKILLS TEST BY SECTOR



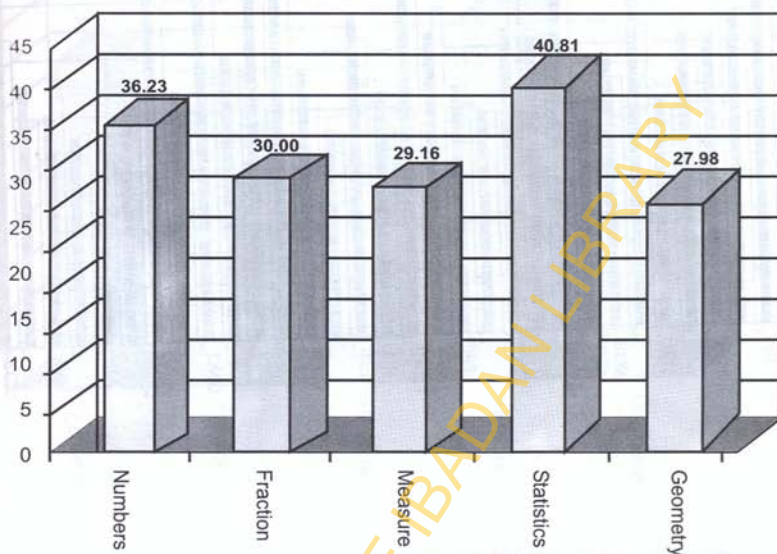
**PERFORMANCE ON NUMERACY TEST
BY STATE AND SCHOOL TYPE**



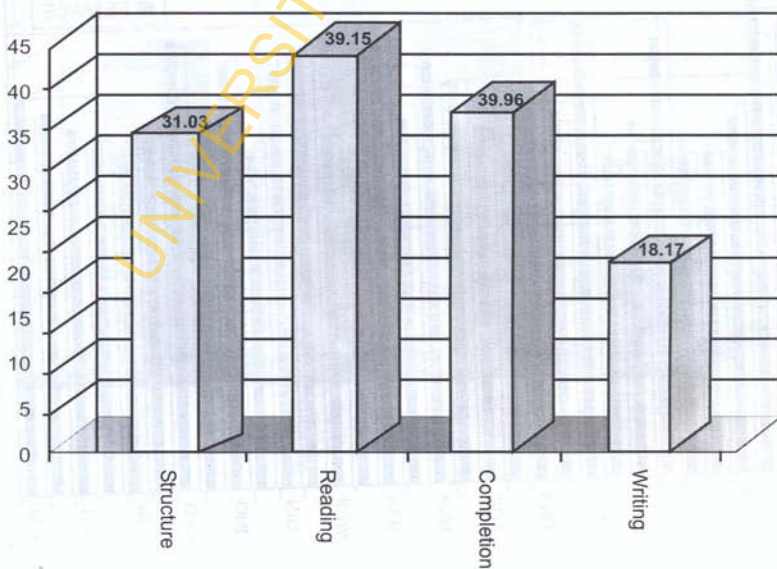
**PERFORMANCE ON NUMERACY TEST
BY STATE AND SCHOOL TYPE**



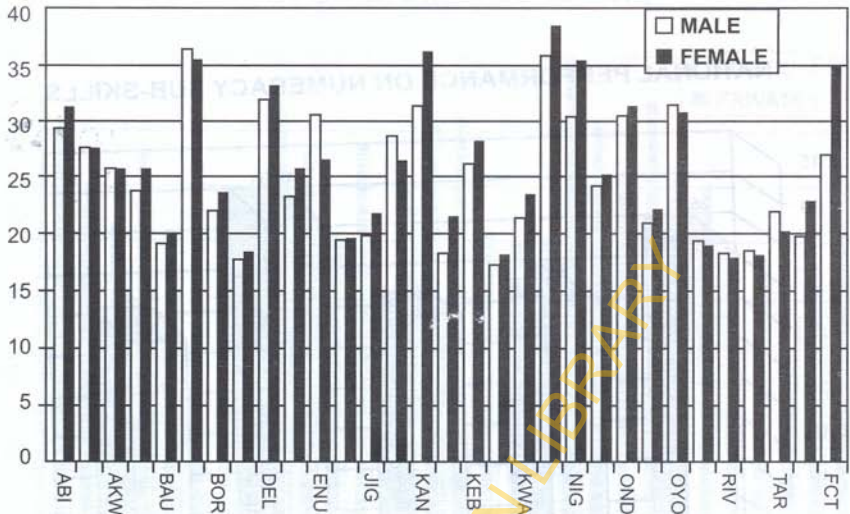
NATIONAL PERFORMANCE ON NUMERACY SUB-SKILLS



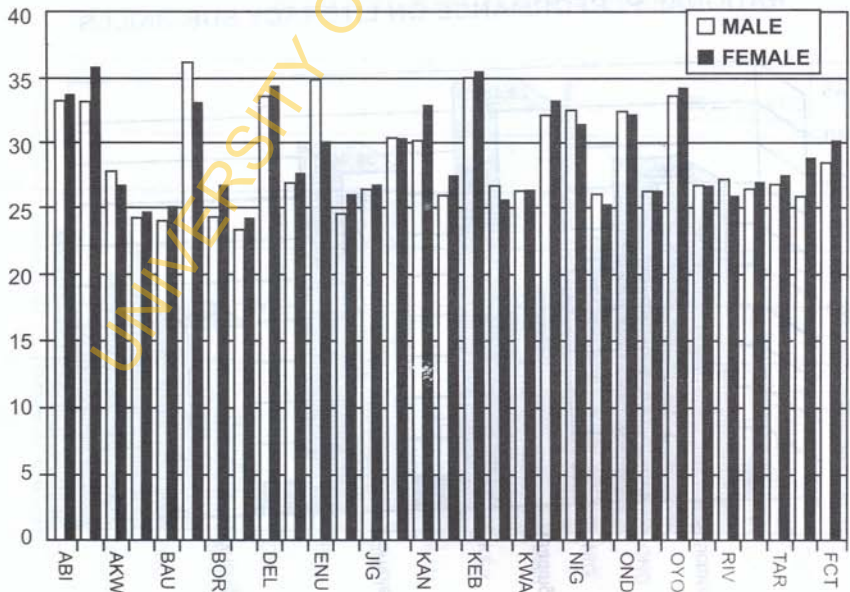
NATIONAL PERFORMANCE ON LITERACY SUB-SKILLS



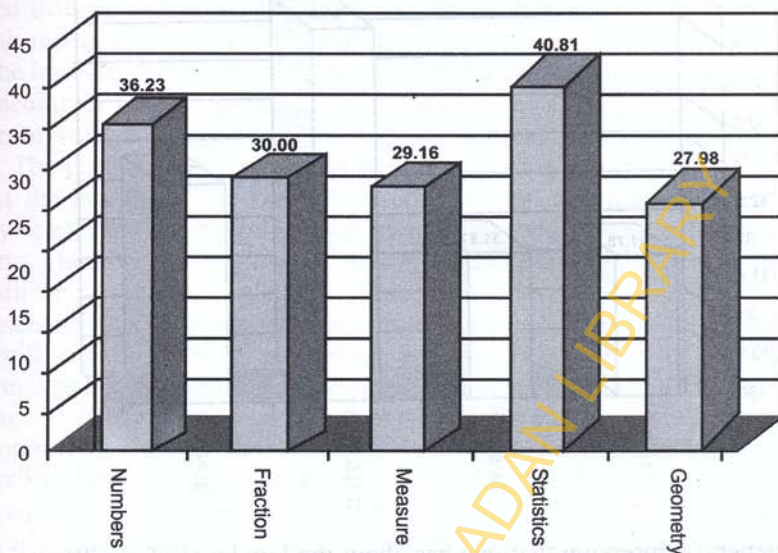
PERFORMANCE ON LITERACY TEST BY STATE AND GENDER



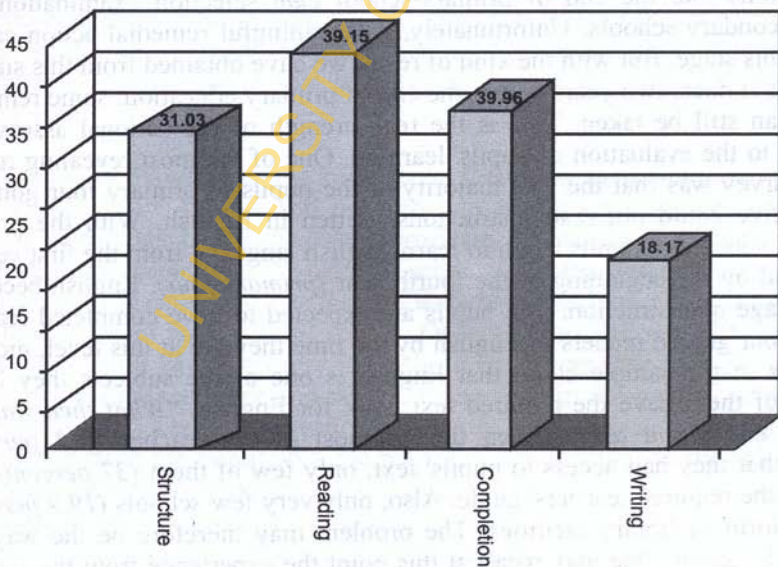
PERFORMANCE ON LIFE SKILLS TEST BY GENDER



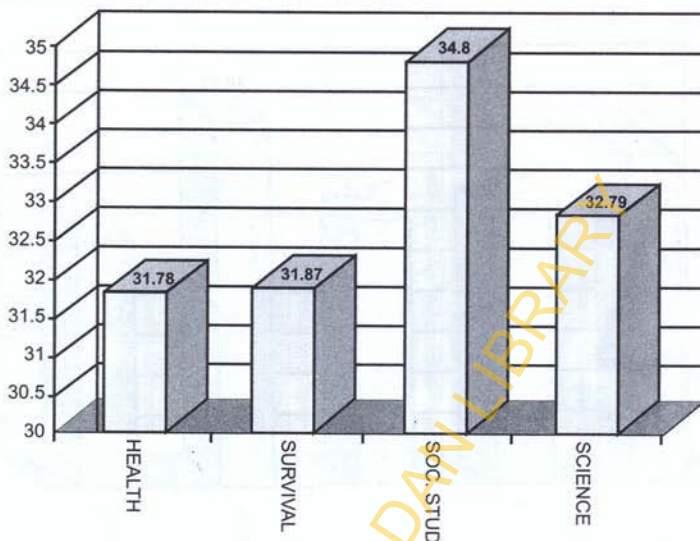
NATIONAL PERFORMANCE ON NUMERACY SUB-SKILLS



NATIONAL PERFORMANCE ON LITERACY SUB-SKILLS



NATIONAL PERFORMANCE ON SUB-SKILLS OF LIFE SKILLS TEST



The general impression that one has about the low level of pupil's attainment in cognitive skills at the end of primary education in Nigeria has been made quite understandable by results from this survey. Opinions are usually expressed about level of attainment of pupils after the publication of the results of public examinations like the end of primary-school *cum* selection examination into junior secondary schools. Unfortunately, no meaningful remedial action can be taken at this stage. But with the kind of result we have obtained from this survey; coming as it does, two years before the end of primary education, some remedial actions can still be taken. This is the real strength of the national assessment approach to the evaluation of pupils' learning. One of the most revealing results of this survey was that the vast majority of the pupils in primary four going to primary five could not read instructions written in English. With the present policy on education, pupils begin to learn English language from the first year in school and by the beginning of the fourth year (*primary four*), English becomes the language of instruction. The pupils are expected to have completed reading three or four graded readers in English by the time they are at this level, most of the pupils in the sample claim that English is one of the subjects they like, majority of them have the required text book for English. "What then was the problem, one might ask?" Even though most of the teachers (63 percent) reported that they had access to pupils' text, only few of them (37 percent) had access to the required teachers' guide. Also, only very few schools (19.9 percent) had any form of library facilities. The problem may therefore be the way the language is taught. One may recall at this point the experience from the famous Ife six year project on the use of mother tongue as language of instruction in all classes at the primary education level while English was taught as a subject. The

project team looked at the then existing programme for the teaching of English and found them unsatisfactory. The team therefore developed an enriched English language programme and trained the teachers who will use it. The result showed that the experimental group was better than the control pupils both in English and some of the other school subjects.

The lesson is therefore clear, that something quite drastic must be done about the teaching of English in our primary schools. For a start, even primary school teacher must have a copy of both the pupils' text and the accompanying teachers' guide. The teachers' guide must be written in such a way that it will be 'robust' against the quality of the teacher. In other words, any teacher, including low quality ones, can use the guide with reasonably good results in terms of pupils' learning. The effect of language (*English*) is noticeable in the performance in all the skill areas. For example in numeracy, any test item which had even the minimum amount of words in it constitutes a big problem for the pupils because they will not be able to read such an item. The result of this was that performance on such items was not better than chance performance. The effect of language on performance also came out strongly in the relational analyses carried out. Interest in English (*as indicated by English being reported as 'my best subject'*) and not finding any topic in English difficult show up as two of the best ten predictors of performance. It can be concluded from all of the above observations that the most urgent step to take in order to improve pupil performance in Primary schools in the country is some kind of '*Literacy Campaign*' in English Language.

Learning Environment

The questionnaires used in this survey provided information for '*painting a picture*' of the environment in which learning was taking place in the schools. Environment in this case should be taken to include the human, material and psychological.

The Teacher as Provider of the Immediate Learning Environment

Most schools in the sample (80 percent) had teachers with either a Teachers Grade II Certificate or the Nigeria Certificate in Education as the minimum qualification for teaching in the nation's schools. The teachers had an average of eleven years of teaching experience and have been teaching primary four for at least three years in their current school. One can therefore say that the typical primary four pupil in the country is likely to have a teacher with about eleven years of teaching experience and who has also been in the pupils' school for at least three years. These observations seem to be signals for expecting good performance from the pupils; but the reality of the situation in the schools was that pupils did not perform well. Again, one may ask, '*what went wrong?*' First of all, let us recall some of the results reported earlier in this write-up.

These '*experienced*' teachers do not usually have copies of either the recommended text books for pupils and/or the accompanying teachers' guides. Also, when an attempt was made to use some of the teacher variables to predict pupils' performance, no teacher variable featured among the best ten predictors

pupils' performance, no teacher variable featured among the best ten predictors of pupils' performance. There must therefore be something in between these teacher variables and the performance of their pupils. One obvious thing that comes to mind is the pattern of interaction between the teachers and their pupils i.e. the classroom practice of the teachers. Unfortunately, this was not covered by the present survey. The result was more or less implying that teachers do not make a difference; but one knows they do. The next survey must therefore include taking a sub sample of teachers whose classroom practices will be observed. From such classroom observations one may be able to identify those teacher practices which tend to promote learning and those which do not. Next to the classroom as learning environment, the whole school is the next factor that can facilitate or impede learning.

The School as a Facilitator of Learning

Schools can facilitate learning through both the human and material resources available in them. Schools must, as a first prerequisite for facilitating learning, provide a pleasant physical surrounding such that pupils will like coming to school. From the response to the pupils' questionnaire, pupils indicated that they love school. This must be in spite of the physical structures which our data collectors reported they saw during the field work. One cannot but note the sharp contrast between most of the privately owned schools and the public schools in terms of their physical structures and general surroundings.

The 'tone' of a school is generally determined by the effectiveness of the leadership of the school. Most of the headteachers in the sampled schools had either the Nigeria Certificate in Education (NCE) (49.6 percent) or the Associateship Certificate in Education (ACE) (18.6 percent) and they were mostly very experienced teachers. Most schools did not have the necessary facilities for effective learning. The few schools which had libraries, laboratories and other special rooms tended to be private schools. Less than half of the schools had such necessary materials for record keeping as School Diaries, Continuous Assessment Record Books etc. Most head-teachers reported that poor conditions of service and irregular payment of salary are some of the most serious problems they have to contend with. The general picture that emerges from the above scenario is that our schools did not provide conducive environment for learning. It is on the basis of some of these observations that the World Bank has come in with some loan to revamp the whole of the primary education sector. Most of the loan is expected to go into the production of text books and their distribution, effective supervision of the schools, development of assessment instruments for monitoring learning achievement in the schools and improvement of the managerial skills of the headteachers of the schools.

The Home's Enabling Role For Pupils' Learning Achievement

The role of the home in providing an enabling environment for pupils to achieve cannot be over emphasized. The home must provide the material needs of the pupils; the home must ensure that the pupils are in good health by making sure that they are well fed and that they receive proper medical attention when

environment for the pupils. Parent's level of education; amount of books available in the home and presence of such gadgets as radio and television are some of the factors that make for this enabling environment. In this survey, most parents reported that they provided exercise books and writing materials for their wards, but many did not provide text books.

Many of the parents also arranged for their wards to have extra help with their school work after school hours, there was every indication that many parents tried to give support to their wards, but there were still quite a number who were not quite supportive. Some headteachers reported lack of interest on the part of some parents (27.4 percent) leading to outright withdrawal of the pupils from school in some cases (22.9 percent). Pupils in rural schools gave 'sickness' as the major reason for being absent from school. In the final analysis, it is the home that will decide which children will come to school and which ones will not. This is particularly true in a country like Nigeria where there is still some ambivalence as to whether primary education is compulsory or not. The official policy (*which is almost twenty years old*) stipulates that primary education shall be free and compulsory as soon as possible. There are however, no sanctions put in place which will handle cases of those who do not send their children to school.

Miscellaneous Matters Arising

I will like to end this lecture by bringing up some issues either as matters arising directly from the lecture or as related matters. I have in the course of the lecture tried to compare national examinations with national assessment bringing out the essential differences I hope I have not created the impression that one can be substituted for the other; this is not possible. What we are trying to present is an approach to assessment (*national assessment*) which will profitably complement the other (*national examination*) in providing the educational system with a rich database for decision making. National examination will always be with us. But as it is now it is bedevilled with a big problem which is threatening the integrity of the whole educational system.

The Problem of Examination Malpractice

This is a problem that, to most people has defied all attempted solutions. It appears candidates are always a step ahead of those seeking solutions to the problem. A very comprehensive study of this problem was undertaken by Uwadiae (1996) showing the multidimensional nature of the problem. The bottom line to the problem of examination malpractice, most writers on the subject agree, is what we may call the low level of learning that now takes place in our educational institutions. The immediate consequence of this situation is lack of self confidence on the part of the students. The question then is why is there little learning taking place in our schools? I will suggest three major reasons: there is very little time being devoted to learning; the resources for ensuring that some learning will take place are not present in most cases and most teachers are not very competent. Any attempt to tackle the phenomenon of

examination malpractice must first address these three basic issues. I will talk about the teacher component of the solution presently.

The attempted solutions to examination malpractice can be classified as follows:

- Legal - decrees have been promulgated and suggestions have been made about reviewing the decrees to make prosecution of offenders easier.
- Moral - there is now in place an examination ethics project. I am not well informed about the activities of that project.
- Security Measures - this is the earliest of the solutions and the students seem to have beaten the security outfits hands down by their sheer ingenuity in devising new approaches.

Curiously enough, there doesn't seem to have been what I will call a professional solution yet attempted — the *'testing profession'* if we can call it that. This solution involves the use of multiple forms of each examination paper which will be randomly assigned to candidates in the examination hall. Each paper may have as many as four equivalent forms going on at the same time such that candidates sitting together will be working on different forms and no candidate will have a foreknowledge of which form he/she will be working on. The equivalence of the different forms will have been established at the test development stage. The use of equivalent forms is the standard procedure we used in the IEA studies and the prototype national assessment study discussed earlier. Of course, we were constrained to use this procedure for a reason different from trying to prevent malpractice.

Another professional approach is to revisit the practice of continuous assessment (CA) in schools. The original intention for CA was that if students know that what they do at school will count towards their final assessment, the urge to cheat at the final examination will be reduced somewhat. There was a rider to the combination of internal and external assessment - the performance on the external examination must not be below a certain level before the candidate can have an overall pass. This rider was adopted to forestall the envisaged problem of inflating the internal assessment scores. Some studies were also done on the problem of finding appropriate weighting for internal and external assessment (Bandeley 1984), Falayajo (1988). Teachers are expected to be assisted by the provision of standardized instruments made available at a central location which they can use to improve the quality of their internal assessments (Ojerinde and Falayajo 1983).

Teacher Education

Teachers constitute one of the pivots of any educational system; consequently the education of teachers is a serious issue whenever we are thinking of improving that system. In our discussion of the results of the prototype national assessment study, we mentioned the need to reinforce the competence of teachers in the teaching of English and Mathematics by providing them with comprehensive teachers' editions of the pupils textbooks. This of course is an adhoc and piec-

meal approach to the problem. The big problem really is that our teachers are no longer being well trained to do the work they are expected to do in school. The professional nature of the preparation of teachers seems to have at best taken the second place in the scheme of things. Teachers who are being prepared to teach in primary schools may never have seen the primary school curriculum guidelines (*let alone have a copy*) before stepping into the classroom. The situation of those being prepared for the secondary schools (*the popular B.Ed teachers*) is even worse. Some of them may not have stood in front of a class for ten days before being absolved into the teaching force. There is a need for a complete restructuring of the content of the programme of the preparation of prospective primary school teachers. I am here referring to the NCE programmes. All NCE programmes must be completely targeted at preparing primary school teachers. All the contents of this programme which presume that the NCE is a preparatory for University entry should be expunged and be replaced with what will ensure more competent primary school teachers. For example, one out of the three years of training should be devoted to guided supervised practical training in schools.

In the case of teachers being prepared for the secondary' schools. (*both junior and senior*) the time has come to say goodbye to the B.Ed programmes. I believe it was a child of emergency or a crash programme to produce graduate teachers. Anybody who wants to be a secondary school teacher should come to the University and take a regular degree of B.A or B.Sc *and then* do a postgraduate professional training for teachers. If the B.Ed must be retained, then it should be an avenue for upward mobility for the teachers in primary schools (*remember they unll all be NCE*) and such a B.Ed programme will be located in the Colleges of Education (*not in the Universities*) and the graduates will still be primary school teachers.

What is the implication of these for the existing set up in the Faculties and Institutes of Education in the Universities? I believe that the dichotomy between the Faculty and the Institute should disappear. There should be one '*something*' of Education. What the something should be called is not a big issue even though for obvious reasons (*I trained in an Institute for Studies in Education*) my choice is clear. But the most important point I what to make is that this something of education will run only Postgraduate programmes and will also retain all the existing departments and new ones to be created as departments. The something of education will run both academic and professional programmes.

Management of Nigerian Examination System

The four bodies managing the national examinations in the country - WAEC, JAMB, NABTEB, NBEM need all the help they can get in coping with the enormous task of conducting national examinations. The final comment I will like to make which applies to WAEC, NABTEB and NBEM is that the Research division of these bodies should be strengthened. Take for example the professional solution to the problem of examination malpractice which I suggested earlier. Only a very virile research division can effectively initiate the use of this approach. Issues in the development of item bank (*not item pool*)

calibration of the items and establishing parallelism among the different test forms are all assignments for the research division of examination bodies. There is therefore a need for capacity building for the personnel of this division.

As I said earlier, I do not feel that JAMB should be scrapped but the task of conducting selection examinations for the Universities should be taken away from it. It should be transformed into a Testing organisation providing Testing service to the Nigerian public. This will make it similar to the Educational Testing Service (ETS) of the United States. In this new status it can produce tests which Universities and other educational institutions can use on individual basis. A ready example of the type of test that comes to mind is the development of Aptitude tests.

Institutionalising National Assessment

This lecture has given me yet another opportunity to sensitize the public to the need for establishing national assessment of education as part of the routine management of our educational system. Sometime in February this year, my technical committee presented the report of the prototype study to an audience made of State Commissioners of Education, Directors of Planning, Research and Statistics divisions of Federal and State Ministries of Education. This was expected to have been followed up with a number of zonal sensitization meetings, only one of such zonal meetings has been held to date. There is an urgent need for a national protem committee to be set up to work out follow up activities to the national report of the monitoring of Learning Achievement (*prototype national assessment*) study. The ICEE of our Institute ran a one month capacity building workshop for senior officials of State Ministries of Education in 1996. This needs to be followed up. The use of national assessment as a device for having effective control over the performance of educational system has become imperative and the government is well advised to move in the direction of institutionalizing this approach to assessment.

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3

FISH HUSBANDRY AND MEDICINE: THE EXPERIENCE OF A TROPICAL VETERINARIAN

B. E. Olufemi

Department of Veterinary Medicine

Introduction

This year's inaugural lecture from the Faculty of Veterinary Medicine is the 6th from the Department of Veterinary Medicine and the 20th from the Faculty. I thank God, to whom, honour and glory belong, for giving me the opportunity to fulfil this academic responsibility in this historical year – the 50th anniversary of the founding of the University of Ibadan – the First and the Best.

While human medicine deals with only the health of man, veterinary medicine has a much wider scope, dealing with the other animals (aerial, terrestrial or aquatic). When I was employed in 1975 as a Lecturer II, I became the first Veterinarian in Nigeria to be asked to specialize in Swine diseases. This interest has continued until date. In 1981, I widened the scope of my specialist interest to include the fish species. I was privileged, through a University of Ibadan Staff Development Fund to train at the famous Institute of Aquaculture, University of Stirling, Scotland. My veterinary background became an advantage to me in my study of fish husbandry and medicine. I thus became the first Nigerian Veterinarian to train as a fish diseases and management specialist. I have decided to limit the scope of today's lecture to fish husbandry and medicine, leaving Swine diseases and management to another occasion.

Definition of Aquaculture

Aquaculture has been defined in a number of ways. It has been called “the art of cultivating the natural produce of water; the raising or fattening of fish in enclosed ponds”. Another author has defined aquaculture as “the rearing of aquatic organisms under controlled or semi-controlled conditions. Thus, aquaculture is “underwater agriculture”. No single definition is universally acceptable, but as the term is used in this lecture, I will consider aquaculture

broadly and state it to be simply the large-scale husbandry or rearing of aquatic organisms, in this case fish, for commercial purposes. *Mariculture* of course, is aquaculture in brackish water or sea water.

The farming of fish, either for food or as a hobby, is a relatively new industry. Man has held fish in ponds and harvested the fruits of the sea for centuries but the knowledge of intensive production methods only developed from the early part of this century.

As the rapid increase in production of farmed fish has occurred, so too have the problems. Congregating fishes in intensive systems leads to higher stocking densities resulting in stress and disease.

For domestic animals, a farmer goes to his veterinarian for advice on husbandry, disease and therapy. Sadly this has not generally been the case in fish farming although many highly gifted non-veterinary fish pathologists have ably advised in this area.

The Role of Veterinarians

Veterinarians are now realizing that their responsibilities do not cease with warm-blooded animals. They are uniquely qualified to assess production practices and disease in the context of both welfare for the animal and profitability for the client. Clinically competent scientists, whether medical or veterinary, can indeed contribute effectively in the assessment and management of fish diseases. Thus the work of Professor Mackie and his medical colleagues on the Furunculosis Committee set up by the British Government in 1930 marked the first real recognition of the economic importance of fish diseases, and provided what Stanislaus Snieszko, the doyen of American fish pathologists (who himself received part of his training at the Jagelonian University Veterinary School, Poland) referred to as 'a "must" for anyone who intends to study communicable diseases of fish'.

Since the 1960s, however, driven by the economic imperative of the commercial expansion of fish culture, our knowledge of fish diseases has expanded beyond all bounds, thanks to the scientific endeavour of multidisciplinary research workers. It is however noteworthy that the contribution of the Veterinary Scientists has been significant both in its volume and its quality. The major advantage that the veterinarians bring to the discipline is the comparative dimension, the ability to relate aetiology and host responses of disease patterns seen in fish populations to the whole spectrum of such conditions in the vertebrate phylum.

In contrast to the situation in the 1960s, when the embryonic fish farmer had virtually no one to turn to (except in the USA where extension services were often very good), nowadays, practising veterinary surgeons are servicing fish farms and farmers just as any other sector of livestock production and being seen to be an essential adjunct to intensive fish production.

One of the features of farmed fish clinical medicine is the generally low value of the individual fish. Thus it is usually possible to sacrifice a few clinical examples to gain diagnostic information which is often of a much higher order of

sophistication than in species where the individual is the subject rather than the flock or school.

My work, as a veterinarian working in the tropics, I believe, has contributed greatly to the advancement of the veterinarian's role in fish clinical medicine. Of particular importance in this respect, of course, is an understanding of the aquatic environment, and of the husbandry systems in which the fish are being maintained. Of no less importance, however, is the understanding of the differences in the pathophysiology and immune response, which a poikilothermic existence imposes on fishes. In the past it was, on occasion, a concern within the veterinary profession as to whether fish were a proper concern for them. The contributions which veterinarians have subsequently made are very clearly demonstrated in this lecture. The lecture also demonstrates that, as with any other livestock production system, the veterinarian by training, by legislative rights and responsibilities, and by experience is the appropriate professional to practise the diagnostic skills derived from the integration of the collaborative scientific efforts of the aetiologists, pathologists and fish biologists of whatever discipline who have created the *corpus* of primary knowledge.

Aims of Aquaculture

The aims of aquaculture are similar to those of agriculture, but with some very important differences:

1. Impounding water with the intention of rearing fish really constitutes the creation of a new environment while conventional agriculture makes use of the existing environment.
2. Fish culture can thus be more productive than conventional livestock rearing on the same area of land – rather than rearing pigs in a multi-storey building!
3. Fish farming can make use of marginal land, such as marsh, which is otherwise unsuitable for agricultural development.
4. It is also a more efficient food production system than almost all other types of animal farming.

Proportionally fish contains a greater amount of edible flesh than pigs, sheep, cattle, goats, etc, and eats a smaller quantity of food to produce this flesh. In other words, to produce one kilogram of meat, a cow would need to consume about 45kg of food, a chicken around 12kg, while a fish would need as little as 5kg. This high efficiency of food conversion is partly due to fish being cold blooded (poikilothermic). Assuming the temperature of their surroundings, they do not have to burn energy to keep warm, and this saving may be expressed as growth. The buoyance of their watery environment also reduces the energy requirement for movement and support – they never have hills to climb. Their excellent food conversion efficiency is also partly due to the quality of their diet. However, there are some disadvantages of fish farming:

1. The proportion of protein in the diet of ruminants is low, and they live mainly on food sources unusable directly by man, especially in poorer countries. In contrast, most fish need a fairly high percentage of protein in their diet.
2. The constant nature of an aquatic environment means that fish does not have to develop the robustness that characterizes land animals, and they are therefore prone or vulnerable to a wide range of predators, parasites and diseases. They can tolerate only relatively small changes in their physical environment and a disease can mean destruction of the entire stock. The evolutionary answer to these problems has been an incredibly high reproduction rate.
3. The capital required to set up an intensive fish farm and the operational demands are considerable. The term *intensive* refers to the high density production of organisms per unit area compared to that occurring naturally.

History of Fish Culture

Fish culture has a substantial history, although its exact origin is still somewhat of a mystery! An Egyptian bas-relief on the tomb of Aktihetep (2500 B.C.) shows what appears to be men removing tilapia from a pond. In China, carp is known to have been spawned and reared about 2500 years ago, although many scholars believe the practice in that country may be twice as old.

Wen Fang, founder of the Chou Dynasty, is often called the first fish-farmer. It is said that when Wen Fang's predecessor, the emperor of the Shang Dynasty, confined Fang to an estate in Hunan Province (1135 to 1122 B.C.), Fang built ponds and kept records on the growth and behaviour of the fish. Fan Li, who wrote about aquaculture in 475 B.C., supported the idea of carp culture and described its practice in his *Yang Yu Ching* (Treatise on Fish-breeding). It was found that when certain combinations of fish were used, greater yields were achieved, and this system of polyculture has been in use ever since. Aquaculture methods spread from China to Korea and then to Japan about 1700 years ago.

The Greek Philosopher Aristotle also spoke of carp, suggesting that the Europeans were also interested in farming this fish. Carp culture was brought to England in the 15th century AD for the first time. Wild fish had been kept before then in England, in "Stewponds", as security for times when red meat was difficult to obtain. The death penalty could be imposed on anyone caught stealing a fish from another's pond.

In modern Africa, attempts to cultivate tilapia species were made in Kenya in 1924. The Congo followed the Kenyan example in 1937. In Central East Africa, the first trials of fish ponds were probably those made in Zambia in 1942 and in Rhodesia (now Zimbabwe) in 1950. The origin of fish cultivation in Nigeria is probably more recent. Efforts were made to develop fish cultivation after the second world war.

The need to increase the amount of animal protein eaten by pregnant women was recognized by the late Professor Oladele Ajose in the early fifties. He

constructed the first fish pond in the former Western Nigeria at Dora in 1954 for the raising of table fish which eventually served as cheap and readily available animal proteins not only to pregnant women but also the community of Dora. There was about a decade of slumber in the construction of other ponds but thereafter, the Government decided to set up demonstration fish ponds which were widely accepted by individuals and communities. Since its introduction to Western Nigeria, the development of fish culture could be conveniently divided into three phases as follows:

- (i) the persuasive and initiation phase - (1956-1977)
- (ii) the partially assisted phase (1978-1982)
- (iii) the do-it-yourself phase (1983 to date)

Today, aquaculture accounts for over 13 million metric tons of aquatic products harvested each year in the world over, and the industry is growing rapidly even in Nigeria. It is extremely important in Asia, where carp, tilapia, yellowtail, salmon, shrimp and seaweeds are grown. In Central America, aquaculture is dominated by a very productive shrimp industry. In Europe, the Atlantic salmon, eels, trout, carp, oysters and mussels are cultured in large numbers. Israel's freshwater and marine culture systems are among the best in the world. In Canada, salmonids are the most cultured species. In the United States, catfish, salmonids, baitfish, crawfish and several species of mollusks also generate significant amounts of income and here at home in Nigeria, fish species cultured include common carp, *Clarias spp.*, *Heterotis niloticus*, *Heterobranchus sp.*, *Gymnarchus niloticus*, and of course our most popular of all – the tilapia species.

The Farming of Tilapias

Tilapia has been something of an overnight sensation in fish farming. It has actually been exploited for some considerable time, but its potential as a farm fish was "rediscovered" during, or just after, the Second World War. According to Chimits (1955).

Since World War II a new fish, tilapia has appeared among the tools of trade of fish culturists and has provoked keen interest everywhere; it has made prodigious progress in fish culture in warm waters and there are great expectations for it as a new source of protein food.

Fossil remains of members of the genus *Tilapia* about 8 million years old have been found (Fryer and Iles 1972). These were found in Lake Victoria area and possibly of a marine ancestor (Kirk, 1972), but little was known about the group until just over a century ago.

One member of the group, *Aureochromis niloticus*, was the subject of detailed observations in Egypt of 5,000 years ago. Depicted in many Egyptian paintings, it was regarded as sacred, symbolizing the hope of reincarnation. There

is a biblical reference indicating that fish ponds were extant in Egypt in the early part of the first millennium B.C. (Isaiah 19:10). Tilapia also formed a major fishery at that time. Kirk (1972) in a review related to culture, discussed tilapia with special reference to the aspects of physiology and breeding behaviour which are relevant to its culture in fresh and brackish water heated effluents; Mathes (1973) lists some 400 references on tilapia in his bibliography of African publications. A computer search of catalogued literature had indicated the existence of some 3000 papers dealing with some aspect of the biology of tilapia. Detail husbandry techniques have been succinctly described by Maar *et al*, (1966). Bardach *et al*, (1972) and Huet (1972), with emphasis being placed on the biology of the group and ways in which it may be manipulated to improve production.

Once promoted as the “miracle fish”, several species of tilapia especially *Sarotherodon mossambicus*, were widely distributed around the tropics during the 1950's. However, the original hopes that tilapia culture would make a significant contribution to protein production soon turned to disillusionment, especially in Africa, as the problems associated with its husbandry became apparent. Although tilapia was relatively simple to cultivate, resistant to poor water quality and diseases, and able to efficiently convert many organic animal and agricultural waste materials into high quality protein, these advantages were offset by one highly significant disadvantage: excessive reproduction in culture ponds. The result of this prolificacy was a large number of small, unmarketable fish which were certainly not acceptable to the African consumer who was traditionally accustomed to the larger fish obtainable from rivers and lakes. Consumers in South East Asia, with their different cultural background, were better able to utilize small fish. The inability to control this unwanted reproduction soon discouraged most attempts at tilapia culture and thousands of fish ponds throughout Africa and Asia were either abandoned or used to rear other species of fish.

Several workers, recognizing the potential of tilapia continued to study methods of reducing or eliminating unwanted reproduction and of improving culture methods in general. The continued success of their efforts has led to a relatively recent revival in tilapia culture, which now seems to have a very hopeful future. As a result of these efforts, enthusiasm for the species has become so high that some have begun to describe tilapia as the future “aquatic chicken”. Workable technologies are now available for raising some of the species or hybrids of tilapia on a profitable basis, even though many problems still remain to be solved.

Fish Diseases

Intensive production of fish increases the probability and severity of parasite and disease outbreaks, some of which can kill an entire population in a short time. Diseases cause economic losses from:

- (i) mortality
- (ii) treatment expense

- (iii) growth reduction during and after an outbreak
- (iv) increase in the time required for the fish to reach market-weight size and therefore postponement or loss of the opportunity to sell the fish

The frequency and importance of diseases which occur on fish farms can be the result of overstocking of ponds, poor conditions of farming e.g. handling the fish badly or feeding them incorrectly. In the wild state, fish are widely dispersed and diseases are often not noticed; the risks of contamination are fewer and losses less.

Diseased fish usually exhibit either *physical* or *behavioural* signs, or both. These signs can be helpful, but also misleading; in almost all instances an accurate evaluation can be made only at a diagnostic laboratory.

The following physical signs suggest disease and the corresponding associations which are often made:

- Dead or dying fish - many diseases, cause should be investigated.
- Open lesions or sores, bloody or reddened areas – bacteria; bacteria secondary to parasite infections; external parasites; toxins.
- Gaping mouths – low oxygen; diseased gills.
- Scale loss – *Myxobolus notemigoni* (milk scale disease);
- External parasites; fighting; predation; rough handling.
- Gills pale, eroded, puffy, bloody or brown, or gill covers flared – anaemia; vitamin deficiency; gill disease; environmental stress; toxins; external parasites. *Branchiomyces* (fungus); *Flexibacter columnaris* (bacterium).
- Bleached skin colour – vitamin E deficiency; low oxygen
- Exophthalmia (pop-eye), stargazing – bacterial dropsy; brain flukes; gas bubble disease; malnutrition; environmental contaminants.
- Bloated belly (dropsy) – bacteremia; white grubs (flukes); ligula (tapeworm); catfish virus (affects fingerlings).
- White “fungus” patches - external fungus; *Epistylis* (protozoan).
- Bloody internal organs - bacteria; virus; vitamin A or B deficiency.
- Fluid in body cavity (cloudy, bloody, or clear) – bacterial dropsy; catfish virus; malnutrition.
- Nodules, pustules, white spots – myxosporidian cysts (protozoons); larval trematodes (flukes); Ichthyophthirus or Ich (protozoon); yellow grub (fluke); larval nematodes.
- Folded fins or tail, pectoral fins pointed forward – toxins; many diseases.
- Spinal curvature – vitamin C deficiency; pesticides; genetic deformities.
- Excess mucus (light grey film), sloughing of skin scratches on body – external parasites; fungus; fighting; predation.
- Emaciation (thin fish, pinheads) reduced growth – any disease that causes fish to reduce feed intake or cease feeding; under-feeding; malnutrition; intestinal worms (helminths); vitamin deficiency.

- Air bubbles under skin – gas bubble disease (excessive N₂ or O₂ in the water).
- Cloudy eyes – eye flukes; nutritional deficiencies.
- Red spots near bases of fins – larval lemnaca (copepod); external parasites; bacteria.
- Foul smelling lesions - *Edwardsiella tarda* (bacterium).
- “Hole in-the-head” – *Edwardsiella ictaluri* (bacterium).
- Brown blood – nitrite toxicity.
- Behavioural signs also indicate the presence of certain diseases.

These include:

- Swimming weakly, lazily, erratically or in spirals – many diseases.
- Failure to feed – many diseases.
- Scratching, flashing, or rubbing against objects in the pond – external parasites.
- Twitching, darting, convulsions – toxins; nutritional disease; external parasites.
- Failure to flee when exposed to fright stimuli – low oxygen; metabolic factors; many diseases.
- Crowding or gathering in vegetation, shallow water, or at water inflow, hiding under objects to avoid light – many diseases; low oxygen; toxins.
- “Topping” or “piping” at water surface, floating head-up, moribund (dying) – low oxygen; toxins; external parasites; bacteria.

From the foregoing, it can be seen that the agents of disease in farmed fishes are very numerous and various. On aetiological basis, these can be divided into four groups – in increasing size. These are:

- (i) Viruses
- (ii) Bacteria
- (iii) Fungi
- (iv) Parasite
- (v) Nutritional and/or metabolic diseases

It is important to note, however, that erratic behaviour and syndromes characteristic of infectious diseases may be produced by environmental stress (low oxygen, supersaturation of dissolved gases such as nitrogen or oxygen), toxins (hydrogen sulphide, ammonia, nitrite, many pesticides and even therapeutic agents used to treat infectious diseases), and nutritional deficiencies. Stressed fish are very likely to allow pathogens in the water to invade their tissues. Most pathogens normally occur in small numbers in water or on the fish surface. Some occur within a few fishes without causing any harm – these are referred to as carrier fish.

Viral Diseases of Fish

Viruses are successful parasites or pathogens that utilize a wide range of hosts from the bacteria and algae to the specialized cells of the highest vascular plants and warm-blooded animals. It is not surprising, therefore, that viruses are also found in fishes. Fish viruses are essentially similar to the viruses found in warm-blooded vertebrates. The routes of infection of fish viruses are essentially similar to those found in other vertebrates, namely oral, respiratory, cutaneous and vertical i.e. from generation to generation. The venereal route has not been documented but cannot be excluded. Domestic and international transfers of live crier fish and contaminated eggs are major factors in the spread of the causal viruses, and this calls for fish health control regulations.

Nottidge, Olufemi and Ibe (1992) showed that the tilapia *Oreochromis niloticus*, did not show any sign of illness or abnormality irrespective of the route of challenge with rabies virus. The work confirmed the hypothesis that fishes are not susceptible to rabies virus even though the fish used was a tropical fresh water species with the temperature of the water being high enough to support the growth of the virus. Clark (1972), had successfully propagated rabies and rabies-related viruses in poikilothermic cell lines with some degree of attenuation, it was therefore pertinent to investigate fish reaction to rabies virus experimental challenge *in vivo*.

The clinical, histopathological and diagnostic aspects of the major fish diseases now known to be of viral aetiology have been summarized, Olufemi (1988). These include lymphocystis, infectious haematopoietic necrosis (IHN), viral haemorrhagic septicaemia (VHS), carp virus septicaemia (CVS) and infectious pancreatic necrosis (IPN). IPN virus is the aetiological agent of serious disease of trout and other salmonids and has been isolated from non-salmonid fish.

Lymphocystis disease is the only viral disease of fish demonstrated to date in cichlids from the East African lakes (Paperna *et al* 1983). Lymphocystis disease virus (LDV) is the aetiological agent of this common benign, unique, giant-cell disease of worldwide distribution found in many freshwater and marine fishes. It is the oldest and best-known fish virus. The virus is unique in that it evokes a non-lethal infection resulting in neoplastic like growths or flat patches on various parts of the body — usually the external body surface. The infection seldom causes death but, depending on the size and location of the lesion, swimming behaviour may be greatly affected. The virus infects cells of the fibroblastic series and causes extensive changes, particularly an increase in the size of the cells.

Nigrelli and Ruggieri (1965) gave a detailed histo-pathological description of the infected cells, which included hyaline capsule, enlarged nucleus, often in various stages of necrosis, one to several nucleoli, granular cytoplasm, and single or clustered intracytoplasmic inclusions.

Lymphocystis disease can cause severe problems in marine fish culture and in tropical aquaria and represents a potential hazard for intensive culture systems.

Bacteria Diseases of Fish

Bacteria are responsible for many fish diseases especially those associated with environmental stresses such as handling. Bacteria are always present in water and they usually almost always occur in small or large numbers on the skin or inside healthy fish. Unlike the situation in higher animals, most of the organisms associated with disease in fish are naturally occurring and widely distributed saprophytes which utilize the organic and mineral matter in the aquatic environment for their growth and multiplication. Only comparatively few species such as *Aeromonas salmonicida*, *Haemophilus piscium* and possibly *Renibacterium salmoninarum* appear to be true obligate parasites which are unable to survive for any length of time outside the fish host. Although the distinction between saprophyte and parasite is of prime importance when disease control or eradication measures are being considered, it is of less significance in the diagnostic bacteriology laboratory as both types of organisms may be isolated from the external body surface or internal tissues of apparently healthy fish.

The transition from commensal to pathogen is invariably triggered by the imposition of one or more "stress" factors which increase the susceptibility of the fish to bacterial infection. Poor water quality and temperature changes are probably the most commonly encountered factors which predispose to clinical disease, but overcrowding, trauma, transportation, nutritional deficiencies, parasitism and primary viral infections may all adversely affect resistance. It is important that this should be borne in mind when assessing the significance of laboratory isolates and prescribing treatments as chemical or antibiotic therapy or prophylactic vaccination measures are seldom entirely satisfactory without proper attention being given to correcting the underlying causes. Representatives of 25 bacteria genera have been implicated as pathogens of freshwater and/or marine fish (Austin and Allen- Austin (1985). Olufemi, Akinlabi and Agbede (1991) isolated eight different bacterial organisms, each isolate originating from a different case, from the African catfish (*Clarias gariepinus*, Burch) in tropical fresh-water earthen ponds in Ibadan.

A considerable number of bacterial diseases of freshwater fish have been recognized in Nigeria. Ogbondeminu and Okaeme (1986), Fasanya *et al.* (1988), Ibiwoye *et al.* (1989), found that most of the bacterial microflora associated with the skin of *Clarias* and *Tilapia* species were Gram negative rods and cocci – usually *Escherichia* and *Citrobacter*. The Gram positive cocci were mainly *Staphylococcus* and *Corynebacterium*

Olufemi, *et al.* (1991), however, isolated *Lactobacillus fermenti* from *C. gariepinus*. The organism was considered to be an opportunistic pathogen, although there has been a report of a pathogenic *Lactobacillus* sp. in fish from North America (Ross and Toth 1974). Other opportunistic organisms isolated from our laboratory are *Micrococcus roseus* and *Enterobacter cloacae*. The pathogenic organisms we isolated are *Actinomyces (Corynebacterium)* sp., *Mycobacterium marinum*, *Pseudomonas anguilliseptica* and *Edwardsiella tarda* (Olufemi *et al.* 1991).

Fungi Diseases of Fish

Because fungi are larger than bacteria, they were recognized earlier as agents of disease. However, of the estimated 200,000 species of fungi known, only about 40 are now known to cause infectious disease (mycoses) in marine or fresh water cultured fish species. Fungi associated with tilapia culture ponds in Nigeria have been described (Okaeme and Olufemi, 1997). Compared with the bacteria and viruses, however, knowledge of fungal pathogens/parasites of aquatic animals is relatively fragmentary. This area of study has presented me with a rewarding and exciting experience !

The fungal origin of a disease is usually suspected on the basis of its clinical behaviour and the appearance of the lesion. The most convincing diagnostic evidence is usually provided by detection of the fungus in lesions and exudates by direct microscopic examination and by isolation and cultivation. In addition, animal inoculation serves to distinguish between pathogenic and non-pathogenic (saprobic) fungi, which can be identical in colonial and cellular morphology; the saprobes are usually innocuous in test animals.

Problems Associated with Studies on Mycotic Diseases in Fish

While mycotic infections of fish are known to exist and have been documented in both fresh and salt water environments (Wolke 1975; Richards 1978; Olufemi, *et al.* 1983), far less is known about these diseases than is generally known about diseases of bacterial or viral aetiology. The lack of knowledge relates to a significant degree to the consensus that fungi infecting fish are normally secondary invaders. This doubtless, relates also to the fact that the commonest most obvious and most frequently studied fungal pathogen of fish, *Saprolegnia parasitica* (*diclina*) appears in many ways to be the example of a secondary opportunistic invader par excellence. Although it is accepted that it may eventually result in mortality, it is generally assumed that a traumatic or primary bacterial or viral disease allows it to invade and thus it is these which must be controlled. There are reports, however, that some piscine fungal disease outbreaks unassociated with other pathogenic agents have been epizootic in proportion and responsible for considerable mass mortality. Such epizootics have been recorded under both aquacultural and natural conditions (Wood *et al.*, 1955; Carmichael 1966; Fijan 1969; and Olufemi *et al.*, 1983). An important fungal (mycotic) disease of fishes is aspergilomycosis caused by *Aspergillus* species. This disease was first described by Olufemi *et al.* (1983).

The *Aspergilli* as Pathogens of Cultured Fishes: Historical Background

The genus of moulds known as *Aspergillus* has always been a factor in man's environment. Even before the development of the microscope, *Aspergillus* colonies were well-known as the white, yellow, green, red or black moulds seen on foods and rotting vegetation, although of course, attempts at proper interpretation of the cause of such growths were not feasible at that time.

Michelli (1729) was the first to distinguish the stalks and spore heads peculiar to the genus. He noted that the spore chains radiated from a central structure to produce a pattern that suggested the 'aspergillum' with which he, as a priest, was familiar. He therefore applied the name *Aspergillus* to the moulds he observed because of the similarity in appearance between the fruiting head of the mould and the brush (aspergillum Latin – rough head) used for sprinkling of holy water.

Considerable interest had developed by the middle of the 19th century when the Aspergilli began to be recognized as active agents in processes of decay, as fermenting agents capable of producing valuable metabolic products, and significantly as causes of human and animal disease. The genus began to take definite form with the work of Wehmer (1901).

In the years since 1945, many new species of *Aspergillus* have been described. Altogether, more than 132 species and 18 varieties have been recognized, in contrast to 77 species and 8 varieties in the Manual of the Aspergilli of 1945 (Raper and Fennel, 1965).

Parallel with the dramatic increase in the size of the genus has been an even greater proliferation of the published literature relating to the aspergilli as agents of decomposition, as tools for physiological and genetic studies, as agents responsible for the production of a variety of products in industry, and significantly as primary or secondary pathogens of animals and man.

Aspergillomycosis in Tilapias

Although systemic diseases caused by a range of pathogenic fungi have been defined under aquaculture conditions (Wolke, 1975; Richards, 1978), systemic disease of fish associated with *Aspergillus spp.* had not been described until comparatively recently (Olufemi *et al.*, 1983, Olufemi, 1984, 1986). This is probably because of the lack of detailed study of tropical fish culture diseases, and the lesser importance of systemic mycotic infections compared to aflatoxicosis. Nevertheless, losses under tropical conditions can be extremely high, and aspergillomycosis is bound to cause even more serious problems as the tropical fish farming industry expands.

First report related to *Aspergillus* infection of fishes was derived from Kenya (Olufemi, Agius and Roberts 1983) where mortalities in intensive tilapia culture at Bamburi, Mombasa, occurred. This led to detailed pathological investigations and microbiological analyses of feedstuffs being used, and thus to the definition of the condition as systemic aspergillomycosis (Olufemi *et al.*, 1983).

The account described aspergillomycosis associated with *A. flavus* and *A. niger* which occurred under intensive aquaculture conditions. The cause and effect relationship which was successfully ascribed to *A. flavus* and *A. niger* in the experimental infection which followed, coupled with the clinicopathological findings suggested that it was genuinely an aspergillomycosis problem. The presence of the two species may have indicated a synergistic effect and the nature of the outbreak also suggested that the original infection probably occurred via contaminated food and emphasizes the importance of prevention of mycotic contamination in tropical farm animal diets.

Pathogenicity

There are always difficulties in specifically relating particular species of *Aspergillus* to actual clinical disease outbreaks because of the ubiquity of the organism. Mere isolation without direct association with clinical histopathological damage is not satisfactory.

It is also difficult to be certain with outbreaks of apparent clinical *Aspergillus* infection, as to whether the infection was primary or the *Aspergillus* was simply taking opportunistic advantage of a pre-existing condition. Therefore, experimental infection studies should be carried out.

In such studies on the experimental pathogenesis of aspergillomycosis in tilapias, Olufemi (1983; 1984; 1986) showed clearly that these fishes are highly susceptible to infection by members of the genus *Aspergillus* although there is variability in the pathogenicity of the various species. *A. flavus* was shown to be more pathogenic to fish than *A. niger*, and the combination of the two species produced a more serious disease than the monospecific infection (Olufemi, 1983). Clinical outbreaks with *Aspergillus sp.* are serious because of infection by more than one *Aspergillus* species – conditions which Olufemi (1985) termed polyspecific infection.

The pathogenicity of *Aspergillus* species may be attributable to their ability to grow under the environmental conditions provided by the host, water temperature appearing to play a significant role in this regard. At 26°C, *A. flavus* was about twice as pathogenic to *Oreochromis niloticus* than at 17°C. *A. flavus*

was able to produce mortalities at various temperatures, whereas *A. niger* was usually only able to initiate the disease when the water temperature was low (17°C) (Olufemi (1983).

Histopathology

The histopathological picture associated with aspergillomycosis may best be described as a systemic necrotizing septicaemia characterized by the formation of granulomas (Olufemi, 1984). The disease may either occur as an acute fulminating or a chronic proliferative form. In the former, larger areas of organs, especially the liver, undergo necrosis. Histologically, there is usually diffuse distribution of macrophages within a stroma of necrotic tissue and fungal hyphae (Olufemi 1985; 1986). The chronic form is probably more common under aquaculture conditions and is characterized by the production of granulomas particularly in the gut wall.

Diagnosis

A presumptive diagnosis of aspergillomycosis can be made from recently dead or moribund fish. A positive diagnosis must rely on the isolation of the organism or histopathological examination of the lesions.

Immunological techniques are widely used in human and in animal medicine for the detection of the disease organism or for testing for the carrier state. The amount of immunity conferred by previous exposure or vaccination can usually be measured by the quantity of specific antibody present in that animal. The use of such techniques for the diagnosis of disease exposure or infection in fish has not been in practice. This is often because of difficulties in obtaining adequate amounts of blood, although there are also major problems relating to environmental effects on antibody production. It has been shown however, that by using the Ouchterlony immunodiffusion test, it is possible to detect and to identify antigens of the *Aspergillus* species fungi in fish with overt disease (Olufemi 1984; 1986). Serological studies were carried out with extracts of *Aspergillus* species and sera samples obtained from *Aspergillus* infected and non-infected tilapias by means of Ouchterlony gel-diffusion technique. Clinically affected tilapias were positive for the presence of circulating antibodies.

Possible Control Methods of Aspergillomycosis and Aflatoxicosis

The knowledge of the epidemiology of any disease provides the possibility of an approach to its control. Although until recently aspergillomycosis had not been described in fishes, there is an extensive literature on aflatoxicosis in fish, the intoxication leading to hepatoma in a wide range of fish species (Ashley *et al* 1964; Butler 1965; Halver 1965; Wales 1970, 1979; Wales and Sinnhuber; 1966; Wolf and Jackson 1963), but particularly in the rainbow trout (Majeed, Jolly and Gopinath, 1984). Aflatoxicosis results from the elaboration of aflatoxins, as metabolic products, by aflatogenic species of *Aspergillus flavus* as it grows on feedstuff prior to feeding.

Undoubtedly one way to prevent fungal contamination of feeds and subsequent mycotoxin formation or aspergillomycosis developing, is the

maintenance of good husbandry and the adequate and rapid drying of feeds to a water content at which fungal growth cannot occur. In the tropical humid atmosphere, moisture absorption during storage means that most fresh fish feeds are subject to fungus spoilage if stored for any excessive periods of time and/or under adverse conditions. Consignments of nuts or cereals rejected for human use should not be used for fish feed compounding. Although aflatoxin residues and infective *Aspergillus* spores may be removed during oil refining (Dollear 1969), the meal will retain residual toxicity. Some ingredients, especially oil seed meals such as peanut or cottonseed meals, used in the formulation of modern pelleted fish feeds, are generally recognized as the foods most frequently contaminated by aflatoxins or *Aspergillus* spores (Sinnhuber *et al.*, 1968; Wolf and Jackson, 1963).

Fish feed manufacturers, especially those producing pellets for tilapias, will inevitably include increasing levels of vegetable proteins in rations as fish meal prices rise, with limits imposed by the necessity of providing sufficient dietary essential amino acids. Such ingredients must, therefore, be very carefully checked for the presence of pathogenic (or toxin producing) fungi such as the *Aspergilli*.

Numerous methods have been evaluated for the destruction of *Aspergillus* organism and aflatoxin in agricultural produce. Although aflatoxins are relatively stable to heat (Dollear 1969), studies with cottonseed meal and cereal grains have demonstrated the feasibility of decontamination by very high temperature treatment in the presence of ammonia (Campbell 1972; Goldblatt 1973). The ammonia-treated product may subsequently be used for animal feed. Treatment of agricultural products with ethylene oxide not only kills insects and fungal contaminants but destroys aflatoxins. These modes of treatment or decontamination warrant further investigation as far as fish pellets are concerned.

The problem of contamination of equipment, buildings, walls, ceilings, and other structures on the fish farm, should not be overlooked. *Aspergillus* spores are readily air-borne and may travel considerable distances. Cleanliness, of course, will contribute significantly to retardation of growth of fungi.

In addition, fungistatic paints may be used on walls, ceiling and all structures likely to be subject to fungal growth. Commonly used in such paints are copper-containing compounds. Care should, however, be taken to prevent pollution of water by the copper compounds as these at certain concentration levels are toxic to fish (Olufemi 1985).

Investment in husbandry and storage improvements will therefore appear to be more productive than the continuous expenditure on chemotherapy which as far as aspergillomycosis is concerned, may be at best palliative. Consequently, the only sound approach to *Aspergillus* problems is prevention. Care should be taken in the storing, handling, shipping and processing of high fungus hazard products so that they will not become invaded by *Aspergillus* species. Together with this must go a relatively foolproof system of surveillance – sampling and testing to make sure that no products significantly contaminated with the fungus escape detection. In the developed countries although this is not exactly easy, it is at least feasible. In the less-developed countries this may not be possible, and in

some of those countries where tilapia culture is intensifying and expanding, it is likely to be a problem for a long time to come.

Parasitic Diseases

About 100 genera of protozoan and metazoan parasites have been described as the aetiologic agents of fish and shell fish diseases (National Academy of Sciences, 1977). Fortunately, only a handful of these parasitic organisms are of serious consequence to pond cultured fish. Saig (1971) states that ectoparasites are the largest group of disease organisms in warm water fish ponds. The significant parasites as far as Nigeria is concerned, include members from the Phyla Protozoa, Platyhelminths, Aschelminthes, Arthropoda and Annelidae (Olufemi 1986).

Fish parasites can be grouped according to their usual location on the host. Ectoparasites are found on the external body surface, including the gills, while endoparasites locate in internal organs such as the liver, kidney or intestines. According to Bauer (1961), parasites affect fish populations by causing:

1. mortality (1-100 percent)
2. reduction in growth
3. weight loss
4. suppression of reproductive activity or efficiency

In addition to these effects the poor carcass quality of fish infested with parasites can result in reduction in market value for aesthetic reasons (Rogers 1978).

An understanding of the parasites life cycle is essential in developing rational prevention and treatment strategies for the control of parasitic disease problems (Olufemi 1988).

Diseases of Nutritional and Metabolic Aetiology

Generally, nutritional diseases are not recognized as a problem in warm water pond fish culture unless stocking rates approach or exceed 4,000 kg/ha. This is believed to be due to the availability of natural foods in the pond's environment. However, nutritional problems in fish populations may appear in the form of reduced fecundity, slowed growth, decreased appetite, increased susceptibility to infectious disease, frank morbidity with clinical signs and pathological lesions, mortality, or some combination of these. It is well known that prolonged storage of feed may result in reduction of feed quality, particularly for vitamin C and the essential fatty acids (Lovell 1976; National Academy of Sciences 1977).

Disease Prevention

Only a few therapeutics are available for the treatment of fish diseases, and it is generally recognized that disease prevention is more economic than treating sick fish with expensive drugs and chemicals. The following management practices often will prevent disease outbreaks:

- (i) *Suitable Pond Management*: Where infectious disease organisms are

known to occur, disease can be eliminated from the pond after the fish have been harvested. The remaining fish can be killed and if possible, the pond should be completely dried. Apply just enough fresh calcium hydroxide (hydrated lime) to cover the entire pond area at a ratio of 100 gm per square meter (1000 kg/ha) or 1 ton/hectare), and additional liberal amounts to the puddles and wet-spots. This chemical leaves no final toxic residue.

The application of calcium hypochlorite (HTH) to water at the rate of 40 pounds per acre-foot (10 ppm available chlorine) has been used for killing fish, and also kills many types of disease organisms. The chemical should remain in the pond two or more days before the pond is drained or flushed. The HTH must be used with caution, because the chemical is corrosive and very irritating to the skin, eyes and nose. If all fish are kept out of the pond for several weeks many fish pathogens (but not their spores) will die. Treatment of brood stock of fingerlings to remove the external parasites is a simple precautionary measure. Also, the exclusion of wild fish that enter fish ponds may help to avoid disease outbreaks.

- (ii) *Maintenance of a Disease-free Water Supply*: Ordinarily no pathogens are introduced with well water. Water from springs, however, may contain wild fish that pass infectious organism along to the cultured fish. If water from streams or reservoirs containing fish is used, one can expect pathogens to be introduced into the culture ponds. At some fish farms, the contaminated incoming water is passed through sand and gravel filters to remove certain protozoans and larger parasites. Reservoir water can be treated with Rotenone® to remove unwanted fish, or with HTH (Calcium hypochlorite) to remove predators and parasites. The chemical must be dissipated or neutralized before fish is stocked into the pond. There is no practical way to remove bacteria and viruses from large, flowing supplies of surface water.
- (iii) *Constant Surveillance*: Where there is danger of transmitting infectious diseases through fish transfer, the fish should first be inspected. The practice of disinfecting nets, seines, tubs and other equipment before and after harvesting and transporting fish, even though no disease problems are observed, reduces the possibility of introducing or spreading infectious diseases.

Recommendations

1. Emphasis should now be on investments to improve and/or increase CULTURE rather than CAPTURE methods of fish production, especially as it is now generally appreciated that fish supplies through CULTURE can play a very important role both from the socio-economic viewpoint as well as environment conservation. It should be

possible to achieve self-sufficiency in fish production within the next few years - let us for example, take the year 2010 A.D. as the magic year, since the year 2000 A.D. is no longer realistic!

2. Provision of incentives through the "*Accelerated Fisheries Production Programme*" has been a major thrust of fisheries policy in Nigeria in the past. The provision of incentives has been less successful than expected. Where subsidies had been provided, it had always been impossible for people to take government for less than Father Christmas. Loanees grab the loans through the schemes as their share of the 'National Cake' for which only the 'stupid' would actually be jailed for failing to repay! Besides, the Federal Departments in the past distributed certain facilities and inputs on political/national character basis, rather than with respect to needs and the preparedness of the communities to put the facilities into full use. Such facilities as breholes, cold storage, ice making machine, etc, now lie idle in many States of Nigeria today and some are being considered for privatization! The determination of government to leave market forces to take its normal course has also not been helpful, since the policy allowed unsubsidized prices of inputs to rise far beyond the reach of most fish farmers. Ayeni (1991) advocated that what is required mostly is people based grassroot planning. He opined that past developmental programmes appeared to have been "inflicted" from above onto the people at the grassroot. He advocated a developmental effort which seeks to ask what people do and wish to do better; what they use and wish to be modernized; and how the *Sarkin Ruwas*, the Councillors for Agriculture at the Local Government level, the State Agricultural and the Federal Fisheries Officers, as well as Research Scientists, come together to plan for what is required and how best to do things. Government investment should now therefore be based on what the people "ask for" and not what "we think" they want at the Federal level.
3. Farmers with major investments in fish culture should seriously consider arranging for training in parasite identification and disease diagnosis for themselves and key personnel, and setting up basic facilities for examining fish and monitoring water quality. This training may provide diagnosticians with vital information that could save time in verifying or selecting the proper treatment. This training, I make bold to announce, is possible at the University of Ibadan, if the NUC would approve.
4. The establishment of specialist fish disease laboratories appear necessary to handle fish clinical materials or specimens referred by fish farmers or by veterinarians. To start with, a fish disease laboratory in every State of the Federation is desirable. The fish diagnostic aspect should be part of the State veterinary diagnostic laboratory dealing with all species. A microbiologist will serve *all* species and so does a

histopathologist, and I so humbly recommend.

5. Fish treatments themselves may either be supplied by the Veterinarian on prescription or be available to the client directly on general sale. In either case, the Veterinarian should be responsible for all fish treatments, as is now the case in most parts of the developed world.
6. In our present state of knowledge on diseases of fish and their control, there are a number of diseases, especially viral infections, for which there are as yet no known treatment, and the infected stock has to be destroyed in order to prevent the disease from spreading to other culture installations. Legal provision is therefore necessary to enable authorities concerned to destroy such stocks and when the infection has been caused by factors beyond the farmer's control, provision for payment of appropriate compensation should be made.
7. The development of aquaculture on either a large or small scale involves the use of a number of specialized equipment and supplies, which are not ordinarily available from the open markets in Nigeria. Examples are:
 - (a) hatchery equipment like jars and troughs
 - (b) rearing tanks
 - (c) special pumps for use in hatcheries and rearing facilities
 - (d) ova and fry graders and containers
 - (e) special trucks for transport of fry and live adult fish
 - (f) cages for cage culture of fish or cage fabric or vinyl-coated plastic netting for making cages
 - (g) feed dispensers and feed timers etc.

It is extremely difficult to base a large-scale aquaculture industry on regular import of all such equipment. In the interest of overall economic development therefore, it is advantageous to develop such auxiliary industries. The effort of Rural Agricultural and Industrial Development Services (RAIDS) in this connection is highly commendable. RAIDS has recently produced a smoking equipment for rural use. A lot more remains to be done!

8. At the present stage of our development in Nigeria, most forms of aquaculture are to be classed as high-risk activities. This is due to hazards, some of which are beyond the control of the operator as they result from environmental changes such as adverse weather conditions, changes in water supply, natural calamities like typhoons, floods, etc and others like epidemics of mortality due to diseases, pollution from domestic, agricultural or industrial effluents, which are only partly under his control. Besides providing assistance to control or minimize the losses caused by such disasters, governments often provide financial and material assistance to farmers and entrepreneurs to rebuild their

installations and culture stocks. This can become a major burden on governments. An alternative means of mitigating such losses is by provision of insurance cover through commercial underwriters.

There are, at this stage of the industry, major problems in arranging insurance cover from the point of view of both the underwriter, who has to provide the cover, and the aquaculturist who needs protection. First of all, there has hardly been any insurance underwriter willing to cover risks, associated with aquaculture production at reasonable premium rates. The general lack of knowledge of insurance companies of the commercial and industrial characteristics of aquaculture and the nature of the risks that they are required to underwrite, has been a major handicap. Insurance covers have to be based on the principle of spreading the cost of risks among the insured by charging premiums that in total exceed the losses that will have to be compensated. The twofold problem that stands in the way of the spread of aquaculture insurance is the lack of expertise among underwriters to assess risks and the scarcity of enterprises that are ready to participate in insurance schemes. The underwriters have to enlist the services of scientific and technical experts to help in assessing risks and advise them on the prevention and reduction of losses.

An insurance facility meant to cater for the needs of the aquaculture industry and available through the normal insurance agents, is now necessary and when sufficiently well developed and well spread in the country, would contribute substantially to greater investments in aquaculture.

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DISTRIBUTIONAL INEQUITY AND THE PROBLEM OF NATIONAL INTEGRATION

Sylvester Abumere
Department of Geography

Introduction

I regard it a great honour and privilege to be asked to give the 1997/98 session inaugural lecture on behalf of the Faculty of the Social Sciences. Looking at the records, this is the 10th inaugural lecture from the Department of Geography, the first having been given in 1951 by Professor B. J. Gamier.

My own specialization enables me to look at what happens to economic development in space. This would mean that whereas economists view economic development mainly in sectoral terms, geographers like me regard it as taking place among areal units. This geographer's viewpoint underlies the issues raised in this inaugural address. My first thought was to christen this address "Nigeria's Two Nations and the Problem of National Unity". After much agonizing, I opted for today's title, "Distributional Inequity and the Problem of National Integration". Distributional inequity is taken to mean differential availability of the fruits of economic development among populations in different Nigeria's areal units. Economic development itself is defined as economic growth plus spread. This would mean that if the benefits of economic growth were concentrated in the hands of a few people or in a few areas, that would not be economic development at all. Equality of access by people and areas to the good things of life is therefore, perhaps, the best way of measuring development. Indeed, the 1996 *Report of the United Nations Development Programme* (UNDP 1996) states that distributional equity is at the heart of economic development. Unequal access is not only inequitable, it can also do tremendous damage to national integration.

I did not realize the extent of the distributional inequity in the space economy of Nigeria until 1976 when we started studies in the new Federal Capital Territory, Abuja. I discovered that over the whole Territory which is about 8,000 sq.kms and therefore two and-a-half times the size of Lagos State and larger than

many of Nigeria's current 36 states, there was no single secondary school, no hospital and no single mile of tarred road. Everywhere you went, there was poverty and a high level of governmental neglect. One came away with the conclusion that Nigeria must truly be two nations – a nation of haves and of have-nots. Later, I found out that the level of deprivation in the Federal Capital Territory (FCT) was true of almost the whole of the Middle Belt of Nigeria in which the FCT is situated. This is usually traced to the neglect of the Middle Belt during the colonial administration. The fact was that unlike the areas to the north which produced exportable crops such as groundnut or to the south which produced palm oil and kernels, rubber and cocoa, the Middle Belt produced mainly food crops such as yams which turned out not to be of much interest to the British. The area did not therefore receive much attention from the colonial administration in the distribution of social and physical infrastructures.

Whatever the reason for the neglect of this area, the point I want to make is that my visual experience in the FCT stimulated my interest in the whole issue of unequal access to development infrastructures. I started to investigate why we have rich and poor areas in a nation, and the consequences of this. In what follows, I will attempt to share my findings. The lecture divides into five sections. After this introduction, I move on to the issue of the spatial pattern of development in Nigeria. This will enable me to distinguish between the areas that have access to development opportunities and those that are not. I will then examine the access gap, that is, the gap of opportunities between the areas that are developed and those that are not. This will be followed by an explanatory framework. Lastly, the obstacles placed in the way of nation-building and national integration by the unequal or "two-nation" phenomenon will be taken up.

Space and Economic Development in Nigeria

In 1911, the Dutch economist, Boeke (Boeke 1953; Furnival 1939), produced a classic on the two-nation concept. He noted the co-existence within one economy of two economic systems, different in behaviour, organization and performance, a phenomenon he described as a dual economy. The duality consisted of a modern, developed, enterprising, industrial, innovative and rich sector and a traditional, subsistence, unentrepreneurial and poor sector. Rather than viewing this dualism in the form of sectors, geographers have often viewed it in terms of space. It is then argued that under certain conditions, growth begins to occur in a certain region and this may produce backwash effects in other areas leading to their stagnation. The consequence of such conditions is the perpetuation of an economy with a dynamic growing area existing side by side with a stagnating one (Hirschman 1958; Myrdal 1957; Friedman 1966; Logan 1972). The idea that space can be subdivided into areas that have development and areas that do not have or into rich and poor areas has dominated researches in regional development in the last three decades or so.

In any attempt to categorize the Nigerian space according to levels of development, the problems of measurement and data will loom large. It used to be fashionable to measure economic development by *per capita* income alone.

The quadrupling of oil prices by OPEC countries in 1973 forced a rethinking of this strategy. This was because many of the Middle East OPEC countries then, such as Saudi Arabia, Kuwait, Qatar and the United Arab Emirates, had *per capita* incomes greater than those of many European countries. It became absurd to argue that these Middle East countries were more developed than the numerous European countries. To obviate this problem, many variables are now used to measure development. These variables attempt to capture the many dimensions of development including economic, social, political and cultural dimensions. Using many variables immediately confronts the researchers in Nigeria with formidable data problems. The data required on the variables are either unavailable or prone to numerous errors. This usually means that the right balance has to be struck between number and reliability of variables.

To distinguish between the areas of more or less development in Nigeria, two strategies were adopted for this address. The first was to use the results of the *Report on Human Development in Nigeria* produced by the United Nations Development Programme (UNDP 1996). The second was based on nineteen indicators of development with the states of Nigeria as the points of observation. The statistical techniques of factor and multivariate analysis were used to regionalize the results.

UNDP Results

In chapter 3 of the UNDP's *Nigerian Human Development Report* (UNDP 1996) an examination was made of the widening gap of opportunities over the nation's space. The *Report* used three indicators to measure development – longevity, knowledge and income. Longevity was measured as life expectancy at birth. Knowledge was measured by two variables including levels of adult literacy and mean years of schooling. Income was measured by purchasing-power based on real GDP *per capita*, adjusted for the Local Cost of Living (that is, purchasing power parity, PPP). These variables were regarded, as providing adequate approximation of the command over resources needed for a decent living. Data on the three variables were then combined to obtain composite indices for the states of Nigeria. Table 1 shows the result so obtained.

Table 1
Components of HDI for Nigeria (1992)

S/N	State	Life Expectancy at Birth (years)	Adult literacy %	Mean years of school	Educational attainment %	Real GDP per capita (PPPS)	Adjusted GDP (PPPS)	HDI
1.	Bendel	53.7	65.6	4.00	45.07	5,003.4	5,003.3	0.631
2.	Rivers	50.2	51.9	3.84	35.88	4,860.7	4,860.7	0.539
3.	C/River	57.8	69.4	3.27	47.36	2,626.0	2,626.0	0.513
4.	Lagos	61.4	65.0	3.92	44.64	2,034.7	2,034.7	0.489
5.	Imo	60.0	75.6	3.80	51.67	1,341.1	1,341.1	0.466
6.	Gongola	57.8	26.0	2.15	18.05	665.1	665.1	0.214
7.	Ondo	49.4	50.6	3.29	34.83	422.9	422.9	0.212
8.	Oyo	51.3	40.4	3.11	27.97	678.1	678.1	0.210
9.	Niger	54.9	16.0	1.04	11.01	1,262.0	1,262.0	0.191
10.	Benue	53.5	27.0	1.91	18.64	809.5	809.5	0.188
11.	Kwara	45.9	40.0	3.00	27.67	1,020.1	1,020.1	0.183
12.	Anambra	44.9	43.1	2.91	29.70	860.1	860.1	0.174
13.	Kano	57.1	12.1	0.73	8.31	692.6	692.6	0.161
14.	Plateau	39.5	36.7	2.18	25.19	1,224.1	1,224.1	0.149
15.	Sokoto	49.2	2.7	0.43	1.94	1,246.2	1,246.2	0.128
16.	Bauchi	36.7	39.8	2.03	27.21	762.2	762.2	0.127
17.	Ogun	37.4	41.8	2.81	28.80	619.3	619.3	0.126
18.	Kaduna	36.6	30.8	1.52	21.04	876.4	876.4	0.101
19.	Borno	37.0	10.0	0.55	6.85	957.8	957.8	0.042
	HDI of 1993	51.5	50.7	1.20	34.20	1,215.0	1,215.0	0.246

Source: UNDP (1996). *Nigerian Human Development Report*, p. 29.

From Table 1, the states with the highest life expectancy at birth are Lagos and Imo with 61.4 years and 60 years respectively. The states with the lowest life expectancy include Kaduna (36.6), Bauchi (36.7), Borno (37.0) and Ogun (37.4). In the case of adult literacy, Imo State has the highest level (75.6%), followed by Cross River (69.4%), Edo and Delta States (former Bendel) (65.6%) and Lagos (65.0%).

States with the least levels of adult literacy include Sokoto (2.7%), Borno (10.0%) and Kano (12.1%). As for mean years of school, former Bendel tops the rest with 4 years, followed by Lagos (3.92 years). Rivers (3.84) and Imo (3.80). The states at the bottom are Sokoto with 0.43 years of schooling, Borno with 0.55 and Kano with 0.73. In the case of Real GDP *per capita*, former Bendel, Rivers, Cross River and Lagos, in that order, top the list while at the bottom are Ondo, Ogun, Gongola, Oyo and Kano.

The composite index derived from these variables, the HDI index, can be seen clearly in Table 1. From this Table, former Bendel, Rivers, Cross River, Lagos and Imo top the list. Note that all the states in the north, apart from Gongola, performed poorly on the HDI. Also note that Ogun State is the only southern state ranking with the low performing northern states (Fig. 1). From this figure, northern Nigeria is virtually a sea of low performing states. The contrast in distributional inequity between the north and the south cannot be more

dramatic. In summarizing Table 1, UNDP (1996) reckons that on the basis of their Human Development Index (HDI), the three leading states of former Bendel, Rivers and Cross River, would easily have qualified in 1990 as middle human development countries occupying positions 79th, 91st and 96th respectively in the world while the lowest HDI – Ogun, Kaduna and Borno would have occupied 148th, 150th and 161st (i.e. the last positions respectively).

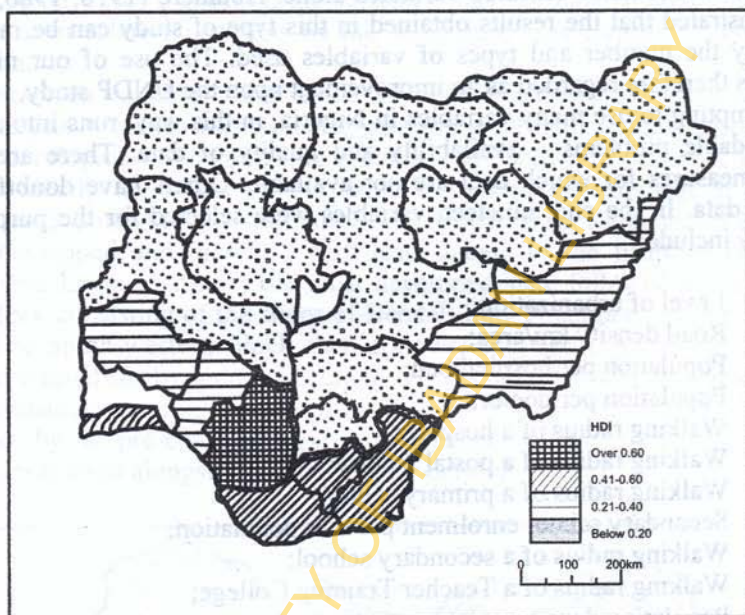


Fig. 1: NIGERIA: HDI by States, 1992

The relative positions of the states in 1992 (Table 1) seem to have been maintained in 1996. From the 1996 results, the UNDP (1996) concluded as follows:

A ranking of the Nigerian States by HDI puts, for example, the Edo and Delta States (formerly Bendel State) on the top with an HDI of 0.666 while Borno has an HDI of 0.156. Were Edo and Delta States constituted into a separate sovereign country, their "nation" would rank 90th in the world—relatively high among the medium-level human development countries while Borno as a separate polity would rank lower than any other country in the world. While Edo and Delta States together have an average life expectancy of 59.5 years, Borno has 39.6 years and against their adult literacy of 79.5%, Borno's is 12.1%. Wide regional disparities is Nigeria's Achilles' heel – the primary source of its perennial conflict, political instability and social unrest.

Results Based on the Nineteen Variables

The point has already been made that to measure economic development adequately requires the use of many variables. The UNDP study used three variables. It can be argued, however, that far more variables are required to capture the numerous dimensions of economic development. The counter intuitive rankings of Lagos and Ogun States in the UNDP study may, in fact, be attributed to the reliance on three variables alone. Abumere (1978, 1980, 1981) has demonstrated that the results obtained in this type of study can be radically affected by the number and types of variables used. The use of our nineteen variables is therefore regarded as an improvement upon the UNDP study.

Attempting to use many variables in Nigeria, in this way, runs into at least two formidable problems – availability and quality of data. There are some sensitive measures for which data are not available. Others have doubtful and unreliable data. In the end, nineteen variables were selected for the purpose in hand. They include:

1. Level of urbanization;
2. Road density km/area;
3. Population per hospital bed;
4. Population per doctor;
5. Walking radius of a hospital;
6. Walking radius of a postal facility;
7. Walking radius of a primary school;
8. Secondary school enrolment per unit population;
9. Walking radius of a secondary school;
10. Walking radius of a Teacher Training College;
11. Population density;
12. Walking radius of a rural bank;
13. Per cent industrial establishments;
14. Per cent industrial employment;
15. Per cent industrial income;
16. Value added in industries;
17. Per cent population served with water supply;
18. *Per capita* water consumption in litres;
19. Per cent population in primal activities.

Sources:

1. Variables 1 and 2 from the *Nigerian Population Census Report*. 1963.
2. Variables 2-10 and 12 from Idachaba, F. S. *et al. Rural Infrastructures in Nigeria* Vol. 2, Federal Department of Rural Development. 1981.
3. Variables 13-16 from Ayeni, Bola (1978) "The Spatial Distribution of Manufacturing Industries in Nigeria." Department of Geography, University of Ibadan, *Technical Report*, No.2.
4. Variables 17-18 from J.O. Ayoade and B. L. Oyebande "Water Resources:" In J. S. Oguntoyinbo *et al. A Geography of Nigeria's Development*, Heinemann, 1978, p. 49.

5. Variable 19 from *Agricultural Development in Nigeria 1973-1985*, Federal Ministry of Agriculture, Lagos, 1974, p. 345.

These variables were regarded as adequate measures of economic development. It needs pointing out however, that most of the data used here are old and are for different time periods. The confidence in using them derives from the belief that although the magnitudes of the data may have changed the relative positions of the cases (states) on the variables may not have altered much. This maintenance of relative positions by the areal units was clearly evident in the UNDP data.

The nineteen variables were factor analyzed (Abumere 1987). Multivariate cluster analysis was then used to categorize the areal units (states) according to levels of development. The resulting groupings are shown in Figure 2. Figure 2 highlights clearly the levels of differential access to development in Nigeria. From Figure 2, almost all the states in the north apart from Kano, are categorized as least developed and therefore with least access to the fruits of economic development. Lagos is clearly the most developed state followed by the south-eastern block consisting of the states of Bendel, Imo, Anambra, Cross River and Rivers. The south-western block then follows: the performance of Lagos is largely accounted for by industrialization. Oil and allied activities probably fuel the performance of the south-eastern block. The south-western block is dominated by a pre-colonial type of urbanization in which elements of traditionalness exist alongside elements of modernity.

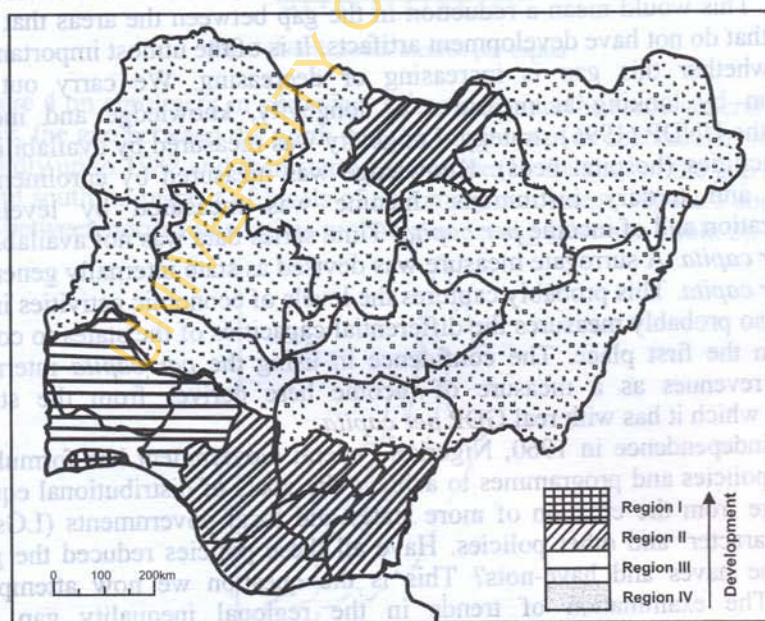


Fig. 2: Nigeria: Four regions according to stage of economic development

The concentration of development in the south, along the coast and lack of it in the hinterland as has been observed for Nigeria here is, of course, typical of colonial type spatial development everywhere in the world. In Africa, the same phenomenon has been observed in Ghana by Forde (1968), in Sierra Leone by Riddell (1970), in Tanzania by Gould (1910), and in Kenya by Soja (1968). This colonial type of development is characterized by the desire of the metropolis to get more out of the economy than it puts in. This leads to all kinds of distortions and distributional inequities. In the first place, it leads to a concentration of efforts (roads, power, trade, etc) in the coastal port areas insofar as it will involve too much expense to extend these efforts to the hinterland. In the second place, it leads to the almost exclusive interest in the export-import trade which turns out to favour mostly coastal port areas. The dichotomy thus created, according to Soja (1968) is dysfunctional to national integration.

Temporal Trends in Distributional Inequity

Immediately after the civil war in 1970, Nigeria adopted five national objectives to be attained, namely:

1. A united, strong and self-reliant nation;
2. A great and dynamic economy;
3. A just and egalitarian society;
4. A land of bright and full opportunities for all citizens; and
5. A free and democratic society.

It is clear that the attainment of distributional equity underlines all these five objectives. This would mean a reduction in the gap between the areas that have and those that do not have development artifacts. It is of the utmost importance to examine whether this gap is increasing or decreasing. We carry out this examination by looking at measures of longevity, knowledge and income following the UNDP (1996) strategy. Longevity was measured by availability of medical facilities (hospital beds). Knowledge was measured by enrolments in secondary and tertiary institutions. Income was measured by levels of industrialization and of income *per capita*. Time series data was not available on income *per capita*. A surrogate measure was devised as state internally generated income *per capita*. This probably captures the levels of economic activities in the states. It also probably measures the differential capacities of the states to collect revenues in the first place. The confidence in using the *per capita* internally generated revenues as a measure of income here derives from the strong correlation which it has with real GDP *per capita*.

Since independence in 1960, Nigeria's Federal Government has formulated numerous policies and programmes to achieve the goals of distributional equity. These range from the creation of more states and local governments (LGs) to 'federal character' and other policies. Have all these policies reduced the gaps between the haves and have-nots? This is the question we now attempt to examine. The examination of trends in the regional inequality gap will concentrate on the north-south gap: The geopolitical situation in Nigeria dictates that this is far more significant than the east-west gap. Since the north as a block

and the south as a block are not internally homogeneous, we would also examine the gaps within the north and within the south.

Results

According to Kilby (1969), the gap in income *per capita* between the north and the south by 1953 was as high as ₦76 (in 1952 money and prices) or 223.5%. The estimates of income *per capita* in the Second National Development Plan for Nigeria, 1968, showed that the gap reduced somewhat but was still as high as 206%. Figure 3 shows that *per capita* incomes are rising over time in both north and south and also clearly in the entire nation. The difference in income between the north and the south appears to be rising over time. This is so because incomes have risen far faster in the south than they have in the north.

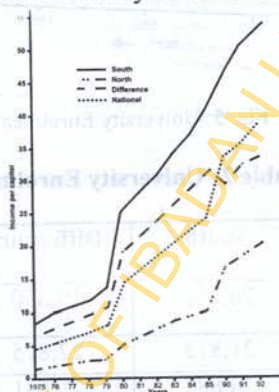


Fig. 3: North-South income per capita

Figure 4 on enrolment in secondary schools depicts the same general picture. However, the gap between the north and the south is not as spectacular. Indeed, it rose rapidly up to 1982 and then started to decline. In the case of the gap between north and south, in respect of levels of university enrolment, Figure 5 shows that the gap between north and south is probably widening (also see Table 2).

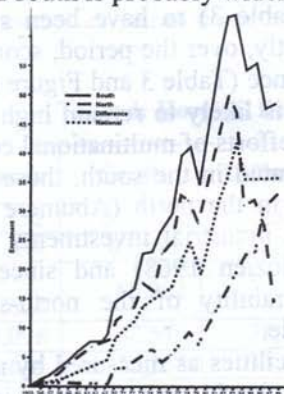


Fig. 4: North-South Secondary School Enrolment

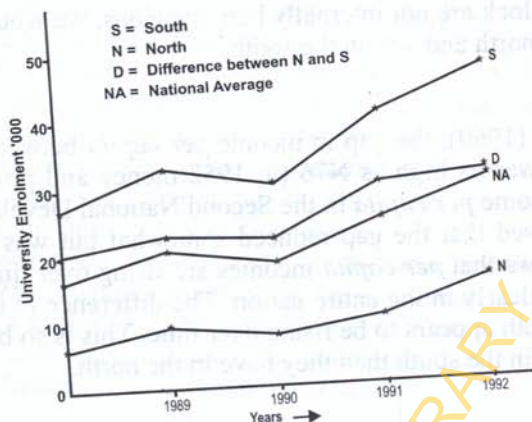


Fig. 5: University Enrolment

Table 2: University Enrolment

Year	North	South	Difference	National Average
1988	6,391	26,241	19,850	16,316
1989	8,938	31,813	22,875	20,376
1990	7,351	28,882	21,531	18,117
1991	9,186	38,504	29,316	23,845
1992	15,425	45,008	29,583	30,217

Source: *Abstract of Statistics*, 1996, Federal Office of Statistics, Lagos.

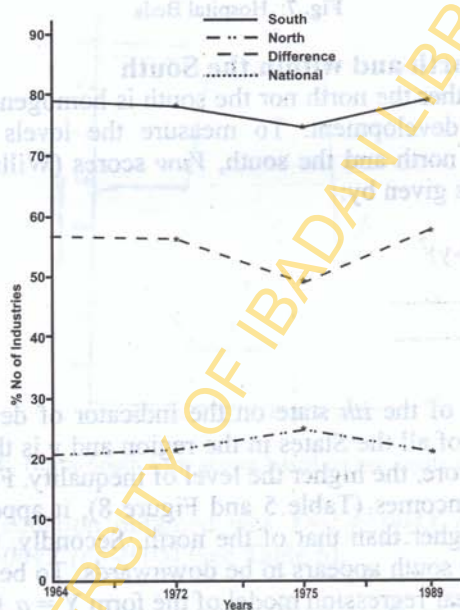
With respect to the gap between the north and the south in levels of industrialization, it appears (Table 3) to have been stable over time. This is because the north has consistently, over the period, scored no more than 25% of the national industrial performance (Table 3 and Figure 6). It is possible to argue that the magnitude of this gap is likely to remain high for a long time. This is because whereas the industrial efforts of multinational corporations and Nigerian private companies are concentrated in the south, those of the Nigerian Federal Government are made mainly in the north (Abumere 1978, 1982). However, since no less than 80% of the industrial investments in Nigeria are made by multinational corporations (Edozien 1968) and since these investments are mainly in the south, the durability of the north-south gap in industrial performance is perhaps inevitable.

We next look at medical facilities as measured by number of hospital beds. Table 4 and Figure 7 show clearly that the gap is widening though not remarkably so.

Table 3: North/South Shares in No. of Industries

Year	North (%)	South (%)	Differences
1964	21.4	78.6	57.2
1972	21.9	78.1	56.2
1975	25.2	74.8	49.6
1989	21.4	78.6	57.2
	22.5	77.5	55.0

Source: For 1994, Hakam; p. 64; for 1972 and 1975, *Industrial Surveys*, Federal Office of Statistics, Lagos; for 1989, Federal Ministry of Industries, Abuja.


Fig 6: North-South percent shares in no of Industries
Table 4: Hospital Beds

Year	North	South	Difference	National Average
1987	33,732	61,773	28,041	47,753
1988	39,098	67,546	28,448	53,322
1989	37,624	66,092	28,468	51,858
1990	39,098	67,546	28,448	53,322
1991	43,624	75,268	31,644	59,446

Source: *Abstract of Statistics*, 1996, Federal Office of Statistics, Lagos.

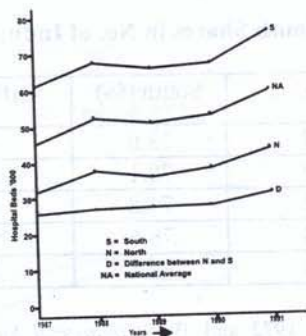


Fig. 7: Hospital Beds

Gaps within the North and within the South

As already noted, neither the north nor the south is homogeneous with respect to levels of access to development. To measure the levels and trends of the inequality within the north and the south, V_{uw} scores (Williamson, 1965) were computed. The V_{uw} is given by:

$$V_{uw} = \frac{\sum_{i=1}^N (y_i - \bar{y})^2}{N \bar{y}}$$

where y_i is the score of the i th state on the indicator of development, \bar{y} is the average of the scores of all the States in the region and y is the national average. The higher the V_{uw} score, the higher the level of inequality. From the V_{uw} scores based on *per capita* incomes (Table 5 and Figure 8), it appears that the access gap in the south is higher than that of the north. Secondly, the overall trend in both the north and the south appears to be downwards. To be more certain about the trend, a simple linear regression model of the form $Y = a + bx$ was fitted.

Table 5: V_{uw} SCORES FOR NORTH AND SOUTH BASED ON *PER CAPITA* INCOMES

Year	North	South
1975	0.43	0.99
1976	0.56	1.01
1977	0.49	1.01
1978	0.53	1.00
1979	0.37	1.00
1980	0.27	1.55

1981	0.26	1.53
1982	0.27	1.54
1983	0.29	1.54
1984	0.32	1.55
1985	0.35	1.58
1990	0.45	0.63
1991	0.47	0.88
1992	0.49	0.68

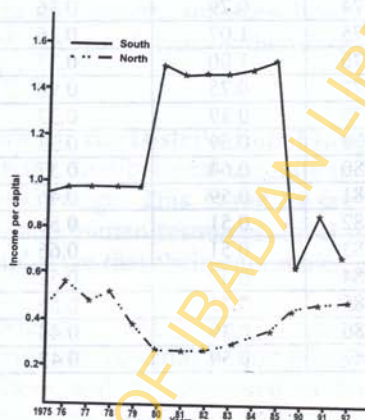


Fig. 8: North-South Vuw scores based on *per capita incomes*

For the north, the equation obtained was $Y=0.42.004X$ ($r=0.1$) while for the south, it was $Y=1.2-004X$ ($r=-0.05$) (see Table 6).

Table 6: Simple Linear Regression Results Based On The *VUW* Scores

Areas	R	a	b	T
North (a) per capita incomes	-0.1	0.42	-0.004	0.35
(b) Sec. Schl. Enrolment	-0.85	1.03	-0.036	12.3***
South (a) per capita incomes	-0.05	1.2	-0.004	0.17
(b) Sec. Schl. Enrolment	0.33	0.05	0.004	1.5
National (a) per capita incomes	0.13	1.27	0.02	0.48
(b) Sec. Schl. Enrolment	-0.47	0.94	-0.007	3.0*

**significant at less than 0.01 level

* significant at 0.05 level.

Although there is some evidence of decline in inequality in both north and south, the evidence is not strong enough for us to be confident (r and b not statistically significant even at the 5% of level).

The V_{uw} for north and south based on secondary school enrolment are shown in Table 7 and Figure 9. The inequality trend appears to be downwards in the north but upwards in the south.

Table 7: V_{uw} Scores for North and South Based on Secondary School Enrolment

Year	North	South
1970	0.65	0.46
1971	1.03	0.47
1972	0.90	0.45
1973	0.86	0.45
1974	0.79	0.36
1975	1.07	0.36
1976	1.00	0.37
1977	0.75	0.90
1978	0.89	0.33
1979	0.59	0.33
1980	0.64	0.37
1981	0.59	0.46
1982	0.51	0.56
1983	0.51	0.65
1984	0.47	0.52
1985	0.43	0.55
1986	0.39	0.44
1987	0.39	0.43

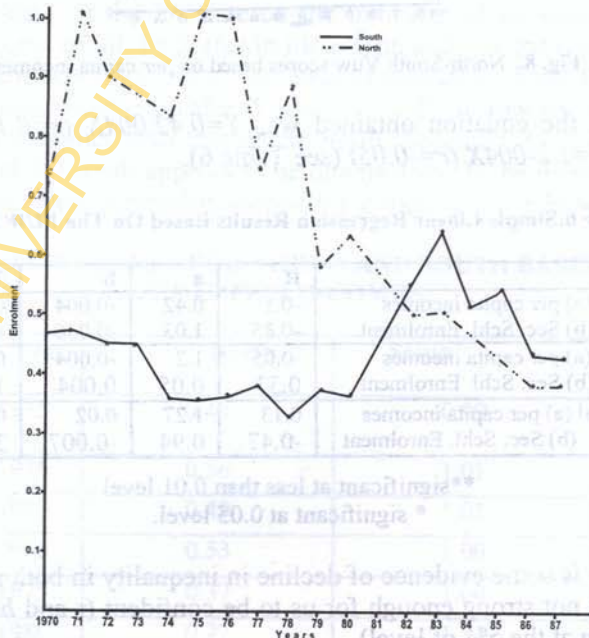


Fig. 9: North-South V_{uw} scores based on secondary school enrolment

The fitted regression equations (Table 6) are $Y=1.03-0.03X$ ($r=-0.85$) for the north and $Y=0.05+0.004X$ ($r=0.33$) for the south. These results show that the inequality in access to secondary education is probably declining in the north but rising in the south.

The conclusion that can be drawn from all these is that firstly, the access gap between north and south is very wide and probably rising. However, the gap appears to be narrowing for facilities where the government has direct responsibility such as education but widening where private sector efforts loom large such as incomes and levels of industrialization. Secondly, although the evidence is not strong the inequality within the north appears to be lower than that within the south. This probably confirms Mabogunje's (1971) view that once industrialization starts in any region, incomes begin to be more unequal. The difference between north and south here is therefore probably accounted for by stage of industrialization.

Explanatory Framework for the Distributional Inequity

In any attempt to explain the distributional inequity in Nigeria, the role played by historical factors will loom large. This is not to say that other factors such as location, culture, natural and human resources, level of urbanization, etc. are not important but it is to emphasize that their importance quickly takes the back seat when compared with the factors of history. The fact is that the seeds of the present inequality in Nigeria were gathered during the pre-colonial period, planted and nurtured during the colonial period blossomed and bore fruits in the post-colonial period. These will be discussed in turn. First, however, I will attempt to provide insights from theory.

(a) Insights from Theory

As will be expected the literature is replete with theories which attempt to provide explanation for regional inequality. We here identify two sets of theories. The first set provides understanding of why we have rich and poor areas, while the second explains the temporal trends in the gap between the rich and poor areas.

Among the first set, we may identify four theories, namely, export base, sector, urban size ratchet and circular causation theories. The **export base theory** states that economic growth in a region depends upon the growth of its exports and that expansion in demand external to the region is the main determinant of regional growth. These exports could be of manufactures, raw materials or ideas. This would mean that areas with these exports will grow more than those without.

The sector theory states that there is always a sectoral shift in demand from agriculture to manufacturing and even later from manufacturing. The main reasons for these shifts are different income elasticities of demand for the products of the sectors. When people's incomes rise, they do not spend proportionately higher amounts on food but instead shift to manufactured goods such as radios, television, carpets, refrigerators, etc. This would mean declining prosperity for the areas producing food and increasing prosperity for the

manufacturing areas. Even within manufacturing a shift from heavy industries to electronics and computer will have similar effects.

The **urban size ratchet theory** simply states that size confers many advantages due to agglomeration, mix of labour pool and accumulated capital investment. As a result, regions with larger cities tend to do better than those with smaller cities or rural settlements.

The **circular cumulative causation theory** emphasizes the importance of an early start and states that once growth starts in a region, self-generating momentum sets in. To ensure that the region continues to have growth more than others.

To these four theories must be added the **concept of distance**. Proximity to a region that has done well is crucial in determining whether a region will do well or not. This is why there is spatial autocorrelation in development around the world. The fact that spatial clusters of development exist enables us to speak of the north and the south when discussing world development. Notice how the factor of proximity enabled the Asian tigers to rise and fall almost together.

Among the second set are the **equilibrium and disequilibrium theories**. The **equilibrium theories** (including neo-classical, Lewis and Ranis-Fei and Hirschmann) argue that given a relatively free mobility of the factors of production, factor movements tend to bring about an equalization of development among regions. Any differences in development between regions are regarded as temporary, due, perhaps, to some slight lag in adjustment. For equilibrium capital will flow from high to low wage regions since the latter offers higher returns to capital, and labour will flow in opposite direction until factor returns are equalized. Convergence of development among the regions is therefore to be expected.

On the other hand, **disequilibrium theories** (Hatrod-Domar, Myrdal, Ullman and Hicksian) predict increasing regional inequality. They argue that economic development tends to be concentrated in the areas where most have already taken place. In that case, the regions that have already done well will continue to do so. It is argued that the higher a region's growth rate the more likely that it will attract capital and investments which will then result in the widening of regional inequality.

(b) Insights from History

The Pre-colonial Period

For centuries before the advent of the Europeans in the area now known as Nigeria, the people had very strong links in trade and ideas with North Africa. The Mediterranean ports of the Maghreb were the outlets for this area's contribution to international trade. The northern parts of present day Nigeria – including Katsina, Kano, Zaria and Kukawa – exported handicrafts, dyed cloths and leather goods to North Africa and in turn imported salt and metals, especially copper. According to Mabogunje (1968), one important consequence of this area's trade with North Africa was that certain development centres emerged in present-day Northern Nigeria. If this trend had continued, Northern Nigeria today

might probably have fared better with respect to development. However, this trend was to change drastically with the advent of the Europeans.

Logan (1972) has pointed out that the most conspicuous effect of the European contact of the 20th century was the dramatic change in the entire economic orientation of West Africa from the North (North Africa) to the South (Europe). According to Logan, Nigeria illustrates very well this reorientation and the kinds of spatial changes which follow. The pre-colonial Europeans traded with the coastal peoples first in slaves but later in oil palm, etc. According to Dike (1956) this trade with Europeans stimulated the economic, political and social life of the coastal peoples in the present Southern Nigeria and new city states emerged in these areas to cope with this prosperity. With time, the economic links which the areas now known as Nigeria had with North Africa became considerably weakened and replaced by economic links with Europe. Spatial changes accompanied this reorientation and the areas of prosperity changed accordingly from the north to the south. The coming of the European missionaries who founded schools, dispensaries, hospitals, etc mainly in the south then reinforced this new spatial pattern begun by the European traders. In this way the north-south dichotomy was well and truly underway.

The Colonial Period

There can be little doubt that British colonial rule in Nigeria served to worsen the north-south dichotomy in development which had started to emerge during the period of the European traders and missionaries. This it did in at least three ways: through its ordering of Nigerian cities; through its pre-occupation with the export and import trade; and through its distribution of amenities and developmental infrastructures. These three are not necessarily mutually exclusive and so need to be discussed together.

In 1917, the colonial administration passed the Township Ordinance which provided for the creation, constitution and administration of all towns in Nigeria (Mabogunje 1968). Three categories of towns were so created – first, second, and third class towns. Lagos was the only first class town. There were eighteen second class towns, twelve in the south and six in the north. Of the fifty third class towns created, as many as thirty-eight were in the south and only twelve were in the north. Figures 10 and 11 show the distributions of the first/second class towns and the third class towns respectively. From these figures, it is clear that most of the towns accorded status in the classification were either along or close to the coast or along the railway lines which had then just been constructed.



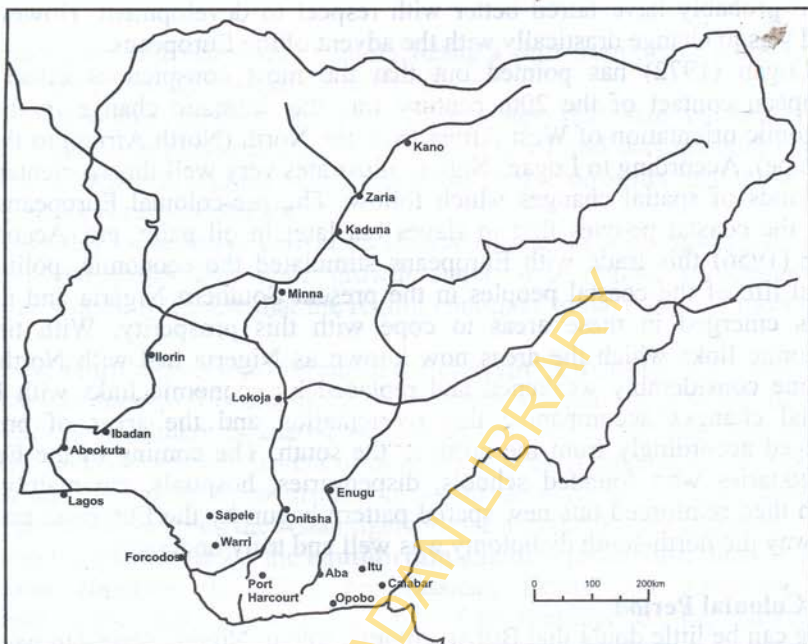


Fig. 10: Distribution of first and second class towns by the British colonial administration

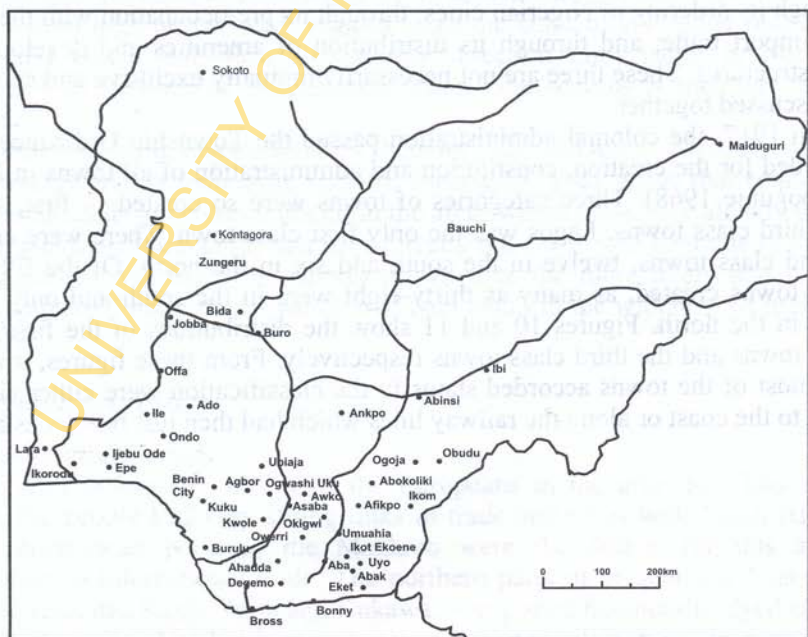


Fig. 11: Third class towns classified by the British colonial administration in 1919
(Source: Mabogunje 1968).

It is usually argued that ability to raise revenue was an important factor in the classification. However, it is difficult to pin down what other factors may have influenced the colonial administration in this township classification. It was certainly not population size alone, otherwise many towns in Figure 11 classified as third class towns, such as Ijebu-Ode and Benin, would at least have qualified as second class towns; while towns, such as Ogbomoso and Osogbo, which were not classified at all even as third class towns, will also have qualified as second class towns. Again the presence of such small centres as Forcados, Itu and Opobo in Figure 10 and Burutu, Koko, Kwale, Brass, Degema, Bonny, Eket, Ankpa, Ibi, etc. in Figure 11 means that other factors other than population size guided the township ordering. It was also not the traditional status of the towns which mattered, otherwise Ife, Sokoto and Benin would have qualified even as first class towns. It seems proximity to coastal ports and facilitation of the export and import trade were important in the rating. Forcados, a small town on the coast (Fig. 10), classified as second class town was so important during the colonial period that until 1914, according to Church (1955), goods for Lagos, the Nigerian capital, were transhipped at Forcados. In the end, we have to accept that proximity to the coast and contribution to the export trade were critical factors in the ranking. This contribution may have been measured firstly as the actual production of the raw materials exported which were at this time mainly palm oil and kernels, secondly, as the role played in the evacuation of the raw materials by serving as ports or other notable transport centres and lastly as role played as base or headquarters of either the colonial administration officials or indeed the officials of the merchant firms. All these factors favoured southern locations more than they did northern ones.

Whatever the reasons for the township classification, however, the important point to make is that this classification guided the colonial administration in the distribution of amenities and other developmental infrastructures. Thus, Lagos the only first class town was the first to get electricity in 1896 followed by the second class towns of Port Harcourt, Enugu and Kaduna in 1929, and Kano and Abeokuta by 1930. Indeed, by 1950, the only first class town had got electricity supply, and of the eighteen towns classified as second class, twelve had received electricity and only three third class towns out of fifty had done so. The same pattern is true of pipe-borne water where, by 1932, of the twelve towns having reasonably good water schemes, nine were either first or second class towns. Eight other centres, mostly third class townships had smaller water schemes (Mabogunje 1968, p. 114). The first and second class towns also had priorities in the distribution of health, educational and transport facilities. Later, even the distribution of colonial investments in basic industries were to follow this pattern.

It is therefore clear that the colonial government emphasis on the export trade with the building of roads and communications networks to facilitate this trade as well as the distribution of amenities and infrastructure on the basis of the township classification were to result in the build-up of developmental advantages well in favour of the coastal areas, meaning southern Nigeria. The explanation of the current spatial imbalance in economic development in Nigeria can therefore be traced, in part, to the activities and policies of the colonial

administration. If the beginnings of the spatial imbalance in Nigeria can be traced firstly to the early traders and secondly to the colonial administration which reinforced this imbalance, then, it must be to the activities of the later traders especially the multinational trading companies that we must turn for an overwhelming reinforcement of the imbalance.

In the 1920s, Nigeria came to be dominated by a relatively small number of large and highly integrated multinational companies. These included the United Africa Company (UAC), John Holt, Paterson Zochonis (PZ), Union Trading Company (UTC), CFAO, SCOA, etc. Kilby (1969) reckons that by 1949, the largest three of these companies accounted for some 49% of all traded commodities in Nigeria. With the discovery of oil in Nigeria in the 1960s, several multinational oil companies began to invest in Nigeria. Now, the volume of multinational investments in Nigeria is very large, in some cases, outstripping national effort. By 1963, according to Edozien (1968), multinational investments in Nigeria represented about 87.3% of all private investment and 80% of total investments in Nigeria. From my own studies of Bendel State of Nigeria, multinational companies accounted for as high as 83% of all investments in the state during the period 1963-69. By all accounts, the volume of multinational investments in Nigeria is simply tremendous. The question is, where were these multinational investments located?

According to Hakam (1966) and Kilby (1969), the factors that guided the location of multinational investments in Nigeria were knowledge of the local market and the economic environment, the existing distribution network and the cost of gathering information. In effect, multinational investments were located in areas which they already knew and these turned out to be the coastal areas which had been crucial for the export and import trade of an earlier period. It is logical, therefore, to hypothesize that multinational investments in Nigeria will show bias for coastal locations.

The arguments in support of this hypothesis are many. For instance, by 1969, well over 50% of all multinational investments in Nigeria were in Lagos. If we add the other coastal towns of Sapele, Warri, PortHarcourt and Calabar, the figure quickly jumps to about 70%. There is, therefore, a strong inverse correlation between distance from the coastal ports and level of multinational investments in Nigeria. Clearly, multinational corporations in Nigeria serve as important agents intensifying the distributional inequity. The circular cumulative causation theory in regional development states that nothing succeeds like success. Once a region has had an early start, it continues to attract development to itself. The endurance of the south-north gap can in part be traced to this phenomenon.

The Post-colonial Period

Nothing spectacular has happened during the post-colonial period to drastically alter the spatial pattern of economic development bequeathed by the pre-colonial and colonial periods. In the first place, since independence, transportation as a vehicle for integrating the economy has not been taken up with the urgency it deserved. The transport structure, especially the railways, with its south-north

orientation, designed to help the export/import trade by the colonial administration has not been altered in any meaningful way. As a result, 38 years after independence, there is still no railway line or major roadway running east-west! In the same way, industrial location policy as a means of redressing the spatial imbalance has never been pursued vigorously enough. According to Aboyade (1968), industrial policies concentrated on granting incentives such as import duty relief, income tax relief and capital allowance, but location policy as a means of achieving a rationally distributed pattern of industrial activity was ignored.

It is often argued that the *status quo* remained in Nigeria long after independence precisely because, according to politicians of the first republic, Nigeria achieved independence on a "platter of gold" without any revolution or bloodshed. Many of those who fought for independence did so not so much because they wanted to change things as that they wanted Nigerians to replace the British. The revolutionary fervour which was clearly apparent in America and Angola where the fight for independence was seen not just to end colonialism but also to alter the system of governance was clearly absent in Nigeria. No where is this endurance of the *status quo* more evident than in our railways. If Lord Lugard were to rise from his grave today, he would recognize virtually all our current railway lines precisely because they were built in his time!! Yet, transport is regarded, around the world, as one of the most important means to integrate a country.

The emergence of oil during the post-colonial period along with numerous concomitant economic activities have only served to reinforce existing spatial inequity. Amidst these plethora of forces that have tended to favour the south, there is a crucial countervailing force in favour of the north. This is the fact that, since independence, political and military powers have always resided in the north. This has meant that the investments by the Federal Government and its agencies (for example, the Petroleum Trust Fund, PTF) have almost always favoured the north without apparent effect on the spatial imbalance.

Distributional Inequity and National Integration

Unequal access can seriously undermine national unity and make the task of national integration difficult. This is especially so when the inequality coincides with ethnic divides. This is true of Nigeria where the regions with or without access are not just political areal units alone but also, in most cases, ethnic units. The fact is that in any nation, there is nothing that promotes ethnic harmony and national unity more than visible distributional equity. Inequality, in addition to threatening national unity, also stands in the way of sustainable development. Nobody will contribute his best when he feels cheated and deprived. So, to those who say that the cake must be baked before it is shared, the true answer is that the envisaged equity in the sharing will affect the baking in the first place!

Distributional inequity is doing havoc to our overall development, affecting ethnic harmony, damaging our social cohesion and ruining our politics. One notable Nigerian politician asserted recently, and I quote:

Northerners are endowed by God with leadership qualities. The Yoruba man knows how to earn a living and has diplomatic qualities. The Igbo is gifted in commerce, trade and technological innovation.

(Aboyade 1997, 14).

Needless to say, that underlying this statement is a sign of desperation arising from perceived unequal access. Clearly, the bizarre division of labour which the statement implies, connotes exclusion which is bad for politics and bad for national unity and integration. All these mean that the major obstacle in the way of national integration in Nigeria is not so much ethnic diversity but distributional inequity. National integration cannot be built upon a foundation of gross distributional inequity.

Take the case of a United Germany. At unification, the problem posed for national integration by the unequal prosperity between the West and the East was real. This is in spite of the fact that the peoples of both East and West are of the same ethnic stock. Chancellor Kohl quickly realized that to integrate a United Germany, the gap in levels of prosperity between the East and the West must be bridged. This was done by pumping investments into the East, by reactivating factories and creating jobs. Note that East Germany was being propped up by investments and creation of jobs in all its areal units. If this was Nigeria, a federal character policy which made individuals from the deprived areas Permanent Secretaries, Directors, etc, will be reached for! The point to emphasize, however, is that Germany realized that it cannot integrate the country given the very unequal access to development between East and West. The lesson to learn here is that inequality tears a country apart far more than ethnicity. No country can achieve national unity and integration unless it tackles the 'two-nation' problem. What can we do? To this, I must now turn.

What to Do

The pattern of Nigeria's spatial inequality is unique. There can be very few countries in the world, if at all, where the areas that hold political power are deprived. Elsewhere, minority and deprived groups and areas seek political power as a platform to help redress their deprivation. The coincidence of political power and socio-economic deprivation is very rare. This is because exclusion usually fuels inequality, and political power is the most important key to the promotion of inclusion and access. In the United States, the blacks have long realized that access to political power is the key to remedy the state of their deprivation. They argue, "Seek first political power and all the other things will be added onto you." So Nigeria represents a special case of political power coinciding with deprivation.

In pondering on what could be done in Nigeria to promote distributional equity, it occurred to me that Nigeria has tried numerous policies from the trivial to the serious. But then, Nigeria is not alone in trying trivial and ephemeral strategies to reduce the inequality gap. According to the London *Economist*, in the United States:

...at the turn of the century, with the economy booming and inequality on the rise, the Salvation Army threw a dinner party at Madison Square Garden. The Stadium's lights beamed down on thousands of poor people tucking into free food. The rich hired boxes and galleries to savour their philanthropy. Every body sang, "Praise God from Whom All Blessings Flow". It was hailed by the Salvation Army Commander as, "the dawning of a new era, the bridging of the gulf between the rich and the poor".

Economist. May 30, 1998, p. 13.

Clearly, acts of philanthropy and feeding of the poor cannot solve the problem of inequality. More seriously, the Federal Government has, over the years, formulated policies and programmes to reduce regional imbalance. These include the creation of more states and Local Governments, Federal Character policy, Directorate of Foods, Roads and Rural Infrastructures (DFRRI) and Community Banks to promote rural development, the Urban Development Bank to provide loans for urban infrastructures, the various housing programmes, creation of the new Federal Capital Territory, Abuja, etc. As this address has shown, these policies have had no substantial effect on the inequality gap. Lipton and Pavallion (1995) have argued that the best way of reducing the access gap is to grow the economy. Economic downturn exacerbates inequality. The problem is that the Nigerian economy has not grown in real terms in the last decade or so.

The best way to reduce the access gap in Nigeria is to put the reduction of this gap at the top of the national agenda. This would mean an affirmative action programme which concentrates on regions rather than on individuals as the current Federal Character policy does. The current Federal Character policy places emphasis on people rather than on areas. It is assumed that if the appointments of Permanent Secretaries, Ministers, Commissioners, General Managers, Board Members, etc. are such that all areas and ethnic groups are represented, then all will be well with spatial imbalance. It is forgotten that even if all such posts were filled by people from the deprived areas alone, the spatial imbalance will still be there. This is because most of the recipients of the Federal Character jobs from the deprived areas do not actually reside in the areas. Their contributions by way of incomes, savings and investments are therefore mostly felt elsewhere, probably more in the prosperous areas than in their deprived homelands. It will therefore be infinitely better for the Federal Government to concentrate on reducing spatial rather than people inequality. In the end, the narrowing of spatial inequality will itself narrow down people inequality.

To implement this areal-centred policy to reduce distributional inequity, it is crucial to set up a Federal Regional Commission similar to that of the European Union. Such a Commission was recommended some years ago but has never got off the ground. The Commission should be charged with the responsibility of bridging the regional imbalance. To achieve this, the Commission will need to identify, from time to time, the deprived regions and concentrate social (schools, hospitals, etc) and physical (roads, electricity, water, etc.) infrastructures in these areas. Investments in industries and social amenities could be attracted, through

various incentives, to the deprived areas. These will increase the access of the people in these deprived areas. With time, this increased access will build capacity among the people of the deprived areas which will enable them compete for jobs and other positions in the national setting without needing the Federal Character policy. Nigeria, of course, already has too many Commissions. The alternative to creating a new institution is the strengthening of the National Planning Commission to put reduction of inequality at the top of its agenda and carry out the areal-centred policies outlined here. This to me, is the way to go if we are serious about attaining distributional equity.

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OGI – PAST, PRESENT AND FUTURE

J.O. Akingbala,
Department of Food Technology

Introduction

It gives one great pleasure to present on behalf of the Faculty of Technology, the seventh in the series of inaugural lectures for the 1997/98 session, and the third ever in Department of Food Technology. The first two lectures from the Department were presented by Professor A.O. Olorunda and Professor O.C. Aworh.

Past definitions of *ogi* as a “starch cake” or starchy extract of cereals need some modification since strictly speaking, *ogi* is the endosperm extract of a fermented cereal. This accounts for the other components e.g. protein, fibre, minerals and fat present in *ogi* apart from starch.

Traditionally, *ogi* is made by steeping maize, sorghum, millet or rice in water at ambient temperature (30°C) for three to five days to soften the grain for wet-milling and wet-sieving to remove bran, sedimentation and dewatering of the extract – *ogi*. Before the advent of mechanical grinders powered by electricity or petroleum products, the softened grain was pounded in a mortar using a pestle. In Benin Republic, *ogi* is made by steeping maize in water overnight. The water is decanted in the morning and the relatively soft grain is ground without water into a dough which is then fermented before use. The dough generally is not sieved.

Basically the raw *ogi* is cooked into two products. The soft porridge called *ogi* or *eko mimu* (Yoruba), *akamu* (Hausa, Igbo) and various modifications of this e.g. *koko* (Hausa); and the hard gel known as *eko jije* (Yoruba) or *agidi* (Yoruba, Igbo) or *kafa* (Hausa). These products were eaten almost daily in most Yoruba homes accompanied by *akara* (fried bean balls), *moinmoin* (steamed bean paste), *ekuru* (steamed bean paste with sauce) *jogi* (steamed melon paste) and sauces; and at least once a day in its various forms *akamu*, *kafa* and *koko*, by the average Hausa family.

Most Nigerians at this lecture who are over fifty years old, were weaned on *ogi*. *Ogi* was consumed by the very young and the very old as a light food and

further diluted or crushed (*agidi*) in water as a thirst quencher. **Ogi** was also used for administering herbal medicines (*agunmu*) which kept our fore-parents healthy or cured of all ailments (*awogbaarun*).

In my first class introduction to **ogi** as a student in the University of Ibadan, I was told that it is a starchy extract of corn, low in protein content and quality and the nutrients need to be enhanced by the use of milk or legume protein. Judging from the protein content of cereals and the losses sustained during the traditional manufacture of **ogi**, this statement may be true. However considering that there is only 3.4% protein in natural liquid cow's milk and at least 5.6% protein in **ogi** by the poorest manufacturing method, **ogi** has a greater protein content than liquid milk. Quality wise though, the milk protein is superior to **ogi** protein, due to the amino acid composition of the protein of cereals from which **ogi** is derived.

Cereals

Cereals are edible fruits of grasses and were probably the first living things that God created. In the **Bible** account of creation (Gen. 1: 10.11), the Holy Bible says "And God called dry land Earth; and the gathering together of the waters called He the seas; and God saw that it was good. And God said, let the earth bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth and it was so" (K.J.V.).

Cereal grains are caryopses composed of the pericarp — a thin covering, the endosperm or food reserve and the germ or embryo. The endosperm is divided into two the floury and the corneous endosperm and texture of the seed is dependent on the relative proportions of these endosperms. The common cereals of economic importance include: wheat, maize, rice, sorghum, barley, oats, rye, and the millets. Others not so common include teff (found in Ethiopia), Acha and triticale — the man-made cereal.

Cereals have high starch content — 80% on dry weight basis, about 12% protein, 3-4.5% fat, 1.8 - 2% fibre and about 2% ash, some vitamins and sometimes different quantities of antinutritional compounds such as phytates, oxalates, condensed polyphenols (tannins), amylase inhibitors and flavonols. Starch content increases from the outside to the interior of the grain, protein content decreases while protein quality improves towards the centre of the kernel. The protein content of cereals range from a mean of 13.4% in rye to 7.6% in rice. Wheat, sorghum, oats and maize are in between these extremes.

Cereal proteins are poor in quality because of deficiencies in the sulphur containing essential amino acids. Lysine is generally in gross deficiency, with tryptophan, isoleucine, methionine, threonine, cystine and valine of marginal deficiency.

Protein

Proteins are composed of amino acids. There are about twenty naturally occurring - amino acids, some of which can be synthesized by man, and are therefore **not essential**. A shortage of any one of the essential acids stops the synthesis of a particular protein. Proteins are formed by amino acid building

blocks in a specific sequence. The protein is formed until the next essential amino acid in the sequence is not forthcoming, then the sequence is stopped. The absence of some essential amino acids causes health problems because the required protein for the bodily function cannot be formed. For the infant, nine amino acids are essential. These include isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine and histidine. The adult does not require histidine, therefore, only eight amino acids are essential.

Apart from amino acid composition, protein digestibility is an important factor in nutrition. Animal proteins are generally more digestible and of better quality to man than plant proteins because they contain a complete profile of all essential amino acids while plant proteins are deficient in some essential amino acids. However, plant proteins can be consumed in a combined form e.g. *ogi* and *akara* to provide a relatively complete required amino acid 'soup'.

Cereal Processing

Cereals are processed for the following reasons:

- to add value;
- to remove inedible parts;
- as intermediate materials in the production of other products e.g. starch and flour;
- to increase shelf-life;
- to increase aesthetic value;
- to improve nutritional quality;
- to remove or reduce antinutritional compounds;
- to make available in ready to-use form; and
- to improve digestibility.

Some of the reasons are interrelated and overlapping. Generally the processing of cereals involves one or several of the following unit operations.

- Drying
- Steeping
- Decortication
- Size reduction
- Heat treatment
- Classification
- Germination
- Fermentation, etc.

These unit operations can be combined in several ways to manipulate nearly any cereal to produce the desired product and to improve the nutritive value of the cereal.

Ogi Processing Operations

Traditional *ogi* processing operations include cleaning, steeping, size reduction (grinding), separation into different portions and further fermentation. Each of these operations contribute to the improvement of cereal into *ogi*, an intermediate material in the production of hot pap or *agidi*. The traditional process is long and wasteful in view of present day technology. The traditional long steep was to soften the grain for manual size reduction, not a fermentation step per se. Though some fermentation occurs, the real fermentation step is during and after sedimentation when the *ogi* is "soured". Excessively long steeping removes the soluble solids including protein into the steep water where they are lost. However, if the steeping period is too short, most of the harder corneous endosperm which is richer in protein, is lost as overs or bran. Fermentation improves flavour, colour, texture, protein quality, digestibility and produces acids which inhibit spoilage and disease causing organisms of *ogi*.

Factors Influencing Ogi Quality

The indices of quality in this instance include: yield, viscosity, flavour, texture, nutritional quality and sensory acceptability. *Ogi* quality is influenced mainly by the raw material,— i.e. presently the type of cereal grain, and the processing method. Of the three most popular cereals for making *ogi* i.e. maize, sorghum and millet, maize appears to be the best for *ogi* production. Maize *ogi* is similar in yields to sorghum, has better flavour, white or custard yellow colour which is preferred and cooks easier than sorghum *ogi*. Nutritionally, there is little difference between sorghum and maize *ogi* contrary to popular beliefs. Also brown sorghum is not the best for food or feed or as supplementary food because of the high tannin content in brown sorghum which reduces digestibility of the food components.

Millets are the best nutritionally. However the *ogi* yields of millets are smaller due to greater losses as solubles during steeping (Banigo 1972). Within each species, there are wide variations in *ogi* quality. Grain texture affects yields (Akingbala *et al.* 1981a) while the tannin content (polyphenolic) affects digestibility, colour and acceptability of *ogi* (Akingbala *et al.* 1981b). Popcorn yields greater amounts of *ogi* with better quality than several maize cultivars (Adenekan 1985). Starch type affects *ogi* quality. Waxy grains produce "thin" *ogi* and cannot be used for *agidi*. (Akingbala *et al.* 1981a). Waxy starches are composed of 100% amylopectin as opposed to the mixture of amylose and amylopectin usually in the ratio of 1:3 in "normal" starches.

High lysine Materials

In 1967, Mertz *et al.* of Purdue University discovered the maize mutant named Opaque 2 or high lysine maize because of its opaque endosperm and greater than normal lysine content on which improvement of the nutritional status of the maize consuming populations was hung. However, the high lysine varieties did not live up to expectation in various food tests. In Mertz's own words; "There was great hope during the early 1970s that Opaque 2 would improve the health of

millions of people in the countries where corn was a major staple in the diet, unfortunately, this did not occur” (Mertz 1990). The Opaque 2 had other problems including chalky grain, small ears, lower yields, greater susceptibilities to fungi and insects, and lower drying rates; it also contained amylase inhibitors. In addition to all these and more importantly, the Opaque 2 or High Lysine corn (HLC) was not suitable for making *ogi* by the traditional commercial methods (Banigo and Adeyemi 1975).

The HLC has been improved over the years into the quality protein maize (OPM) which has harder and more translucent endosperm than the comparable *ogi* yields, comparable *ogi* protein digestibility and greater lysine and tryptophan contents in *ogi*, than the normal corn (Agbara 1991).

Factors affecting the nutritional quality of *ogi* for adults include proximate composition of the *ogi* which is linked closely to the proximate composition of the grain and the method of *ogi* production. Generally, the nutritional quality of the grain is improved during *ogi* manufacture. The protein quality is improved as well as digestibilities of the other components. Because of the larger capacity of the adult stomach, adults may derive considerable nutrients from *ogi* especially when supplemented with legume products.

Ogi alone is highly incapable of satisfying the requirements of a growing child during the food-acustoming period — before the child is satiated (weaning). Akinyele and Omotola (1986) reported that the factors which limit the energy intakes of an infant weaned onto a lower energy gruel are the volume that the child can consume at one time and the frequency of feeding. An infant dependent on bulky gruels would be receiving 878kj of energy and 4.8g protein daily against the recommended daily allowance of 3229kj and 13g for a 6 month, 7kg child (FAO/WHO 1973). Realizing that the child might not be having enough, our people force-feed the child till the stomach and the eyes begin to bulge.

The solid content of *ogi* porridge rarely exceeds 10% and for *agidi* 15%, the rest is water. Hence the Yoruba saying: “*Oyinbo mu tea, mo mu ko, omii gbona la jo nmu*”. The translation, “there is no major difference between the white man’s tea and *ogi* porridge, both are basically hot water” is not far from the truth. Advantages of *ogi* as a weaning food include the following:

- it is cheap
- it is available
- it is easy to prepare
- when freshly-prepared and hot, it is pathogen-free
- it is easily digestible
- it can be made to satisfy the needs of a growing child.

The disadvantages include:

- low protein content
- poor nutritional quality

- bulkiness
- if handled carelessly, it has been reported to cause diarrhoea.

Ogi: Past, Present and Future

The Past

Before the 1960s, very little was reported on *ogi* or any other Nigerian traditional food, as Food Science and Technology as a discipline was established in Nigerian Universities only in the 1970s (Aworh 1994). Early pioneer scholars on *ogi*, Akinrele (1966) Oke (1967) and Banigo (1967) were chemists and biochemists. Akinrele submitted a thesis titled "A Biochemical Study of the Traditional Method of Preparation of *ogi* and its effect on the Nutritive Value of Corn" for the award of a Ph.D. degree of the University of Ibadan in 1966. He had also published several well-researched articles including "The Nutritive Value of *Ogi* a Nigerian Infant Food (1967); "An Assessment of the Nutritive Value of a Maize — Soya Mixture, "soy-ogi", as a Weaning Food in Nigeria (Akinrele and Edwards 1974). These and the works of Oke (1967), the Ph.D thesis of Banigo (1967), other published articles by Banigo and Muller (1972a,b), Banigo *et al.* 1974), Banigo and Adeyemi (1975) and Oyenuga (1968) formed the basis for my submission to my supervisor in 1977, when asked to write a proposal for a Masters' degree project on *ogi*, then, in my intellectual naivety, I had asserted that all the work on *ogi* had been done.

The emphasis of these initial (pioneering) works were to describe and evaluate *ogi* as food to an international community. The traditional process of *ogi* preparation was described. Microorganisms involved in the wild fermentation of grain to *ogi* were described and their contribution to *ogi* acidity, flavour, acceptability and storage were reported. Nutritional losses during *ogi* manufacture were also highlighted.

Present and Future

Efforts of the pioneers of studies on *ogi* have been rewarded. *Ogi* is now well known internationally though still stigmatized as a poor weaning food, bereft of protein. However, many of the present day workers see *ogi* differently — the reports that fermentation improves cereal protein quality were to my knowledge first presented in the late 1970s and early 1980s by Fields and his students (Hamad and Fields 1979; Kazanas 1979; Au and Fields 1979; Hamad and Fields 1981). This has changed the way we view *ogi* nutritional quality. The emphases of most present works have been on improving *ogi* yields, evaluating new materials in the manufacture of *ogi* to improve nutritive status, review of processing methodology, isolating and evaluating starter organisms for *ogi* fermentation and improvement of *ogi* acceptability.

My Contributions

My contributions towards knowledge on the improvement of *ogi* started about two decades ago. My first two papers on *ogi* (Akingbala *et al.* 1981a & b), were extracted from my Master's thesis — Characterization of Selected Sorghums for

the Preparation of *Ogi*, A Nigerian Fermented Food (1979), which highlighted the contributions of endosperm texture, endosperm type and presence of tannins as important parameters for determining sorghum *ogi* quality.

Similar evaluation has been done for maize where *ogi* yields and qualities were compared for normal, high lysine corn, quality protein maize, popcorn etc; and maize of different grades — sound, slightly damaged and heavily damaged (Ogunsekan 1988; Agbara 1991; Olayemi 1986, Akingbala *et al.* 1986). Work on improvement of *ogi* quality was done in three dimensions viz — evaluation of improved and new raw materials for *ogi* production (Ogunsekan 1988; Olayemi 1986, Agbara 1991; Sangodoyin 1990), improvement of traditional method of *ogi* production (Ogunsekan 1988; Agbara 1991; Animashaun 1992; Oyeleye 1997) and fortification of *ogi* using available cheap local resources e.g. okra seed (Adenekan 1985; Amakoromo 1987; Ashaye 1992; Oyeleye 1997; Akingbala *et al.* 1994).

Evaluation of New Materials

Grain amaranth (*Amaranthus cruentus*) was evaluated for *ogi* quality using the traditional *ogi* production method (Akingbala *et al.* 1994). Grain amaranth is more nutritious than cereal grain judging by its proximate chemical composition and protein quality. However because of its very small size, it is very difficult to grind. Also after fermentation, steeped grain amaranth does not sediment in water at room temperature. However, the *ogi* produced from this material was well accepted.

Fortification

Ogi protein had been fortified using protein from sesame seed (Ekpeyong *et al.* 1977), soybean (Akinrele and Oniwinde 1981) and other protein-rich seeds. The mature okra seed is one of these. The okra seed has the following proximate chemical composition: 20.3% crude protein, 18.2% starch, 36.7% crude fibre, 14.0% fat and 5.0% ash. When dehulled, protein and other components increase while fibre decreases. Dehulled, defatted okra seed cotyledon may contain up to 50% protein. Okra seed increases *ogi* protein content, but also contributes an awful seed odour. Toasting of the seed before dehulling replaces this flavour with a nutty flavour which was well accepted and a chocolaty brown *ogi* which was well rated.

Flavouring

The acceptance of the nutty flavour of *ogi* fortified with toasted okra seed indicated that consumers, especially the young ones prefer flavours other than the traditional mainly lactic acid flavour of *ogi*. Adeyemi (1988) had earlier reported a preference for *ogi* flavoured with ripe pawpaw, mango and banana fruits. Oyeleye (1997) confirmed this finding by reporting greater acceptance of *ogi* to which vanilla flavour and colour had been added.

Changes in Ogi Processing Method

The low nutrient quality of *ogi* had been blamed on the traditional *ogi* processing

method by several workers (Oke 1966; Akinrele 1967; Akingbala *et al* 1981a). Since most of the nutrients are lost via the steep water, wash water, and sieving, these materials may be saved if these steps are omitted. Thus Animashaun (1992), produced *ogi* from ground sorghum paste. Yields of *ogi* from dry milled unsieved sorghum was 98.5% and the protein content was 98.1% of that in the grain. In comparison, yield of *ogi* from the traditional method was 57.8% and the protein content was 77.6% of protein of the grain. However, flavour, texture and colour of the sieved *ogi* were more acceptable than those of *ogi* from unsieved paste.

Preparation of Ogi From Malted Grain

Another deficiency of *ogi* as a transition food is its bulk. Ljungqvist *et al.* (1981) concluded that the prevalent protein - energy malnutrition of the third world was due to low energy density foods. *Ogi* density can be increased by reducing its viscosity through malting.

Malting is the germination and limited seedling growth of cereal grains (Aisien and Palmers 1983). Food reserves of the endosperm are hydrolyzed by enzymes such as α -amylase, β -glucanase, proteases and lipases during germination (Aisien and Gosh 1978). Thus, malting has the advantage of pre-digesting the nutrients for greater availability for use. Other advantages of malting are: increase in B vitamin content, increase in lysine and tryptophan contents, increase in sweetness and decrease in viscosity.

The use of malted maize for producing *ogi* was straight-forward and produced the expected results (Agbara 1991). However, use of sorghum malt for *ogi* was more tricky because of the controversy surrounding the use of sorghum sprouts. Wangs and Fields (1978) suggested that sorghum should be germinated at home to produce more nutritive foods. However, Panusuik and Bill (1984) opposed this suggestion based on the high HCN content (613 ppm) of sorghum sprout which is considered dangerous. It is safe to use sorghum malt for *ogi* production, while tables 7 and 8, and figure 1 show the advantages of using the malt for preparing *ogi* especially for the young (Animashaun 1982) Malted cereals are however unsuitable for *ogi* for *agidi* production because of the mushy texture of the gel formed (Nwagwe 1997).

Ogi - The Future

In addition to the studies highlighted earlier, the future of *ogi* production and quality is typified by the work of Adebawo (1997), who isolated and characterized strains of *lactobacillus plantarum* which secretes excess lysine (up to four times the amount secreted by the wild strain) and produced acceptable *ogi*. *Ogi* of the future will be generally well defined, by law as to the composition and nutrient information per serving; produced in factories as dry powdered products, flavoured and coloured. Packaging materials and storage conditions for *ogi* are presently being tested. Easy-to-prepare precooked *ogi* may be sold dry. Biotechnology will play more important roles in the preparation, definition and preservation of *ogi*.

ARABIC, THE MUSLIM PRAYERS AND BEYOND

Sayed H. A. Malik

Department of Arabic and Islamic Studies

Introduction

This inaugural lecture is the second from the Department of Arabic and Islamic Studies. The first was delivered on Thursday, January 30, 1986 by the late Professor Musa Abdul, who was the first Nigerian on the academic staff of the Department. His lecture came from the Islamic Studies component of the Department" and was titled: "Religious challenges to National Development".

My lecture is coming from the Arabic Language component of our Department. Therefore, I have the honour of delivering the first inaugural lecture from the chair of Arabic Language of this University.

The title of my Lecture is: "Arabic, the Muslim Prayers and Beyond", and the intention is to examine the relationship of Arabic with the religion of Islam, its historic contribution in the past and its role in modern times. The relevance of Arabic to the contemporary human societies will, I hope, emerge in the course of the lecture.

Arabic as a Language of a Revealed Religion

Wherever Islam was preached, encouragement was given to the learning of Arabic and to the establishment of schools for teaching the reading of the Qur'an and for the study of the Arabic Language and Islamic Literature. This is in consonance with the divine injunction in the Qur'an which stresses the importance of literacy in the life of man. This divine injunction is as follows:

- 1- اِقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ.
- 2- خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ.
- 3- اِقْرَأْ وَرَبُّكَ الْأَكْرَمُ.
- 4- الَّذِي عَلَّمَ بِالْقَلَمِ.
- 5- عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ.

1. Read! In the Name of your Lord Who has created (all that exists)
2. He has created man from a clot (of thick coagulated blood).
3. Read! And you Lord is the Most Generous.
4. Who has taught (the writing) by the pen.
5. He has taught man that which he did not know.

(Qur'an; 96:1-5).

It is evident that the main factor responsible for the spread of Arabic to areas outside the Arabian peninsula is Islam. Being the language of the Qur'an and the Islamic branches of knowledge (i.e. commentaries of the Qur'an, hadith-criticism, Islamic Law, theology etc.), Arabic has inevitably been interwoven with Islam. The intimate relationship between the two is reflected in the attributes and beliefs of the Arab and non-Arab Muslims over the centuries. They have always had great reverence for the Qur'an which exerted from the outset, a great influence on their religious, political, social and intellectual life.

The fact that every Muslim must recite portions of the Qur'an in its original Arabic in his ritual prayers, no matter what his native tongue may be, promoted considerably the study of Arabic, both as a native and foreign language. In the early centuries of Islam, there were linguistic developments which stemmed directly from the religious stimulus and aesthetic appreciation of the Qur'an.

In the long run, many non-Arabs were motivated to learn Arabic and suddenly the language found its users fast multiplying with the passage of years. Such fast increases in the number of Arabic users invariably led to the loss of the original purity and correctness of the language. Consequently, many ungrammatical Arabic expressions were soon to be heard in oral expressions as well as in the reading of the Qur'an. And with time, not only the non-Arabs were committing such grammatical mistakes but many Arabs as well. These developments naturally led to meticulous philological studies which culminated in the writing of valuable books on grammar, lexicography and other aspects of the language, all of which form the Arabic heritage to the present day¹. Thus, the Arabic Qur'an became the pivot around which linguistic studies revolved. Arabic grammar and morphology, for instance, were developed in order to protect the Qur'an from corruption by foreigners who later accepted Islam as a way of life; Qur'an exegesis evolved in an attempt to give the correct interpretation of specific verses of the Qur'an; Phonetics and the art of the recitation of the Qur'an in accordance with the established code of pronunciation and intonation emerged to ensure the correct production of the phonemes which make up the Qur'anic words and expressions. Arabic lexicography and Philology developed so that specific expressions contained in the Qur'an may be traced to their roots. Arabic rhetorics evolved to explain the use of unfamiliar images in the Qur'an².

The Qur'an was believed to represent the highest linguistic achievement of the Arabic language. For this reason, it has become a factor to be considered in any study of the Arabic language. This conviction must have facilitated the rapid development and dissemination of Arabic and contributed immensely to its transformation from an obscure dialect into one of the important languages of medieval and modern times.

Commenting on the relationship of Arabic with the Islamic religion, Browne, a non-Muslim, has observed:

The Arabic language is in a special degree the language of a great religion. To us the Bible is the Bible, whether we read it in the original tongues or in our own, but it is otherwise with the Qur'an amongst the Muslims. To them this Arabic Qur'an is the very word of God, an objective, not a subjective revelation³.

The Quran, which is held by the Muslims to be the very word of God, was revealed to Muhammad in the Arabic language. This book is thus regarded as the source of all knowledge and wisdom. Since the Arabic Qur'an is the word of God, it is inimitable and is generally held untranslatable. For this reason, Muslims in every age and place have considered it a religious duty to acquaint themselves with Arabic so as to be able to read the Qur'an in its original language. Thus, Arabic has become the religious language of all Muslims irrespective of colour, race or nationality. Hitti emphasized this point when he said:

The classical form is not only the literary form used by all the Arabic writing peoples but also the religious language of all Muslims, no matter what their native tongue may be. To Muslims, Arabic is the only appropriate language of approach to Allah⁴.

Many Muslim theologians, philosophers and philologists upheld the doctrine of the divine nature of the Qur'an. This came to encompass the Arabic language itself. In the introduction to his well-known Arabic lexicon, *Lisānu-l-'Arab*, Ibn Mansur says that it is God who made the Arabic language superior to all other languages and that He enhanced it further by revealing the Qur'an through it and by making it the language of the people of paradise. He relates a tradition attributed to Prophet Muhammad stating the three reasons why people love the Arabs:

أَنَا عَرَبِيٌّ. وَالْقُرْآنُ عَرَبِيٌّ. وَلِغَةِ أَهْلِ
الْجَنَّةِ الْعَرَبِيَّةِ.

I am an Arab; the Qur'an is Arabic; and the language of the people of Paradise is Arabic⁵.

Similarly, Mahmud Taymur, a famous Egyptian scholar and a member of the Egyptian language Academy, rejects the views of those who consider standard Arabic doomed to perish as Latin did. He argues that Arabic is the language of a revealed religion (*Lughatu dīnin samāwiyyin*) and that it is bound to remain a living language as long as the Qur'an and Islam exist⁶.

This situation is aptly described by Chejne as follows:

It is the kind of conviction coupled with the religious devotion of the faithful that was the main factor contributing to the belief in the supremacy of the Arabic language as revealed through the Qur'ān and in the necessity for learning and reproducing the language of God's word in a way befitting its divine origin⁷.

It is worth noting that the grammar taught in the schools of the Arab world today is virtually identical with the grammatical system devised by the eight-century Muslim scholars. It should also be pointed out that the efforts of these scholars were confined to classical Arabic rather than spoken Arabic dialects. Thus, while the latter developed faster along different lines in different areas, the former was much slower in development holding the classical form of the Qur'an and pre-Islamic poetry as its model and was always close to this model no matter in which areas the literature was produced. This implies that standard Arabic was protected from what is normally termed 'linguistic decay' to which some European languages like Latin and Old English have been exposed⁸. As a result, the spoken Arabic of the different Arab countries can truly be described as dialects of one and the same language rather than separate languages.

Arabic as a Medium of Historical Documentation

From the historical perspective, Africa, like some other continents, is greatly indebted to Arabic for serving as the vehicle of a vast literature and for keeping African historical records which we, as Africans, can proudly call our own. Many centuries before the coming of Europeans to West Africa, Arabic had brought its educational achievements as well as its rich literature to the West African environment. It is on record that for about three hundred years, between the 17th and 19th centuries, Arabic documents remained the only sources of information for European writers who were interested in the history of the Western and Central Sudan. Many of the scholarly works written by native West African authors in Arabic or in their native languages using the Arabic script formed valuable source material for the reconstruction of African history. It is worth noting that these Arabic works contain convincing and sufficient evidence to show that Africa had never been a dark continent as claimed by European writers on Africa. This point has been well articulated by renowned African scholars. For instance, the late Professor K.O. Dike, a former Vice-Chancellor of this University said:

As a historian myself, I have taken the keenest interest in this development for it is through the aid of these Arabic documents, and those written in African languages in the Arabic script, that the scholar will be aided in his task of unlocking the secrets of the African past. It had been a revelation to the whole world of scholarship to realize for the first time that Africa before the European penetration, so far from being a "dark continent", was

in fact a continent where light of scholarship shone brightly, as the Arabic works now being discovered bear testimony.⁹

Emphasizing the importance of Arabic in the history of the Sokoto Caliphate, Last commented:

... the fullest histories of the first fifty years of the nineteenth century are those written in Arabic ... For the later period, it is the Arabic sources again ... that provide the data for the Sokoto administration and its crises during the last two decades of the nineteenth century... Without recourse to the Arabic sources no adequate study of Sokoto, I believe, is possible. Most modern historians have overlooked the importance of the Arabic sources in relation to the oral tradition, owing to the property of published texts or translations. Further, since the translations that are generally known are sometimes misleading, scholarship based on them is somewhat vitiated¹⁰.

Commenting on the important role of the Arabic scholars in various research efforts aimed at discovering indigenous materials for writing authentic Nigerian history, the late Professor Dike said:

...It is through their work on the enormous amount of Arabic material in Archives and Libraries, both public and private, that we shall be enabled to put together a coherent picture of Northern Nigerian history based on our own indigenous source materials and not, as in the past, chiefly on the report of colonial administrator and foreign travellers, valuable though much of these material is. The significance of this for the new generation of Nigerian students in schools and colleges can hardly be over-emphasized. The Arabic scholars of the present, drawing upon the writings of the Arabic scholars of the past, will be able to bring before us the events and happenings of the past ages of Nigeria, and so help us to write a history we may rightly call our own¹¹.

It is pertinent to mention that records written in Arabic or in Swahili using the Arabic script also constitute an important source material for the history of East African countries. On this point Kamera and two other scholars comment as follows:

But the most important documents of medieval history on the eastern coast is [sic] found in written records. Most of them were written in Swahili (using Arabic characters), in Portuguese, English and German, and in Arabic, Persian and Gujerati¹².

It is thus clear from the assertions of scholars of African history that the importance of Arabic to African history, including West African history, is immense. Since records of pre-colonial Africa existed only in Arabic or in African languages written in the Arabic script, knowledge of Arabic is certainly indispensable to historians of those periods of African history. The validity of this assertion is underlined by the fact that the doctorate theses of at least two former students of the Department of History of this University had to be jointly supervised by our Department of Arabic and Islamic Studies and the Department of History. Both of them are now accomplished historians of international repute.

That Arabic is very relevant to African history is also attested by the fact that the title of the journal published for the Historical Society of Nigeria is *Tarikh*, which is the Arabic word for "history".

It hardly needs saying, of course, that there will be no history if there are no events, and events can only be prevented from falling into oblivion if they are recorded through the instrumentality of language. It is, therefore, important to note that prior to the European penetration, Arabic language had played a crucial role by serving as the only indigenous African language through which the events of the African past were recorded for the present and future generations.

Arabic Literacy

In all communities that have embraced Islam, the history of Arabic literacy is traceable to the advent of Islam in such communities. Thus, Arabic has made outstanding literary contributions to the indigenous West African civilization by bringing the first form of literacy (i.e. Literacy in Arabic) to West African countries before the coming of the colonial masters to the area. Many West African languages such as Wolof, Mandinka, Hausa, Fulfulde and Yoruba were commonly written in the Arabic script before the introduction of the Latin script. Writing in local languages using the Arabic script is known as *ajami*. Until the twentieth century, Hausa and Fulfulde were written in this Islamic literacy tradition¹³.

Records show that by the first quarter of the nineteenth century, itinerant Hausa trader-teachers had settled in Yorubaland teaching the natives basic Islamic sciences and Arabic literacy. A testimony of the cultivation of Arabic by the Yoruba at that time is given by Richard Lander, the British explorer who, in company of Captain Clapperton, visited parts of Yorubaland between 1825 and 1826. He has recorded:

There were Mallams (teachers) from Hausa reside [sic] in almost every town through which they passed. The Mallams were in such towns propagating their religion and teaching the inhabitants to read and write in Arabic. Therefore, Islamic education had evidently been introduced to towns like Oyo, Ogbomoso, Ikoyi, Iseyin, Igboho and Badagry, at least, by the beginning of the last century¹⁴.

Furthermore, the encouragement and patronage of the ruling elite enhanced Arabic-Islamic learning in major towns of Yorubaland in the nineteenth century. For instance, it is on record that Apati, a chieftain of the Owu clan, sent eight of his children for instruction in Qur'anic studies under the guardianship of a Fulani Mallam who accompanied the clan during its migration to the city of Abeokuta in the nineteenth century¹⁵. It is, therefore, not surprising that the earliest documents in Yoruba language, as in other West African languages, employed Arabic script. This is because Arabic was the only written language known to the natives before the advent of Western education and the introduction of the Latin script. That Arabic literacy was a prominent phenomenon in the Yoruba Muslim communities by the beginning of the nineteenth century when colonialism was being imposed and Christianity was being introduced is further confirmed by another evidence to the effect that the Christian missionaries in their attempt to develop a standard Yoruba orthography to enable them to undertake scholastic and evangelistic work considered, among other options, adapting the Arabic script. On this point Samuel Johnson says:

The earliest attempt to reduce this language into writing was in the early forties of the last century, when the Church Missionary Society, ... organized a mission to the Yoruba country.... After several fruitless efforts had been made either to invent new characters, or adapt the Arabic, which was already known to Moslem Yorubas, the Roman character was naturally adopted¹⁶.

The prominence of Arabic literacy before the advent of colonialism in Africa is also true in the case of East Africa as attested by the following statements of Tolmacheva's:

There is evidence that literacy came to the East African coast very soon after hijra; but that it was at first a hieratic art confined to religious works in the Arabic language¹⁷.

There is the story of a British professor of African languages who visited the president of a West African country sometime ago. While the professor was talking about education and literacy in Africa, the president was surprised to hear about the high literacy rate in his country. When the president asked the professor for evidence, the professor requested the Head of State to allow his cook and servants to be brought in. They could, of course, neither write in English nor in the Latin script. But when the visiting professor insisted that they should write anything, they all started to write their names in the Arabic script¹⁸. Thus was the British professor able to prove his point to the president who had previously regarded his servants as illiterate.

It should be noted that in recent times, there is a growing interest of Muslim peoples in using the Arabic script to write their native languages. For instance, there are at present in Northern Nigeria publications in Hausa language using the Arabic script. These include books, pamphlets and weekly newspapers. The

current effort being made by the Morocco-based Islamic Educational Scientific and Cultural Organization (ISESCO) in encouraging the use of the Arabic script in writing the languages of Muslim peoples is noteworthy in this regard. Four Nigerian languages – Hausa, Kanuri, Fulfulde and Yoruba – are among the fifteen languages selected from East and West Africa by this organization which, in collaboration with the Islamic Development Bank, Jeddah (Saudi Arabia) has standardized the Arabic symbols and manufactured special typewriters are available in the Department of Arabic and Islamic Studies of this University.

Empirical evidence shows that there are many people in West and East Africa today who cannot write either in the English or the Latin script but who still read and write things in their local languages using the Arabic script. Thus, those who are erroneously considered illiterate are in fact literate in Arabic. An indication, perhaps, that more Nigerians are literate in Arabic than in English is the fact that the Nigerian currency note carries an inscription indicating its value in a Nigerian language written in the Arabic script.

From the foregoing analysis, it is clear that many countries in West and East Africa has proved no exceptions to the general rule that the spread of Islam is accompanied by a spread of literacy in Arabic which provides a means of opening up communications in a way not possible for illiterate people. Therefore, the role of the Arabic language in providing a common form of literacy over large parts of West and East Africa as well as in establishing a means of both local and international communication and as a vehicle for education right up to the present day cannot be ignored.

Arabic Literacy Contribution

Apart from the Qur'an, which was revealed in Arabic, the Hadith and the literary works which explain in clear terms the religious, philosophical and legal foundations of the Islamic community and its contributions to world civilization in the fields of literature, arts, science, medicine and architecture, were originally written in Arabic before they were translated to other languages. It should be further noted that in the ninth and tenth centuries, which were accompanied by an enormous literary output, the Arabic language acquired a universal character. As the medium of intellectual expression, it has a general appeal not only among Muslims but also among non-Muslims.

Commenting on the important role which Arabic played from the eleventh century onwards, Chejne says:

Arabic served as the medium for transmitting Greco-Arabic lore to the West through the translation of Arabic books into Latin, Spanish and Sicily served as the link between East and West in the cultural osmosis that had an enormous influence on Western thought¹⁹.

Moreover, it should be pointed out that Arabic served as the medium through which many of the excellent works of the Romans and the Greeks were passed to modern Europe. On this point Hitti observes:

Language, 'next to religion, constituted the major enduring contribution of Arabians. For some three hundred years, beginning in the mid-eight century, Arabic was the vehicle for transmitting scientific, philosophic and literary thought, which was quantitatively and qualitatively superior to anything being transmitted in Latin, Hindu, Chinese or any other language²⁰.

Thus, scores of books were preserved in the Arabic translation whereas the original writing of such works was lost forever.

An important aspect of the literary contribution of Arabic is in the area of travel literature. It is to be noted that Arabic travel literature constitutes a large segment of the general main stream of Arabic literature. Many Arab and Muslim travellers have contributed in varying degrees to our knowledge of the people and places with which they came into contact at certain periods of Islamic history. It is pertinent to mention that scholarly travels for the sake of acquiring knowledge in both medieval and contemporary Muslim societies are motivated by religious purposes. In this connection, the following *hadith* (tradition) of Prophet Muhammad is very relevant:

من خرج في طلب العلم و هو في
سبيل الله حتى يرجع

He who goes out in search of knowledge will
be in the path of Allah until he returns.

Thus, travel as a meritorious activity is endowed with an ancient pedigree in the Muslim tradition.

One of the most famous contributions to Arabic travel literature is the Moroccan, Muhammad Ibn Abdallah, known as Ibn Battuta. He travelled widely in Africa, Asia and Europe. One of his primary aims was to describe the contemporary scenes of the Islamic World and beyond.

Among the most outstanding works of medieval Arabic travel literature are the two books written by Ibn Jubair and Ibn Battuta. The books are still available in Arabic and some European languages²¹. It is to be noted that Ibn Battuta's work and the results of field research and historical studies of other Muslim travellers are still of interest not only to historians, geographers, anthropologists and folklorists, but also to students of literature and stylistics.

Arabic was used in various ways during the nineteenth century in Nigeria in particular and West Africa in general. They include correspondence, political books and pamphlets, treatises of advice to rulers, biographical literature, histories, ethnography, sociology and education²². It should be pointed out, however, that the uses to which Arabic was put in the past should not be interpreted to mean, in spite of the impact of education in English or French over the past eight years, that the language is falling into disuse in West and East Africa as a means of communication and recording history or as a medium of education. In fact, the tradition of Arabic scholarship is still very much alive in

Nigeria and other West African countries. In these areas, many learned Islamic scholars still use Arabic to express their ideas and to record events. Many of them also have large libraries and correspond with each other in the Arabic language.

A thorough examination of the level of scholarship and the degree of proficiency and artistry achieved by indigenous West African Arabic scholars reveals that Arabic has become a symbol of intellectual development and identity of Islamic communities of sub-Saharan Africa. From the second-half of the twentieth century, West African scholars writing in Arabic with remarkable ease have increased considerably. They have written scholarly works in every genre of Arabic scholarship such as poetry, prose, short stories and novels in addition to their great contributions in the field of pure Islamic sciences. A survey of the extant literary works of these 'ulama' shows that they have been very prolific.

In their provisional account of the Arabic literature of Nigeria up to 1804, Bivar and Hiskett (1962) listed some 45 Arabic works written by Nigerian scholars²³. Kensdale (1955) published a catalogue of the Arabic manuscripts preserved in the Kenneth Dike Library (formerly Ibadan University Library), University of Ibadan,²⁴ while Balogun (1975) listed 115 Arabic works written by Uthman Dan Fodiyo²⁵. Bello is also reported to have listed 521 Arabic works attributable to Nigerian writers²⁶. Similarly, Bashir (1985) listed 101 by Abdullah b. Fudi, 114 by Muhammad Bello b. Uthman b. Fudi, 51 by Shaikh Junaidu, the late Waziri of Sokoto, 44 by 'Abdul Qadir b. al-Mustafa and three by Asma'u, the daughter of Uthman Dan Fodiyo²⁷.

That Arabic literary composition was held in high esteem in the Sokoto caliphate is attested by Last who avers:

To write poetry in Arabic was the attainment of a cultured man, and the famous poems of the founders of the Sokoto caliphate became part of Sokoto culture: the poems of the Shaikh (Uthman Dan Fodiyo), Bello and others were learnt by rote by children; today they are broadcast over the radio²⁸.

It is pertinent to mention that the cultivation of Arabic literacy scholarship in the nineteenth century in West Africa was not confined to male scholars only. Nana Asma'u, the famous daughter of Shaikh Uthman Dan Fodiyo "was one of the most learned of the Shaikh's children, a poet in Fulfulde and Arabic, and an author of three books in Arabic"²⁹.

As has been pointed out earlier in this lecture, the cultivation of Arabic-Islamic learning was prominent in Yorubaland in the nineteenth century. The uses to which Arabic is put in Yorubaland confirm its relevance and importance to the Yoruba Muslim community. From the time Arabic found its way to Yorubaland up till the present day, many learned natives of Yorubaland have not only used written Arabic for all sorts of purposes – religious, social and educational – but have also produced sizeable works of great academic value in Arabic³⁰. In this connection Muslim scholars in the city of Ibadan have always played a leading role.

An important fact which indicates the importance of Arabic in Yorubaland is that certain records were kept in Arabic, notably those of *qadi*'s courts. Many families in parts of Yorubaland are called '*alikai*' families because their forefathers were *Shari'ah* court judges. It is on record that Oba Abibu Olagunju, the first Muslim Timi of Ede in Osun State, who ruled in the second half of the nineteenth century, accorded the *Shari'ah* official recognition in his domain. Consequently, a *shari'ah* court was officially established in Ede at a quarter called Agbeni in 1913³¹. The name of the first *qadi* (alkali) of the court was Sindiku (Siddiq) who recorded the proceedings of the court in the Arabic language.

It should be noted that the extent of Arabic penetration into Yorubaland is not confined to the area of scholarship but is also visible, together with Islam, among the lowest classes of the society. That is why we still see thousands of private and unrecognized Arabic schools everywhere in Yorubaland devoted to the teaching of Arabic and Islamic literature to the exclusion of almost anything else. Thousands of Yoruba Muslim children attend these schools, many of them thereby forfeiting their places in the recognized Government schools. The establishment of these Arabic schools was and is still a spontaneous reaction on the part of the Muslim masses and a way of demonstrating their strong interest in Arabic Studies. As has been said, Arabic was the only form of education before the colonial era. Far from fading away with the spread of the Western-type schools, these Arabic schools are on the increase everywhere in Yorubaland. Therefore, the relevance of Arabic to the Yoruba Muslim community (like any other Muslim community) cannot be overemphasized.

The remarkable diffusion of Arabic language among the various ethnic communities of sub-Saharan Africa has made it a status symbol of the cultured. As Last has rightly observed, "Arabic was the *lingua franca* of the learned: being not merely a literary but also a spoken language (admittedly in the classical form) throughout Muslim West Africa, it was often the only means of communication between the communities of Tuareg, Kanuri, Hausa, Fulani, Nupe or Yoruba. Further, the religious and scholastic character of the Sokoto caliphate ensured that Arabic was the language of state"³².

Arabic vis-à-vis Other Foreign Languages

While many Nigerians are aware that Arabic is one of the foreign languages taught in Nigerian schools, only a few of them know that the provision for its teaching in Nigerian schools is much less adequate than that for the teaching of English and French. This imbalance can be attributed to the fact that there are still some misconceptions about Arabic in spite of its long history in Nigeria. One of such misconceptions is that Arabic is only relevant to Qur'anic teaching and Muslim prayers. Obviously, this view is held by people who were educated in missionary schools and even public schools which are noted for prejudices against the Arabic language and the Islamic religion. This kind of misconception can be regarded as a remnant of the colonial past.

The misconceptions about Arabic are manifested in a number of hostile attitudes, stands and statements related to the teaching and learning of the

language even in tertiary institutions. On one occasion, to cite just one instance, the late Professor El-Garh, who was then the Head of the Department of Arabic and Islamic Studies, was introduced to a female University of Ibadan Professor at a social gathering. She then asked Professor El-Garh: "For how long do you keep students in your Department?" Professor El-Garh replied: "We keep them for four years". She then retorted: "Four years! Is there anything to learn in Arabic other than these Muslim prayers?" Obviously, the learned professor was quite ignorant of the fact that in modern times the role of Arabic as a language transcends the religious sphere.

There is no doubt that the most popular of all the foreign languages taught in Nigerian schools is English. The reasons for the popularity of English are obvious. First, English is a colonial language and, as such, it has been adopted as the official language of Nigeria. Secondly, it is the language of science and technology. Thirdly, English serves as a kind of international medium of communication. For these reasons adequate provisions are made for its teaching in Nigerian schools. Hence, Nigerians who are literate in English show evidence of a high degree of competence in using it.

But despite the fact that English is Nigeria's official language which serves, among other things, as the medium of communication for persons from the different ethnic groups, it is not used by the majority of Nigerians. It is only popular among the elites who are literate in English. Professor Ayo Bamgbose, a distinguished linguist, has summarized the situation with regard to the place of English in Nigeria in the following words:

The case of English has always been overstated. It is true that English in Nigeria is a common language, but only for educated elites. Perhaps as many as 90 per cent of our people in both urban and rural areas are untouched by its alleged communicative role³³.

French enjoys a more favourable position in Nigerian schools than Arabic even though it arrived in Nigeria much later than Arabic. An objective assessment of the situation in most primary and secondary schools shows that the teaching of French is encouraged more than that of Arabic. One continues to wonder why the current wave of enthusiasm for French in schools has not been extended to Arabic. It certainly should be, in our own opinion.

Considering the present socio-linguistic situation in Nigeria, it is pertinent to mention that at least one well-known Nigerian linguist has acknowledged the fact that Arabic, like English, is another foreign language whose influence over millions of Nigerians cannot be ignored. This view has been expressed by Professor Ayo Banjo as follows:

But we must remember that English is not the only non-Nigerian language that exerts a strong influence over millions of Nigerians. There is also Arabic, and those who have it in their repertoire have more situations to adjust to appropriately³⁴.

Universal Applicability of Arabic Wise Sayings

Arabic wise sayings, like proverbs, are brief epigrammatic utterances presenting well-known truths that are popular and familiar to most people. They reflect the way of life of the Arabs, their social relations, moral values, manners and customs. In addition, they reflect their powerful expressions and eloquence, and their mastery of the Arabic language.

On the whole, Arabic wise sayings constitute a rich source for Arabic literature as they are universally applicable to various contemporary situations. Here are some examples.

On knowledge:

1- كلّ عزّ لم يؤيد بعلم فالى ذلّ يصير.

- (1) Every glory unsupported by knowledge will soon vanish and be replaced by humiliation³⁵.

2- أي شيء أدرك من فاته العلم و أي شيء أضاع من أدرك العلم.

- (2) What has he got who has missed knowledge, and what has he missed who has acquired knowledge?³⁶

On Justice:

العدل لا يعرف صديقاً.
Justice does not know any friend.

On the importance of health:

الصحة تاج فوق رؤوس الأصحاء لا يراه إلا المرضى.

Health is a crown on the heads of the healthy people, but only the sick people see it.

On the ephemeral nature of worldly power:

لو دامت لغيرك لما جاء دورك.

If the position you occupy were to last for ever,
your turn would not have come.

Influence of Arabic on other Languages

As the language of the Qur'ān and a vehicle of Islamic culture, Arabic has influenced the languages of Muslim peoples, resulting in syntactical and lexical borrowings.

In Asia, Persian, Turkish, Urdu and Malay are amongst the languages that have been tremendously influenced by Arabic. In Africa too, Somali, Swahili, Mandinka, Wolof, Hausa, Fulfulde, Kanuri and Yoruba have acquired loans from Arabic words and expressions. Thus, Arabic has enriched these languages with thousands of religious, political, legal and commercial words and expressions.

Arabic Influence on Swahili

Swahili, which is spoken in Tanzania and other East African countries, has been greatly influenced by Arabic. One of the theories concerning the origin of Swahili language is that it is a creole that came into being when the coastal Bantu tribes in East Africa inter-married with Arabs. In this connection, Dr. G.S.P. Freeman-Greenville in his article on medieval evidences for Swahili has argued:

Swahili owes much to Arabic: and the first indication of such a process of hybridization on the East African coast is in the Periplus of the Erythraean sea, written by an unknown Alexandrine Sea-Captain of the 1st Century A.D...³⁷

Professor Muhammad Hassan Bakalla computes that Swahili has borrowed more than thirty percent of its vocabulary from the Arabic language³⁸. It is interesting to note that the influence of Arabic is also reflected on proper nouns and epithets used in the Swahili language. For instance, the name of the capital of Tanzania, Dar es Salaam, is borrowed from the Arabic phrase "*dārus-salām*" meaning "the home of peace". Also the popular Swahili epithet for Julius Nyerere, the former Tanzanian President, is "*mwalimu*" which is borrowed from the Arabic word "*Mu'allim*" meaning "a teacher".

Arabic Loan Words in Hausa

Hausa has borrowed extensively from Arabic³⁹. It has also adopted Arabic names for the seven days of the week. Apart from many lexical items used in Hausa which are loan words from Arabic, a good example of the influence of the latter on the former is the use of the pronoun prefixes /ya-/ and /ta-/ for masculine and feminine nouns respectively. The following sentences amply illustrate this point:

ARABIC	HAUSA	MEANING
(i) <u>yadhab</u> يذهب	yana tafiya	he is going
(ii) <u>tadhab</u> تذهب	tana tafiya	she is going

Similarly, the pronominal suffixes /-ka/ and /-ki/ are used for masculine and feminine nouns respectively in both Arabic and Hausa as shown in the following examples:

ARABIC	HAUSA	MEANING
(i) baituka بَيْتُكَ	gidanka	your house (masculine)
(ii) baituki بَيْتِكَ	gidanki	your house (feminine)

Some other examples of the Arabic lexical items commonly used in Hausa are the following:

ARABIC	HAUSA	MEANING
(i) al'ahad الأحد	lahadi	Sunday
(ii) al'ithnain الإثنين	litinen	Monday
(iii) 'aththulatha الثلاثاء	talaata	Tuesday
(iv) al'arbi'a' الأربعاء	laaraba	Wednesday
(v) alkhāmīs الخميس	alhamis	Thursday
(vi) aljum'ah الجمعة	juma'a	Friday
(vii) assabt السبت	asabari	Saturday
(viii) al'akhbar الأخبار	labaari	news
(viii) jarīdah جريدة	jariida	newspaper
(ix) dars درس	darasi	lesson
(x) tālib طالب	daalibi	student
(xi) 'ilm علم	ilimi	knowledge
(xii) mu'allim معلم	maalami	teacher
(xiii) mithāl مثال	misaali	example

Arabic Loan Words in Yoruba

Yoruba language is also not free from the influence of Arabic. Prof. Ogunbiyi (1984) has identified eight subject matter groups in which the Yoruba language has borrowed words and expressions from the Arabic language⁴⁰. As a matter of

fact, the range of Arabic loan words in Yoruba shows the impact of the language on the linguistic and cultural life of the Yoruba people. Here, an attempt will be made to focus attention on some of the Arabic loan words which are frequently used by Yoruba speakers in their daily speech, in Yoruba classical poetry (*ewi*), as well as in Yoruba radio and television programmes. Reference will also be made to some Arabic words used in the translation of the Bible into Yoruba.

(A) Examples of the Arabic loan words used in *ewi*.

1. Iyan ajaju lo n fa sababi ibinu
A continuous argument causes anger.

The Yoruba word *sababi* is borrowed from the Arabic word *sabab* meaning "reason, cause". The *ewi* in which this word was used was read on N.B.C. Ibadan by Olalomi Amole on March 6, 1976.

2. Ma fi epe ye kadara omo
Don't change the child's destiny with curse.

The word *kadara* is borrowed from the Arabic word *qadar* meaning "destiny, fate". The *ewi* was read on N.B.C. Ibadan on March 23, 1976.

3. Alamori aye kanpa
The affair of this world is not a simple thing.

The word *alamori* is borrowed from the Arabic word *al'amr* meaning "affair". This *ewi* was read on N.B.C. Ibadan on November 11, 1976.

4. E tuuba ninu ise ibi
Repent of evil deeds.

The Yoruba word *tuuba* is a loan word from the Arabic word *taubah* meaning "repentance".

5. E da aniyani tuntun ninu odun tuntun
Make a new intention in the new year.

The word *aniyan* is borrowed from the Arabic word *an-niyyah* meaning "intention". The Yoruba words *tuuba* and *aniyan* were used in the *ewi* read on Radio Nigeria, Ibadan by Ademola Isola on December 31, 1982.

(B) Examples of Arabic loan words used in Yoruba news bulletins.

1. N won kan saara si ijoba ipinle Oyo fun mimu itoju awon omo abirun ni ibaada.

The Oyo State Government was commended for taking good care of the handicapped children (i.e. The Government regarded the care of the handicapped children as a divine service).

2. Olori ile wa ni ki awon omo akeko mu ere idaraya ni ibaada gegebi bi nwon se mu eko won ni ibaada.
Our Head of State appealed to school children to take sports seriously just as they take their studies seriously.

The word *ibaada* is borrowed from the Arabic word *ibaadah* meaning "divine service, act of devotion". This word was used in the 8p.m. Radio O-Y-O Yoruba News Bulletin of December 16, 1981 and 11.00 a.m. Radio Nigeria, Ibadan Yoruba News Bulletin of May 18, 1982 respectively.

3. A n toka aleebu si awon towa ni ijoba
We pin-point the fault of those in Government.

The word *aleebu* is a loan word from the Arabic word *al-'aib* meaning "fault, defect". The statement in which the word *aleebu* was used was made by a pastor in a Palm Sunday sermon carried on NTA Ibadan Yoruba News Bulletin at 9.30a.m. on April 4, 1981.

4. Komisanna Adedoja se sandakata si ile ise
Redio O-Y-O fun ise daadaa re.
Commissioner Adedoja commended Radio O-Y-O for its truth and sincerity.

The word *sadankata* is a loan word from the Arabic expression *sadaqta* meaning "you have spoken the truth". This expression was used in the Radio O-Y-O Yoruba News Bulletin at 5.30p.m. on April 1, 1986.

5. Nwon da seriya fun awon ole naa
The robbers were given the punishment they
Deserved in accordance with the law.

The word *seriya* is a loan word from the Arabic word *Shari'ah* meaning "Islamic Law". This expression is often heard on Radio and Television in reports on cases of robbery and the punishment attached to it.

(C) Examples of Arabic loan words used in Radio advertisements

1. E yee gba riba mo
Stop taking bribe

The word *riba* is a loan from the Arabic word *riba* meaning "usury, bribe". This statement is often heard on Radio Nigeria, Ibadan. It is designed to eradicate bribery in the Nigerian society.

2. E yee je haramu
Stop engaging in an illegal act.

The word *haramu* is a loan word from the Arabic word *haram* meaning “illegal act, cheating.” This statement is also often heard on Radio Nigeria, Ibadan. It is meant to discourage corruption in the society.

3. Eyin sowosowo e yee se makaruru
O you traders! Stop engaging in dishonest acts.

The word *makaruru* is a loan word from the Arabic word *makruh* meaning “a detested thing, a dishonest act”. Radio O-Y-O designs this advertisement in order to discourage traders from cheating or engaging in commercial malpractices.

(D) Examples of Arabic loan words used in various editions of the Yoruba Bible.

1. “Jesu pade won, o wipe, Alafia”
“Jesus met them and said, “Hail!”

The Yoruba word *alaafia* is a loan word from the Arabic word *al-afiya* meaning “good health, well-being”. It is used in Matteu, 28:9, Samueli 3:21 and Iwe Owe 17:1.

2. “Gbo adura mi, Oluwa”
“Hear my prayer, O Lord”.

The Yoruba word *adua* is borrowed from the Arabic word *ad-du'a'* meaning “prayer”. It is used in Orin Dafidi, 102:1; 65:2 and 142:8.

3. “Kalamu ayawo akowe li ahon mi”
“My tongue is like the pen of a ready scribe”.

The word *kalamu* is borrowed from the Arabic word *qalam* meaning “pen”. It is used in Orin Dafidi 41:1.

4. “O si wi fun won pe, E je ki a lo si ilu miran,
ki emi ki o le wasu nibe pelu”.
“And he said to them, let us go on to the next towns, that I may preach there also”.

The Yoruba word *iwaasu* is borrowed from the Arabic word *wa'z* meaning “sermon, preaching”. The word is used in Marku, 1:38 and 1:7 as well as in Matteu, 10:7.

5. “Bi a ti koo ninu iwe Woli Isaiah”
As it is written in Isaiah the Prophet”.

The word *wolii* is borrowed from the Arabic word *waliy* meaning "saint, holy man". This word is used in Marku 1:2.

All the Arabic words used in Yoruba which are cited above are taken from BIBELI MIMO (The Bible in Yoruba, corrected edition) published by United Bible Societies, Lagos, 1969. The English translations are taken from the HOLY BIBLE Revised Standard Version published by Thomas Nelson and Sons Ltd., London 1957.

Indeed the general distribution of Arabic loan words in Yoruba and their acceptability all over Yorubaland indicate that the words must have entered the Yoruba language and perhaps in the early days of Islam in Yorubaland. This is why such words and expressions are often used by Yoruba men and women regardless of whether they are Muslims, Christians or Traditional worshippers.

That the history of the contact between Yoruba and Arabic through Islam has been a very long one is attested by this popular Yoruba saying:

Aye l'aba 'fa
Aye l'aba 'male
Osan gangan ni igbagbo
wole de⁴¹.

We met ifa (the Yoruba traditional religion) in this world,
We met Islam in the world; but
Christianity came later in the day.

While talking about the influence on some important Nigerian languages, we consider it pertinent to remark that Arabic is, indeed, qualified to be regarded as a Nigerian language. This view can be supported by the fact that a Nigerian ethnic group, the Shuwa Arabs, who are found in Borno State, speak Arabic as their mother tongue. Since these Shuwa Arabs have a definite location within the political map of this country, it cannot be denied that they are bonafide citizens of Nigeria.

Religious prejudices notwithstanding, it is virtually impossible to eliminate Arabic loan words from the living vocabulary of the Nigerian languages referred to in this lecture. I venture to say that any attempt to remove the indelible impact of Arabic on these languages will be an exercise in futility. This is because not even a dictator can prevent people from speaking as they please.

Africa's Lingua Franca: Arabic as an Option

In the quest for Pan-Africanism, the Union of writers of the African peoples agreed on the need to adopt a national language for all the countries of Africa. This is clear from the following statement made by Professor Wole Soyinka, one of the members of the Union:

At the Conference in Algiers in 1975, the All-Africa Union of Teachers boldly resolved that the continent of Africa adopt one

common language and proposed a selection from Hausa, Arabic and Swahili⁴².

The call for the adoption of Swahili was later made by the Union and it was repeated by Professor Wole Soyinka at the 1977 FESTAC colloquium.

Without going into the merits of the choice of Swahili by the Union, Arabic seems to be highly qualified to the lingua franca of Africa. After all, it is not a foreign language as is the case with English, French, Afrikaans or other non-African languages. This view is predicated on the premise that Arabic is the national language of the whole of North Africa and the common language of many communities in sub-Saharan Africa. In this connection, Last has this to say:

The lingua franca of the community was Arabic, and thus it transcended national divisions⁴³.

The criteria to be used in choosing a national language, as advocated by Professor. Ayo Banjo,⁴⁴ include the following:

1. Population: This has to do with the number of people who already speak the language as native speakers and whether there is a standard variety of the language.
2. Acceptability: How acceptable the language is to the native speakers of other languages
3. Typology: What the relationship of the language is to other languages.
4. State of Development: This has to do with whether or not the language already has a standard orthography in use.
5. Literary Status: This has to do with the quantity and quality of the literature existing in the language.

Bearing these criteria in mind, the choice would seem to be Arabic as far as choosing a lingua franca for Africa is concerned.

First, Arabic has the largest number of people who speak it either as a native or non-native language in Africa. Also, there is a standard variety of Arabic which enjoys universal acceptability all over the Muslim world. Secondly, the influence of Arabic on many African languages has been discussed. Thirdly, there is a well-known Arabic script which has served and is still serving as a medium of writing many African languages. Fourthly, it has been established that a large quantity of good quality Arabic literature exists in the Arab world and in Muslim communities in Asia and Africa. Fifthly, Arabic has been recognized as an international language: it is one of the six official languages used by the Organization of African Unity (O.A.U.) and the African Petroleum Producers Association (APPA), Arabic is the only indigenous African language.

Problems Facing the Teaching of Arabic in Nigeria

I do not intend to dwell at length in this lecture on all the pedagogical and related problems facing the Arabic language in Nigeria. This important aspect has been treated extensively by non-Nigerian and Nigerian Arabists such as Mr. Selim Hakim, Professor Ayoub, Prof. Ogunbiyi and Prof. Malik. Nevertheless, an attempt will be made to highlight some aspects of this problem. These aspects include the following:

1. *Weak Background of Arabic Learners*

The standard of the students who learn Arabic in secondary schools is very low. The reason for this is that most of these students have no previous knowledge of Arabic before their admission to secondary schools as a result of non-teaching of Arabic in their primary schools. Hence, these pupils know absolutely nothing about Arabic.

2. *Inadequacy of Trained Arabic Teachers*

In most states in Nigeria, there are no colleges where Arabic teachers are trained. In the Northern states where a few Arabic teachers' colleges exist, the teachers produced in those colleges are few, and as such, they cannot meet the demand for trained Arabic teachers in both the primary and secondary schools. Hence, there is scarcity of trained Arabic teachers in most states of Nigeria.

3. *Non-availability of Suitable Instructional Materials*

At present, there are not enough good books on the Arabic language suitable for various categories of readers and levels of learners.

The problems that have been identified as confronting the teaching of Arabic in Nigeria at present are in no way insurmountable. One way of solving the problems is the early introduction of Arabic language at the primary school level. The merit is that many pupils will have a good background in Arabic. Consequently, many of them will be encouraged to learn Arabic in secondary schools as well as in Teachers' Colleges and other institutions of higher learning. The training of Arabic teachers should be taken very seriously at the elementary, secondary and tertiary levels. To achieve this objective, refresher courses, seminars and in-service training programmes should be organized for Arabic teachers.

With regard to the availability of instructional materials, the situation has improved through the emergence of a new breed of indigenous Nigerian Arabic writers such as Binuyo, Hijab, the late Professor Suwaid, Professor Ogunbiyi, Professor Malik and Professor Oseni. Nevertheless, a lot more needs to be done in the area of the provision of a wide variety of suitable Arabic books and instructional materials which employ new audio-visual techniques and supplementary aids such as phonographs, magnetic tapes, slides, flashcards, films as well as language laboratories with facilities for group and individual practice. While such books should be very relevant to the learners' environment, they should also reflect the true picture of Arabic and Islamic culture.

It should be admitted that the religious factor has far-reaching consequences on people's attitude to Arabic in Nigeria. This has also affected government support for the cause of Arabic scholarship. Consequently, Arabic has suffered considerably from religious prejudice and subjectivity.

Considering the various aspects of Arabic and its relevance to sub-Saharan Africa, its religious and historical values, its linguistic and literary values, its indelible impact on a number of indigenous African languages and its role on the international scene, there is need to re-appraise the role of Arabic in Nigeria. This is with a view to formulating an objective and realistic policy which will improve the teaching of Arabic and encourage more people to learn it so that access to the original sources of our heritage as preserved in Arabic documents will be made possible for many Nigerians in the next millenium.

It should be pointed out that an important aspect of the Islamic culture and civilization is literacy in Arabic. Through Islamic education, non-Arab Muslims all over the world are exposed not only to Arabic and Islamic literature but also to new ideas and the Arabic literary world. A remarkable feature of the exposure of non-Arab Muslims to a different civilization is the fact that Islam offers an alternative access to a renowned culture and enduring human civilization other than through Christianity and submission to European cultural colonization.

It is appropriate on this occasion to remember my late mother, who did not live long enough to enjoy the fruits of her labour. I pray that Allah may have mercy on her. I must also express my sincere gratitude to my father, who made my nature the object of his precious care. My profound thanks are due to my wife and children for their patience over the seemingly interminable period of time involved in my study and writing of Arabic materials which compelled me to be away from them for most of the hours of the day and night. In terms of love, care, affection and assistance my wife, Khadijah Titilade, is to me what Khadijah bint Khuwailid was to Prophet Muhammad. I pledge my eternal love for her and our children. I also convey my appreciation to my benefactors, friends and well-wishers.

In my efforts to be a Nigerian Arabist, I have benefited, as is to be expected, from the knowledge and expertise of many teachers whom I hold in high esteem. But, encouragement, inspiration and scholarly guidance came at a crucial time from the late Professor Muhammed Salim El-Garh and the late Professor Musa Ajilogba Abdul, both distinguished scholars who made outstanding contributions to Arabic and Islamic scholarship. It is to their memories that this humble exercise is dedicated.

Mr. Vice-Chancellor, distinguished guests, ladies and gentlemen, I can think of no better words to conclude this lecture than the divine words contained in the following verses of the Qur'an:

1- وَمَا أَوْتِيْتُمْ مِّنَ الْعِلْمِ إِلَّا قَلِيْلًا.

1. And of knowledge, you (mankind) have been given only a little.
(Qur'an 17:85).

2- وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيْمٌ.

2. And above all those endowed with knowledge is the All-knowing (Allah)
(Qur'an 12:76)

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BOTANY – BEYOND CONVENTIONAL AGRICULTURE

O. Osonubi

Department of Botany and Microbiology

Introduction

I give honour and glory to Almighty God for making today a reality and for giving me the opportunity to deliver this inaugural lecture on behalf of the Faculty of Science. The topic of my inaugural lecture is “Botany – Beyond Conventional Agriculture”. As an agriculturist and a botanist, I have chosen this topic because of its interest to humanity and also to marry the tower and town, town and gown in botany and agriculture. In order to bring the topic into a more appropriate focus, I have decided to break it into the following subheadings:

- (a) What is Botany?
- (b) The contribution of Botany to agricultural sustainability
- (c) Adaptability and adoptability

What is Botany?

To any scientist, Botany is simply the study of plants. Whereas to a plant biologist, botany is the mother of all sciences, which is to say that botany is all encompassing, directly and indirectly related. For example:

In agriculture, without green plants, there can be no agriculture;

In medicine and veterinary medicine, No human being or animal can survive without consuming plants or its products;

In pharmacy, most drugs are products of plants;

In chemistry, dyes, essential oils, common reagents like alcohols are obtained from plants;

In physics, speeds and forces are checked by plants;

In geography, location, vegetation and spatial relations are appropriately occasioned by distribution of plants;

In urban planning, the interest is in the cosmetic relocation of plants (trees, grasses and flowers) in the cities and their residences;

In zoology, all flesh is grass.

The Contribution of Botany to Agricultural Sustainability

What is agricultural sustainability? Sustainability in agriculture is a biologically-based system that ensures long-term adequate levels of food production without degrading the resource base i.e. soil medium. In the last two decades, International Agricultural Research Centres (IARC) situated in the tropics, particularly in Sub-saharan Africa have been concentrating their efforts on the development of improved crops based on biological processes. One of such farming systems is referred to as *alley farming/alley cropping* (Kang and Wilson 1987) or *hedgerow intercropping* or *avenue cropping* (Wijewardene and Waidyanatha 1984). Other natural methods regarded as biologically based systems include planting of cover crops, crop rotation and biological pest control (Reganold *et al.* 1987).

Alley cropping concept was introduced by the International Institute of Tropical Agriculture (IITA) in the mid-1970s. It is a farming system in which arable crops are planted in the alleys formed by hedgerows of trees/shrubs, particularly legumes. The system combines both the cropping and the fallow phases. The hedgerows are cut back at planting and subsequently pruned at regular intervals during cropping season to prevent shading and to reduce competition with the associated food crops. The prunings are used as mulch for the associated food crops. The system offers longer cropping yield with increased land use efficiency. However, alley cropping has not matched the reported potential because the trials were regarded as peculiarities of the research scientists by the resource-poor farmers. Furthermore, the monetary benefits of alley-cropping are not realized until 2-3 years after commencement.

The role of soil microorganisms in management of the resource base has been ignored or virtually overlooked by most soil and plant scientists. For example, most research programmes in the name of sustainable agriculture underscore the role of mycorrhizal fungi as a soil microbiological resource for crop production. Until about 20 years ago, mycorrhizal fungi were known to increase P uptake, enhance N_2 - fixation of *Rhizobium*, and drought resistance of plants in the greenhouse experiments, particularly in temperate countries. Most of these greenhouse studies showed that mycorrhizal associations are effective biological mechanisms for the plants to counteract commonly found edapho-climatic tropical stress situations. Until 10 years ago, no practical experience had been gained on how to manage mycorrhizal fungi under field conditions in Nigeria and no practical results had been presented on whether mycorrhizal fungi could be used as a soil microbiological resource to improve crop production in the tropics.

The term 'mycorrhiza' was coined by Frank in 1885 to describe the symbiotic association of plant roots and fungi. Of the five types of mycorrhizae, two of

them – ecto- and endo- mycorrhizae are the most important. For the purpose of this inaugural lecture, endomycorrhiza which is also known as vesicular-arbuscular mycorrhiza (VAM) will be described and will henceforth be referred to in this lecture. These are some of the beautiful microorganisms called VA mycorrhiza which God has made available to man for the purpose of improving crop yields and to reduce the use of inorganic fertilizers. The word mycorrhiza means – *myco*: fungus; *rhiza*: root, hence mycorrhiza means 'root fungus'. In VAM type, the mycorrhiza consists of spores, vesicles and arbuscles (hence the name) and hyphae. The spores germinate and produce both intercellular and intracellular hyphae which penetrate the root cortical cells, forming specialized haustoria – like structures within the cells called arbuscles, where metabolic exchanges take place between fungus and host cytoplasm. In many VAM fungi, there is development of spherical sac-like structures known as vesicles which are formed in the cortical cells and function as nutrient storage organs or as propagules in root fragments. The VAM-fungal hyphae extend from the root out into the soil where they interface with soil particles. Soil (extraradical) hyphae function as absorptive structures for mineral elements and water. Because of the extension of hyphae from the root into the soil for several centimetres, they can effectively absorb immobile nutrients from the bulk soil and thereby bridge over the zone of nutrient depletion around roots. The soil hyphae also attract other microbes and together they form water-stable aggregates necessary for good soil tilth. In summary and for all ecosystems, the coupling of plants with rhizosphere microbial processes is optimized by VAM fungi and they form symbiotic relationship with plant roots (Bethlenfalvay 1982).

The main purpose of this inaugural lecture is that of painting VA mycorrhizae into the picture of sustainable agriculture in Nigeria. The impression created hitherto was that VAM fungi would work best in infertile acid soils (Sieverding 1991), however, our evidence shows that they can work in near neutral and alkaline soils in Nigeria. My first effort into mycorrhizal research 10 years ago was exciting. In contrast to many reports, trees that are drought tolerant are less dependent on mycorrhiza (Fig. 1) and only those trees that cannot withstand drought-stress are more dependent on mycorrhiza for survival under

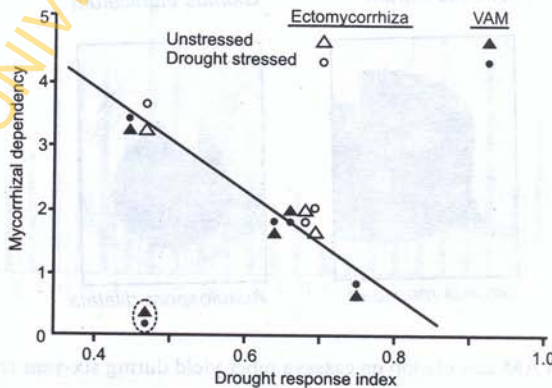


Fig. 1: Relationship between Mycorrhizal dependency and Drought response index
MD = 7.16 - 8.16 DRI $r = -0.96$

drought-stressed conditions (Osonubi *et al.* 1991). This pioneering work was done in conjunction with IITA and Drs. Awotoye and Atayese who were then in the forefront of mycorrhizal research.

In my desperate attempt to test the practical application of mycorrhiza in the field, I sought collaboration with IITA and within a short time, a research grant under the auspices of Alley Farming Network for Tropical Africa (AFNETA) managed by IITA was made available. This gave me and my team the ample opportunity of exploiting the benefits of VAM fungi in the field. Then the issue of where to practise alley farming came in and we approached the Faculty of Agriculture which told us that the only land for the type of research we were contemplating was available at Ajibode but that it had been abandoned by students because of nematode infection and the fact that the top of the slope was too gravelly for cropping. We jumped at the offer, nevertheless, as it would provide the sort of challenge required. To the glory of God, that land has been under cultivation from 1990 to date as a result of alley cropping and mycorrhizal research. It was this experience that led us to the title of this inaugural lecture "Botany – Beyond Conventional Agriculture". In an alley cropping carried out and constantly monitored for six years at Ajibode, it was consistently shown that VAM fungi improved both the yield of cassava intercrop (Fig.2) and hedgerow trees (Awotoye *et al.* 1992; Atayese *et al.* 1993; Osonubi *et al.* 1995; Okon *et al.* 1996; Fagbola *et al.* 1998 a and b; Liasu, 1999). This work was carried out in conjunction with Drs. Atayese, Awotoye, Fagbola, Okon and Messrs Oyetunji, Liasu and Adetunji.

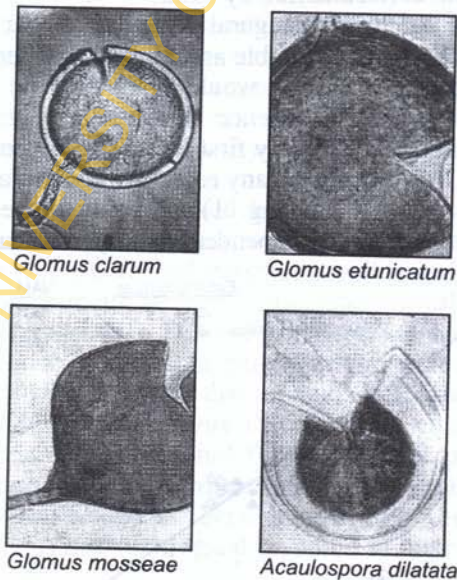


Fig. 2: Effect of VAM inoculation on cassava tuber yield during six-year continuous alley cropping.

VAM inoculation had no effect on cassava root yield in year one as there was no mulching of cassava with the prunings from hedgerows. However, in years two and three, root yields improved significantly because VAM made the nutrients from the applied prunings available to cassava. Also, cassava root yields from the uninoculated alleys of *Gliricidia* ('*Agun mani 'ye'*) (and *Leucaena* ('*Sekeseke'*) were increased over the yields in year one. In the inoculated plots after year three, the root yield of cassava alley-cropped with *Gliricidia* was about 80-100% greater than cassava alley-cropped with *Senna* ('*Cassia'*) and control (without trees). In years four and five, VAM inoculation had no effect on the cassava root yield except when fertilized (year five). The non-significant difference in the root yields of cassava between inoculated and uninoculated plots could be attributed to competition between the hedgerows and cassava plants. Hence, when more nutrients (fertilized with 25kg ha⁻¹ NPK) were made available to the plots, cassava root yields in both inoculated and uninoculated plots increased in years five and six. The sporadic root yield increase in inoculated *Senna* plot (years five and six) could be attributed to the fact that the competition between *Senna* hedgerows and cassava had been removed by fertilizer application. This is likely to be so as many fine roots of *Senna* trees inhabit the same topsoil with cassava roots (Ruhigwa *et al.* 1992).

In other comparative experiments, similar alley cropping experiments were set up at the top and base of the slope (Fig. 3) (Osonubi *et al.* 1994). In year one, cassava root yields were significantly lower at the top than at the base of the slope, the latter being more fertile than the former. However, in year two, VAM inoculation restored the anomalies between the top and base of the slope by bringing the cassava root yield to similar levels. The root yield restoration between the two parts of the slope could not have been due to alley cropping alone as the root yields from the uninoculated plots varied significantly from each other irrespective of hedgerows.

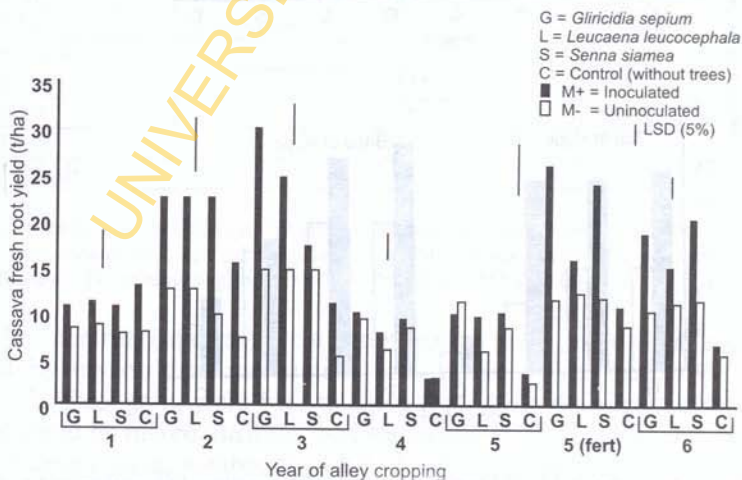


Fig.3: Effect of VAM on cassava tuber yield at the different parts of the slope during a two-year alley cropping period.

Alley Cropping Experiments with Mixed Hedgerows

In contrast to the two alley cropping experiments in which one tree species was utilized as hedgerow, the present experiment utilized the mixing of interplanting of two tree species as hedgerows. In the experiment, the objective was to determine the influence of mycorrhizal inoculation and two pruning regimes on the leaf biomass and nutrient yield of sole *Gliricidia sepium* (a nodulating tree), *Senna* (syn *Cassia*) *siamea* (a non-nodulating tree), and their mixtures as hedgerows and their subsequent effect on two cassava cultivars and intercropped maize.

In both *Gliricidia* and *Senna*, there were similar leaf dry matter in sole and mixed inoculated or uninoculated trees for either of the pruning regime and for most of the pruning harvests, although significant differences occurred between inoculated and uninoculated mixed or sole trees (Fig. 4). There was no difference between the total leaf dry matter of the two- and three-month pruning regimes in *Gliricidia*. However, in contrast to *Gliricidia*, the total leaf dry matter of two-month pruning regime of *Senna* was lower than its three-month pruning regime except for sole uninoculated trees.

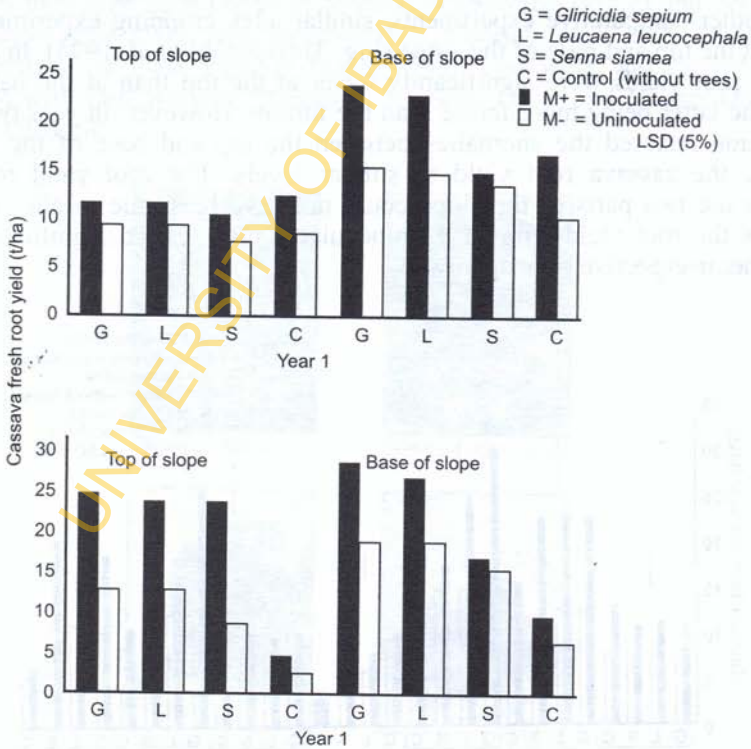


Fig. 4: Effects of pruning and VAM inoculation on leaf dry matter of *G. sepium* and *S. siamea*. Vertical bars represent LSD (5%).

Generally, inoculation and mixing of trees in the same hedgerows significantly increased the total N and P yield in *Gliricidia* and *Senna* with greater values in the former than in the latter (Table 1). In *Gliricidia* and except for mixed inoculated trees, while total N yield in the leaf was higher in three-monthly pruned trees, the converse was the case for P. For *Senna*, the total N and P yields were higher in three-monthly than two-monthly pruned trees.

Table 1: Effect of pruning regime and mycorrhizal inoculation on the total foliar N and P yield of hedgerow trees.

Treatment	Pruning regime	N		P	
		←	→	←	→
		(kg ha ⁻¹)			
<i>G. sepium</i>					
SoM ⁺	2 months	358.4d		14.7c	
SoM ⁻	2 months	250.2g		5.5k	
MiM ⁺	2 months	810.0a		16.2a	
MiM ⁻	2 months	267.3f		8.5g	
SoM ⁺	3 months	454.4c		11.5f	
SoM ⁻	3 months	302.7e		4.5l	
MiM ⁺	3 months	551.1b		15.5b	
MiM ⁻	3 months	349.3d		5.8j	
<i>S. siamea</i>					
SoM ⁺	2 months	233.6h		8.5g	
SoM ⁻	2 months	92.9k		4.3m	
MiM ⁺	2 months	312.4e		12.8e	
MiM ⁻	2 months	119.0j		6.2l	
SoM ⁺	3 months	301.2e		11.5f	
SoM ⁻	3 months	117.8j		4.5l	
MiM ⁺	3 months	349.6de		13.6d	
MiM ⁻	3 months	186.9l		7.8h	
Interactions					
MxMi		***		***	
MxPr		**		**	
MixPr		**		*	
MxMixPr		**		**	

Means within each column followed by different letters are significantly different at $P < 0.05$. M⁺ vesicular – arbuscular mycorrhizal inoculation or (M⁻) uninoculation. So, sole hedgerows; Mi, mixed hedgerows; Pr, pruning regime. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Except for control (treeless) treatment, maize grain yield was significantly increased by mycorrhizal inoculation irrespective of the hedgerow treatment (Table 2). Highest grain yield was obtained from *gliricidia* alleys inoculated with VAM followed by mixed *gliricidia* and *senna* alleys. This could have been due to the high nutrient yield, notably N and P (Table 1), as well as fast decomposition and nutrient release of *Gliricidia* prunings. In spite of the higher nutrient yield from three-month pruning regime of hedgerow trees, the root tuber yield of the

two cassava cultivars under two-month pruning regime was higher than their counterparts under three-month pruning regime (Fig.5), indicating judicious use of nutrients at relative short intervals rather than at long intervals. TMS 30572 gave higher yields with sole *Gliricidia* and *Senna* prunings than TMS 4(2)1425. Also, indigenous mycorrhiza were more compatible with TMS 30572 than with TMS 4(2)1425. In all treatments, including the control that received no pruning, VAM inoculation consistently increased the root tuber yield over uninoculated counterparts.

Table 2: Effect of alley cropping and mycorrhizal inoculation on the dry grain yield of intercropped maize

Hedgerow tree	Dry grain yield (kg ha ⁻¹)
<i>G. sepium</i>	
M ⁺	1108.4a
M ⁻	724.5c
<i>S. siamea</i>	
M ⁺	661.2c
M ⁻	266.3e
<i>Gs + SS (mixed)</i>	
M ⁺	961.4b
M ⁻	782.9c
Control	
M ⁺	472.1d
M ⁻	370.0d
Interaction	
M and H	**

Means followed by different letters are significantly different at P<0.05, M⁺, VAM inoculation, M⁻, uninoculation H hedgerow tree.

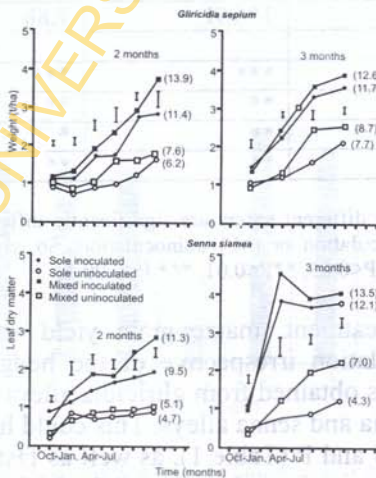


Fig. 5: Effect of pruning regime and VAM inoculation on the fresh not yield of cassava cultivars.

It is pertinent to mention here that by the second year of operation, the soil under alley cropping and VAM inoculation which was originally full of gravel had turned brown and full of humus, while the soil under alley cropping without inoculation retained its original dirty white colour still full of gravel and difficult to work with. One of the implications of VAM inoculation in this study is the optimization of mineral nutrients from applied prunings. The consistent positive response as a result of VAM inoculation is an indication that VAM technique is either complementary or a major component in agroforestry systems. This experiment was carried out in conjunction with Mrs. Sonibare, Dr Okon, and Dr Sanginga of IITA.

Assessment of VAM fungus mediation of heavy metals in refuse dump site

This trial was performed on refuse dump site close to the residential area. Soil nutrients (N & P) were very high in the dump site (Table 3). Similarly, the levels of heavy metals and micronutrients that could be toxic to the plants were very high (Osundina 1999). After the experiment and except for N, the levels of various nutrients and the heavy metals were significantly lower in the soil than the levels before the commencement of the experiment. Mycorrhizal inoculation significantly reduced the heavy metal in the harvested grains. High levels of heavy metals and micronutrients in the refuse dump would pose health hazards to man. This is a clear warning to all of us who eat fresh boiled maize planted on dump sites that we may be slowly accumulating poisons in our bodies. However, from the present study, effective VAM inoculation could protect host plant from metal toxicity. This is welcome news to man as consumption of maize grains grown on refuse dump sites around homes or in farms will pose no potential health risk when the seeds at planting are inoculated with effective VAM fungus.

Table 3: Effect of VAM inoculation on chemical contents of the dump site soil and maize grain before and after the experiment.

	pH	N	P (mg)	Pb kg ⁻¹	Mn Soil)	Cu	Fe	Zn
Before	6.4	450.6	5.3	5.1	15.1	12.9	93.3	13.8
After	6.2	395.7	4.2	1.2	5.2	3.3	28.7	4.9
LSD (50%)	-	62.1	0.4	1.6	4.8	6.2	12.7	3.2
For grains (mg plant ⁻¹)	-	-	-	-	-	-	-	-
M [*]	-	-	-	12.6b	152.7b	20.4b	216.2b	43.6a
M ⁱ	-	-	-	24.1a	183.5a	26.5a	282.1a	40.2a

VAM inoculation on cowpea and subsequent cassava yield

The influence of VAM inoculation on cowpea yield was evaluated in researcher-farmer managed farms in two villages in Oyo State. After harvesting, cassava cuttings were planted during the following season on the ridges already incorporated with the cowpea trashes.

VAM inoculation enhanced the yield of both cowpea and cassava crops. The yield of the uninoculated crops were 40-60% lower than the inoculated crops (Table 4). It can be deduced from the study that VAM inoculation induced greater nodulation of cowpea and hence greater N and other mineral nutrients which benefited the subsequent cassava that followed. The existing VAM propagules from cowpea and the current VAM inoculum are likely to be responsible for accelerated nutrient release from the cowpea residues. Hence, VAM inoculation is an essential component of restoration strategy.

Table 4. On - farm evaluation of VAM inoculation on cowpea and cassava yields

Treatment	Agboye	Fasola
Cowpea seed yield (kg ha ⁻¹) M ⁺	550a	590a
M ⁻	280b	285b
Cassava tuber yield (t ha ⁻¹) M ⁺	12.1a	14.3a
M ⁻	7.4b	7.2b

Values with the same plant species followed by different letters are significantly different at $P < 0.05$ when compared by Duncan's multiple range test M⁺, inoculated; M⁻, uninoculated.

VAM inoculation and cocoa production

We also investigated the influence of VAM inoculation on the pod carrying capacity of cocoa trees in Ondo State (Osonubi 1996). In collaboration with Professor Adegeye (Department of Agricultural Economics) and Dr. Akintola (Department of Geography) of this reputable university, we inoculated cocoa trees in Akure (Ondo State capital), with VAM and left others uninoculated after hand pollinating them. In any cocoa plantation that has been producing pods and beans for at least five years, there would be locked up nutrients around the trees from the fallen and decomposed leaves and the various chemicals that would have been sprayed on cocoa plants.

The effect of our inoculation was that many inoculated trees were able to carry 60-105 pods per tree to maturity while the uninoculated trees were only able to carry 10-25 pods per tree to maturity. All the pods ripened at the same time and they were also filled with beans. This would be economical to the cocoa farmers as the labour for harvesting would be at once instead of the staggered labour that used to characterize cocoa harvesting during the production period.

VAM in biological control of soil-borne pathogens

When pepper (*Capsicum annum*) ('*Ata rodo*') seedlings were infected with a soil-borne pathogen, *Phytophthora infestans*, the seedlings responded with signs of damping-off, the leaf-curl, chlorosis of both the stem and leaves and then defoliation of leaves. When the seedlings were treated with VAM simultaneously (immediately) or concomitantly (two weeks interval - VAM before pathogen or pathogen before VAM), the disease symptoms on pepper plants were drastically reduced.

The basis for pathogenesis was found out to be the secretion of cell wall degrading enzymes by pathogens. These enzymes are cellulases and pectinases. The latter include pectin methyl esterase (PME) and polygalacturonase (PG). Both the cellulases and pectinases degrade the cell walls and middle lamella of infected plant tissues leading to tissue maceration which facilitates the penetration of the tissue by the pathogens. The activities of these enzymes help the pathogens in providing them with nutrients in the infected tissues.

When VAM is used as a means of control, the effect is two-way. Firstly, VAM inoculated plants are nutritionally healthier than the uninoculated plants. In the inoculated plants, P and other nutrients are made more available by VAM hyphae than in the uninoculated plants and the former are therefore able to withstand and resist the pathogenic infection than the latter (Salami 1998). Secondly, the cell wall degrading enzymes e.g. polygalacturonases are counteracted by effective VAM by keeping in check the activities of the degrading enzymes. In addition, the mycorrhiza fungi are able to stimulate higher production of catalase (oxidative) enzymes which modify phenolic compounds for inhibitory substances like quinones against the pathogen (*Phytophthora infestans*). The overall effect of mycorrhiza inoculation in this study was the restriction of inward invasion of pathogen into the plant's roots, which invariably reduced the plant's disease incidence severity. Drs. (Mrs.) Salami, Odebo and I carried out this work.

Adaptability and adoptability

I have tried to show from the evidences of my research that effective vesicular-arbuscular mycorrhiza can provide solutions to some of the problems militating against sustainable agriculture in Nigeria. There is no problem with the production of VAM for farm-use by individuals, it is like bread and butter. Both male and female farmers freely participated in the training of production and use of VAM fungi on the farms. The fact that the tools and materials used for VAM production could be adapted to resources within the village environment and the farmers' willingness to produce VAM on their own have gone to show that VAM technology is sustainable.

As regards alley cropping, although significant economic gains can be obtained from practising the technology, farmer adoption still remains low. This is because the technology is fairly complex. Farmers familiar with plantation crops and with management of trees under bush-fallow systems may find it easier to adapt alley cropping. One of the problems identified with the technology is that many farmers and even agricultural scientists do not know the fertility potential of hedgerow trees like *Gliricidia* (*Agun moni* 'ye), *Leucaena* (*Sekeseke*), *Senna* (*Cassia*) and others that are used for mulching. Therefore, there is the need for learning-adoption process for the would-be adopters. In spite of these shortcomings, many farmers who were introduced to the technology have looked for a better match of the technology with their resources and preferences by adopting and making important modifications to the technology (Adekunle 1998), which include using the hedgerows as life fences, planting the stems as staking materials for yam with an added fallow phase.

People do things better when pulled by incentives rather than pushed by regulations. Many farmers willing to imbibe alley cropping are handicapped by basic tools like good hoes and cutlasses. Our provision of these little incentives with the holding of regular meetings have assisted us in keeping most of our adopters in Oyo and Osun States. It is therefore important that our government should make funds available to direct future research into the modifications preferred by the resource-poor farmers and test them in high potential areas.

Conclusion

I have never regretted being a Botanist with a stint in Microbiology. Many are called but few are chosen. To date, I give glory to God that two out of my trained students are now Associate Professors (Readers) in Nigerian universities. My lectureship and research endeavours in the Department of Botany and Microbiology of this premier university have provided me with the opportunity of travelling to all continents either to carry out research or deliver scientific papers. In countries like Britain, USA and Canada, admission into Botany programme is like a camel entering into the needle's eye because it is a programme for pure academic research. However, in Nigeria it is the other way round because people are interested in professional programmes that will bring immediate returns on the money invested in their education.

Owing to our dynamic nature in the Department of Botany and Microbiology, we are floating a professional Masters in Economic Botany (MEB) that will tap our natural plant resources and create jobs and employment for would-be graduates. It is the first of its kind in the African region. Those things we would be imparting to the students in the MEB programme are results of research findings in the past two to three decades. So, there is need for funding of research programmes. When International Agencies provide grants, the disbursements are timely. However, when it comes to our own Nigerian government being called upon to fund research, the funds are not made available in time, apart from the notable impediments' to frustrating the efforts of the researcher. Delay in releasing funds for agricultural research is tantamount to non releasing of funds at all because of seasonal dependency of agriculture.

Any nation that fails to take adequate care of, and provide for its youths is on the way to frustration and ruins. In most of the academic departments within our universities, particularly in the natural and agricultural sciences, many of our young colleagues are yet to obtain their Ph.D degrees after having spent many years on their programmes. Many of them have no facilities to work with and there are no research grants made available to them. At this juncture, it is important to remind the government and the universities, that these categories of academic staff in addition to the newly minted Ph.D degree holders in all our universities should not be allowed to waste away. They should be provided with research funds to keep them gainfully encouraged and motivated into research investigations. If this issue is not addressed in all areas of learning, it will get to a stage when it will be difficult to replace the experienced hands. I am of the opinion that this issue should be raised at every available opportunity we have of meeting with representatives of government.

The establishment of Agricultural Development Projects (ADPs) in all the states of the federation is a right step in the right direction in terms of bridging the gap between the researcher and the resource-poor farmers, that is Extension. The performance of these bodies was rated high initially, however, in the last three years, most of their activities have been tremendously reduced because of our lack of maintenance culture. If results of research findings are to get to the ultimate users and increase food production for the teeming population of this country, drastic steps must be taken to sustain the good structures that have been put in place.

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8

NUTRITION, SURVIVAL AND LIFE EXPECTANCY

Funke Ajayi

Department of Human Nutrition

Introduction

This inaugural lecture is the third from the Department of Human Nutrition since its inception in 1963. The first lecture was given by Professor Adewale Omololu, now retired and the second by Professor Isaac Olaolu Akinyele in 1993. Today, the inhabitants of the universe are demanding all the basic necessities of life as well as all the amenities essential for adequate standard of living. Although more food is being produced in some parts of the world than the inhabitants can possibly eat, roughly half of the people of the world go hungry daily.

The global food situation especially the food security problems in Nigeria was the theme of the inaugural lecture delivered by Professor I.O. Akinyele and titled "Give Us This Day Our Daily Bread". The confounding factors in the utilization of these foods and the consequences on the well-being of the individual constitute the focus of this inaugural lecture titled "Nutrition, Survival and Life Expectancy".

The Covenant

When God created Adam his intention was that man should enjoy all benefits of creation; that was why he put him in the Garden of Eden (Gen. 1: 29-30) where all his needs were provided in abundance. God must have intended for him to live forever. Unfortunately, he sinned and was thrown out of the Garden with a curse (Gen. 3: 17b). He lived for 130 years, gave birth to Seth and lived for another 800 years. The "lifespan" of our forefathers from Adam to Noah as given in the Bible is found in the book of Genesis 5: 3-32.

Lifespan, from this account can then be defined as the greatest possible age to which an individual can live. However, situations and circumstances can influence and prevent the fulfilment of this potential inheritance. This is evident when God made a pronouncement in Genesis 6: 3 saying "My spirit shall not always strive with man, for that he is flesh: yet his days shall be an hundred and

twenty years (120 years). So, God entered into a covenant with man and this becomes the prescribed "lifespan" for man.

Since then, survival has been the preoccupation of man and man is constantly in search of food. This phenomenon of life-span applies to all cells of the body. For example, the red blood cells which carry oxygen throughout the body have a lifespan of 120 days and are replaced every four months. Even the cells of the mouth or intestines have a shorter lifespan and are replaced much faster — on a daily basis.

Life Expectancy

Life expectancy is often indicated at birth and gives an estimate of the total number of years newborn infants would live under the prevailing mortality risks within the population at the time of birth.

Globally between 1980 and 1993, overall life expectancy has increased by more than 4 years to about 65 years. However, the gaps are still widening between the rich and the poor, between population groups, between sexes and between ages. In developing countries in particular, the span of life between infancy and old age is concealed by the shadows of poverty and inequity and the dual burden of suffering and disease. According to 1997 calculations, (UNICEF 1999) a person in one of the least developed countries in the world has a life expectancy of 43 years compared to a life expectancy of 78 years for another from the most developed countries. By the year 2000, life expectancy at birth is expected to decrease to 42 years in some of the poorest countries and reach a peak of 79 years in the richest countries. Furthermore, projection to the next millennium 2050 (Table) shows a marked increase in life expectancy for developing countries, and the gain is particularly high for Sub-Saharan Africa (thus, life expectancy is at least 30 years higher in developed than in the poorest countries).

In industrialized countries women live on the average about 6 years longer than men (Damton-Hill 1995) women in industrialized countries live about 15 years longer than those in middle income developing countries and about 30 years longer than those in the poorest countries, where life expectancy is 50 years. The difference in women's life expectancy in rich and poor countries has only slightly decreased during the last 20 years. Inequalities in mortality rates seen within countries, are associated largely with class differences.

A large part of the difference between men's and women's life expectancy is due to differences in alcohol and tobacco consumption, as well as accidents, suicide and incidence of chronic diseases. In countries where increased numbers of women smoke, there is a rising mortality rate for older women.

According to the dietary patterns account for variation in life expectancy, vegans or strict vegetarians and to a certain extent Seventh Day Adventists children who are accustomed to high consumption of plant foods are apt to grow slower and are leaner than omnivorous children. These vegetarians compared with the general population experience somewhat lower mortalities from lower incidence of degenerative diseases and have longer expectation of life. The vegetarian diet is bulky, hence, the near vegetarian pattern of diet of the African

child explains in part of the lower amount of food eaten and the lesser growth recorded. Also, the monotonous nature of vegetarian diet may contribute to the growth impairment observed in Mexican children aged 7-9 years

Nutrition

Eating good quality and healthy food adequate in all the nutrients required by the body does not guarantee good nutrition or health. The food must successfully meet with the challenges of ingestion, digestion, absorption, assimilation and elimination.

In Nigeria, the greatest challenge we face today is how to find and select appropriate foods that provide a variety as well as an abundance of nutrients i.e. nutrient diversity and nutrient density.

The nutritional status of a population is a reflection of national development and is a good indicator of effectiveness of national resource allocation. Adequate nutrition is a major contribution to physiological and economic growth. Hence, adequate nutrition is a reflection of body growth, work output, motivation and educational and mental attainment. In essence, economic growth and development depend on adequacy of food and efficient utilization of the nutrients provided.

How long an individual lives is dictated by the quality of nutrition. The impact of nutrition is laid down at conception and is a determinant of how long an individual lives and freedom from diseases and illnesses throughout life.

Nutrition had earlier been regarded as a national concern where every country feeds for its own citizens. However, nutrition drew international attention in 1950 when kwashiorkor was recognized as a major killer in developing countries. In less fatal cases, it contributed to retarded physical growth, increased susceptibility to infection and in very severe cases, depressed development of the central nervous system.

The earlier conception was that if the energy value of the food supply was increased (i.e. the calories are adequate) then a limited amount of protein would suffice to cater for growth and repair of tissues. This led to a shift in terminology from protein calorie malnutrition to the use of the term energy protein deficit.

Little did the world know that nutritional problems exist in America, "the land of plenty" until a television documentary "Hunger in America" in 1968 revealed the existence of hunger in the midst of plenty. This revelation led to the emergence of White House Conferences on Food, Nutrition, and Health in 1969 and 1974.

These Conferences brought into limelight the magnitude of the scourge "Malnutrition". Efforts to correct this vacuum eventually lifted nutrition unto a higher pedestal and is given recognition as a National and International Priority. Thus, nutrition has become a household word and is a subject of research not only in science-based disciplines like Agriculture and Biochemistry but also in the social sciences such as Economics, Sociology, Anthropology and Psychology.

Food has been the preoccupation of man from the Stone Age to the Industrial Age. Food fulfils many important roles in the life of an individual. Man is a

product of his *environments* which are biological, physiological and psychosocial.

Nutritional well-being is greatly influenced by the nutrient content of foods consumed in relation to physiological needs which are determined by age, sex, level of physical activity and health status. The efficiency of nutrient utilization by the body also plays a significant role in the ability of the individual to adapt to varying levels of nutrient intake.

A diet is considered adequate when it provides sufficient energy, carbohydrates, protein, fat, micronutrients (vitamins and minerals) and other essential components, including dietary fibre to meet the body's needs. A diet that promotes optimum well-being must be balanced with regards to nutrient content, diversified in relation to food choice and must be culturally acceptable. Hence, diets that provide inadequate or excessive amounts of nutrients lead to malnutrition. Undernutrition arising from insufficient food/nutrient intake is prevalent in the developing countries while overnutrition due to excess consumption of nutrients is widespread in industrialized countries.

Energy is the basic need of every organism including man. Hence, the dietary energy supply (DES) has become a widely used estimate of the average daily energy available for human consumption from the food supply within a given period. The DES figures synthesized by FAO from the data of Food Balance sheets indicate trends in food and energy supplies at national and regional levels.

According to FAO World Food Summit (1996) average per *caput* food supplies have been on the increase since 1970s such that by 1988-1989 there was enough food in the world. Individual requirements would have been met if distribution had been equitable. During this period, over 786 million people in developing countries regularly failed to have access to enough food to meet their energy requirements, compared to 941 million in 1969-71.

Statistics of malnourished individuals globally is scary. The latest rough estimate put the number of undernourished individuals from inadequate food intake at 780 million which constitutes about 20 percent of the developing world's population. In the same vein, over 192 million children are suffering from protein-energy malnutrition (PEM). On the other hand, various micronutrient deficiencies are assuming greater significance affecting about 2000 million people. In addition, chronic diet-related non-communicable diseases such as cardiovascular diseases, some cancers and obesity are assuming public health significance particularly in developing countries.

Maternal Nutrition

High mortality and morbidity have been reported for women during reproduction arising from malnutrition and infection. Maternal mortality rates also show wide variations ranging from 50 to 700 per 100,000 live births. Currently over 90% of all maternal deaths occur in developing countries.

Maternal weight gain (pre-pregnancy and during pregnancy) is considered the most sensitive measure of acute nutritional stress in pregnancy. According to Prentice *et al.* (1987) the incidence of LBW decreased significantly from 20 to 6% after severely malnourished and underweight mothers received caloric

supplementation (431 kcal/day) during pregnancy. Also, continuous daily supplementation with 465kcal through two pregnancies and the lactation period produced a more significant increase (300g) in the birthweight (Kusin *et al.* 1992).

Seasonal fluctuations in food availability invariably influence the cost of food and quality of life, nevertheless, women who gained little weight during pregnancy gave birth to babies with normal weight (Tripathi *et al.* 1987). The favourable pregnancy outcome in these women is explained by Durnin (1987) as successful "adaptation" to the high energy burden of reproduction which may occur when the system is energetically stressed.

Chronic maternal undernutrition is often complicated by infection, repeated and closely spaced pregnancies and physiological stress of growth as occurs in teenage pregnancy. Undoubtedly, poor maternal nutrition during pregnancy would imply a risk of nutrient availability to the foetus who is totally dependent on the maternal store of nutrients for its nutrition and development.

The negative effect of rising price on quantity and quality of food consumed was expressed by Falusi (1985). Falusi inferred that the quality of feeding was generally affected by the high price of starchy staples.

Bassey and Ajayi (1999) studied the market price of food sold in Akwa Ibom over a six year period and prepared a time plot relating the cost of starchy staples, animal products to pregnancy outcome. Seasonal variations were observed in the cost of food stuffs with general increases occurring throughout. The increase in the market price of animal products was pronounced. The third quarter of the year appeared to be the most unfavourable period for pregnancy outcome because of the food restricted second quarter while the fourth quarter of the year was the most favourable.

Mortality and Morbidity in Infancy

How long a baby is expected to live (i. e. life expectancy) is pre-determined before birth (prenatally). Data abound that growth before birth (prenatal) is influenced by the intrauterine environment while postnatal growth is influenced by the physical environment and care provided. Epidemiological data have shown that low birth weight is detrimental to survival in infants. A baby is termed low birth weight if he weighs less than 2,500g at birth. In fact, such babies are at a disadvantage during the first few weeks of life. The mortality rate for infants with normal birth weight is put at 2/1 000 live births but it is as high as 86/1000 for low birth weight (LBW) infants. The prevalence of LBW is at least 3 times higher in developing than in industrialized countries.

A greater proportion of low birth weight (LBW) infants can be traced to maternal malnutrition rather than to prematurity. Maternal malnutrition before conception or during pregnancy leads to growth retardation in the foetus (intrauterine growth retardation) and accounts for a greater percentage of the low birth weight babies in developing countries. Intrauterine growth retardation is at least five times as high in developing countries as in industrialized countries. Invariably, small babies grow to become small adults and a vicious cycle of growth failure is perpetrated from generation to generation.

From scattered and limited retrospective and prospective studies on new born babies in rural and urban settings in Nigeria (Hussain and Omololu 1983; Lawoyin and Oyediran 1992; Airede 1995). The incidence of LBW deliveries is reported to vary from 8.3 – 20%. According to UNICEF (1999) the national prevalence rate of LBW is 16%. However, when pregnancy is superimposed on growth in adolescence, a higher incidence of LBW is commonly observed. LBW is reported to be higher in teenage mothers than in older mothers. (Lawoyin and Oyediran 1992). The data of Bernstein-Oguntona (1999) also emphasized that the younger the teenager, the greater the chances of delivering a baby of low birth weight.

Bassey and Ajayi (1999) also analysed hospital data of a mixed population from a retrospective study in Akwa Ibom State involving 16,175 infants born within the period 1988-1993. The mean birth weight of the infants was 3053 + 47g (SD of the mean). The total number of newborn infants with a birth weight below 2,500g (LBW) was 1,844. This translated to a LBW incidence of 11.4%. Intrauterine growth retarded delivery, a reflection of maternal malnutrition accounted for 73% of the LBW infants while prematurity was 27%

Foetal Growth

The health status of the mother may have direct or indirect impact on foetal growth. Maternal infection is known to depress appetite and reduce food intake thereby restricting nutrients for foetal use. Also, the metabolic stress of infection as in malaria or other fevers may increase the excretion of nutrients from the body thereby raising the requirements for nutrients by the mother herself. Furthermore, epidemiological studies have emphasized the impact of intestinal parasites such as hookworm and ascaris in decreased absorption of energy, protein and micro-nutrients (such as vitamin A, zinc and iron, in particular). In extreme cases, the foetus itself may become infected or placental efficiency may be grossly affected and the transfer of nutrients from the mother to the foetus jeopardized.

Nutrition Security in Infancy

Breastmilk provides nutrition security for the infant. Infancy is the only time in the life cycle when the child depends on only one food source (breastmilk) for his nutritional needs. Hence lactational failure is detrimental to child survival.

Insufficient milk production is a common cause of failure of lactation in developing countries which is often attributed to inadequate energy intake to sustain milk production. (Bates 1987). In particular, milk composition is mostly affected by the mother's intake of water soluble vitamins. It is less influenced by her consumption of fat soluble vitamins, and is relatively unaffected by maternal mineral intake. Therefore, Allen (1992) suggested that maternal deficiency of the water soluble vitamins as well as vitamin A and iodine should be avoided. Studies carried out in different parts of the country have reported riboflavin deficiency among population groups. Attempts to identify the implication effect for infant nutrition encourage our study of the level contained in breastmilk the only food for the newborn infant.

Onurah and Ajayi (1985) studied riboflavin content in breastmilk of lactating Nigerian women six weeks *post partum* (after delivery). The mean riboflavin content of breastmilk was 0.34mg/l (range 0.22 to 0.47 mg riboflavin/l). However, infants, suckled by these mothers look healthy. Unfortunately, their total daily breastmilk consumption was not measured. Support for sustainability of breastfeeding encourages us to look into possible changes in breastmilk riboflavin under storage. We conclude that riboflavin level did not change after refrigeration for 5 days provided power failure does not occur. So, infants whose mothers secrete low volume of breastmilk can be helped from the breastmilk bank supply. Thus, household storage of breastmilk on a small scale will contribute to the sustenance of exclusive breastfeeding especially where the employment site does not provide a breastfeeding centre. At the national level, operation of a breastmilk bank may constitute a temporary solution for HIV infected mothers who would like to give breastmilk to their babies and for babies who lost their mothers at birth. Therefore, proper pasteurization, handling and storage of breastmilk samples would protect them from contamination.

Complementary Foods

The introduction of additional foods in infant feeding must be properly timed. Complementary foods (foods consumed in addition to breastmilk) are often introduced at a time when breastmilk alone is no longer able to satisfy the physiological needs of the infant for energy and specific nutrients. The optimal time for introduction of complementary food is controversial. However, the nutrient content and the number of meals or frequency of feeding would determine the nutrient intake of infants. The relatively high energy requirements of infants demand that the complementary food should be energy dense, of good quality (nutrient dense) but not bulky. Nutrient density and bioavailability are probably the factors most commonly used as indicators of dietary quality (Brown 1991). The contamination of the food is related to the preparation or processing method, as well as the time lapse between preparation and consumption (Brown *et al.* 1995).

In order to avert nutritional deficiencies and secondary functional impairment, complementary foods must be wisely chosen. An array of complementary foods have been produced for infant feeding in Nigeria with cultural acceptability, cost and diversity as common considerations. Akinyele and Abudu (1990) produced household adaptable complementary foods of high nutrient density from cowpeas. Ketiku and Olusanya (1986) formulated complementary foods in which meat was a prominent component along with fruit and vegetables or cereal and vegetables. The high quality of the protein source must have contributed to the high biological values reported.

Recently, Alabi and Ajayi (1999) formulated eight different kinds of diets from locally available staples. Home processing techniques of malting, roasting parboiling and pounding were employed to encourage adoption and reduce cost in comparison to commercially produced ones. The diets consisted of mixtures of sorghum and cowpea, sorghum and groundnut flour in the ratio of 70:30. For four of the diets, part of the staples was replaced with cassava leaves in the ratio

of 5-30%. The protein content of the mixture was 12.3-16.6%, crude fibre 2.3 to 6.1% and energy value 389-446ca/100g. The protein content compared favourably to another blend containing malted sorghum-corn-crayfish. The formulated diets were biologically evaluated using rats as test animals. The results indicated that the mixtures would support normal growth and development of young children. Thus, care givers can successfully combine available staples to nutritional advantage of children and prevent malnutrition and associated unhealthy consequences.

Adolescence

The International Year of the Youth celebrated in 1985 and the World Health Assembly in 1989 focus attention on the adolescents. The adolescents comprise about 30% of the total World Population. Between 1960 and 1980, the youth population increased by 66% while the global population increased by 46%. Over 70% of these youth live in the developing countries and the number is expected to reach 83% by the year 2000. According to the World Health Organization (1992), the adolescence is a period characterized by dramatic anatomical, behavioural and physiological changes. The characteristic growth spurt in adolescence raises requirements for nutrients, thus exposing the group to multiple nutritional deficiencies especially the B-group of vitamins, zinc and iron. Our studies for over a decade focus on the dietary pattern, food selection and nutrient intake of free-living adolescents in rural and urban settings. The role of institutions in influencing dietary habits of this group was also assessed in federal and state government-controlled schools.

Our comparative studies on nutritional status of rural and urban adolescents revealed that rural adolescents are 8-15cm shorter in height 4-8kg higher in weight. These are indications suggestive of persistent chronic malnutrition in rural areas. Nutrient intake of rural adolescents was markedly low for energy, protein and riboflavin. Functional impairment due to restricted intake of riboflavin (Vitamin B1) was assessed. The contribution of animal sources to the total protein intake was also lower 15% versus 26% for rural and urban subjects, respectively. Nutrients' intake of rural adolescents was lower than that of urban adolescents especially energy, protein and riboflavin. Lower intake of other nutrients like vitamin B6 and zinc which were not measured could have occurred.

Recent studies on energy intake of urban adolescents by Cole *et al.* (1997) reported similar energy values but much higher body weight than for our rural subjects. The lower body weight in rural adolescents is not surprising because of their higher activity level. Other investigators have reported that an imbalance between energy intake and expenditure has a negative effect on body composition.

The Institutions (Ibadan Grammar School, Government College, Ibadan, Federal Government Colleges at Odogbolu and Ijanikin) provided the students with adequate foods which are equally high in nutrients. Unfortunately, disparity was observed in nutrients intake of students because the sharing of the food by the students was haphazard in nature. A class differentiation to the detriment of younger students was obvious with school prefects followed by the mess boys

receiving choice and larger portions of each food item. Protein intake ranged from 45- 77g/day and riboflavin was 0.45-0.83 mg/1000kcal.

From these studies, we also determined riboflavin status required for metabolic function using either the load test enzyme stimulation techniques. From regression analysis (Ajayi 1979) it was established that a minimum intake of 0.4mg riboflavin/ 1000kcal or 0.65mg available riboflavin was equivalent to saturation of enzyme glutathione reductase with riboflavin activity Coefficient-EGRAC/1.20). This recommendation proved adequate in later studies (Ajayi and James 1984). A comparison of urban adolescents drawn from International School (Cole *et al.* 1995) with our urban female adolescents (Ajayi 1984 Korede and Ajayi 1992-93) showed that Federal Government College Odogbolu and Ijanikin had higher energy and nutrient intakes than Cole's subjects. To some extent, government policies like Structural Adjustment Programme operative in the 90s and other socio-economic policies must have produced negative effects on the nutrient intake of Cole's subjects. Such an effect was absent from studies conducted early in the 80s (Ajayi 1984).

Ageing

Lifestyle Changes

Ageing is a global phenomenon. In 1990, 55% of 176 million of the elderly population of the world were living in the so-called developing world. By 2025, the proportion is expected to rise to 65%. The ever-increasing number of elderly people raises issues about the quality of life in the extra years. Economic condition, nutrition, level of education influence feelings of life satisfaction will all have impact on ageing.

Increased food availability has been shown to be associated with increasing life expectancy up to a stage after which further increases in dietary fat intake may actually be associated with a reduction in life expectancy. Other factors attributable to development of coronary heart disease in old age are, when one's internal and external environments synchronize (meaningful and manageable life), satisfaction is positive.

Women and men age differently and women live longer than men at all ages hence cannot be considered the weaker sex. They also seem to be more resilient than men at all ages. No wonder they can cope effectively with their diverse roles. The typical female advantage in life expectancy ranges from 5 to 8 years. It is therefore not surprising that the oldest people you find around in homes, even in villages are mostly women.

The biological advantage in life expectancy of women compared to men may not be readily observed in developing countries where closely spaced pregnancy, large family size, poor access to health facilities and childbirth complications condemn them to premature death. Although occupational risks may account in part for the reduced longevity in men. In addition, men voluntarily indulge more in lifestyle risks like smoking and alcohol consumption which contribute to higher incidence of death from lung cancer, violence and road accidents.

In Nigeria and other developing countries where social security schemes in old age are not operative, older people are always dependent on their families.

Factors commonly associated with increased risk of developing cardiovascular disease become more evident with age and include current smoking habits, family history of coronary heart disease, hypertension, diabetes mellitus and high blood cholesterol level (Murray and Lopez 1997).

Lifestyle and Diseases

Longer and healthier lives are achievable through a delicate balance of diet, relaxation, exercise and rest. The epidemiologic and demographic transition suggest a shift in disease profile from one dominated by infectious and communicable diseases to a scenario characterized by premature adult mortality from chronic degenerative and non-communicable disease. In essence, the very high mortality at the younger ages is giving way to an emergency pattern' dominated by chronic disease and injuries with lower mortality reaching a peak at older ages hence the phenomenal increase in life expectancy.

This association is further explained by the current trend of drift from rural to urban areas which is expected to increase from 37% in 1995 to 57% in the year 2025. In effect, both internal migration and rapid urbanization have encouraged changes in dietary pattern and lifestyles.

The technological changes have given rise to the modern dietary pattern that is high in saturated fats, sugars and refined food devoid or of low fibre content. China is a good example of developing countries in economic and demographic transition demonstrating dramatic changes in food consumption patterns. The intake consists of high fat diets rich in animal products with little change in energy intake.

The industrialization, modernization and urbanization phenomena in industrialized countries have led to intense mechanization, reduction in occupational activities and increased leisure time, most of which is devoted to sedentary activities such as watching of television. The change in physical activity pattern has contributed to the high incidence of obesity (excessive weight accumulation) in children and adults in industrialized societies. This trend is spreading fast into developing countries. For example, rural-to-urban migration in Nigeria has reduced participation in physical activity needed for agricultural production.

Furthermore, pursuit of sedentary leisure time activities similar to what obtains in the developed world has contributed to the emergency of obesity even in developing countries. Obesity is a major risk factor for several chronic diseases. Thus, the changes in dietary patterns and physical activity levels and the accompanying changes in body composition and body weight will undoubtedly account for the increased risk of NCDs in developing countries.

Accordingly, coronary heart disease, cancer, diabetes may be exacerbated by lifestyle habits characterized by lack of rest, physical activity, inappropriate diets, use of tobacco and alcohol consumption. A recent analysis of mortality trends (Murray and Lopez 1997) revealed that cardiovascular disease is a leading cause of mortality, while death due to cancer ranks third.

There is evidence linking CHD in later life with events during uterine growth in particular. The association was particularly strong for infants who at birth

weighed less than 2500g, were short in length and had small head circumference. The highest prevalence was also found in adults whose mothers weighed less than 45kg (100lb) during pregnancy. These associations were independent of coronary risk factors such as hypertension, non-insulin dependent diabetes, abnormalities in lipid metabolism and blood coagulation.

Strategies for Enhancing Longevity

Today, our choice of food has broadened, and food is readily transported across the States. Unfortunately, the quality of the food is greatly affected if they are moved over a long distance. For example, chemical changes like oxidation may be initiated during such movements and this is capable of destroying its vitamins A and C content. In this environment, light can also destroy nutrients like riboflavin, Vitamin A and Vitamin C and induce oxidative changes in fats. Excessive ripening of fruits will make them rotten and unconsumable. Storage of foods under damp environment will promote microbial growth which will destroy the nutrients and constitute potential hazard to us. Food preparation methods in the home like peeling (yam) cutting and dicing (vegetables) coupled with exposure to light or heat reduce the nutrient content of our foods further. Bulk preparation of food (soups, sauces) accompanied by repeated warming is detrimental to the retention of nutrients in food. Even keeping prepared food over steam for hours before consumption destroys the nutrients.

In addition to these various ways by which nutrients are lost from our foods social habits like smoking, alcohol consumption and dieting may limit the benefit we derive from nutrients present in foods. Other aspects of our lifestyle can also increase the demand for nutrients such as physical activity (need for antioxidants increase) daily exposure to environmental pollution — car exhaust, filth, contaminated water, cigarette smoke, stress (physical and mental) and medication. Under these prevailing conditions, an individual must gain optimal health and avoid instalmental or premature death, the only option is to take vitamin and mineral supplements.

Supplementation

Supplementation, although expensive produces an immediate and rapid improvement in metabolic functions. Our supplementation studies using water soluble vitamins alone or together with iron (Ajayi *et al.* 1990) were accompanied by increases in haemoglobin concentration which essentially make more oxygen available to the cells and enhance performance.

Fortification

This is a long term strategy that can be used to raise the nutrient content of foods. Cooperation is required at all levels — the consumer, the industry and government. The policy of iodization of salt embarked upon by the government has successfully spread to at least 95% of households.

Liquid milk and margarine are currently being fortified with Vitamins A and D, but how many Nigerians can afford to buy them? The debate still goes on as to acceptable foods to be fortified with vitamin A and Iron. Other nutrients especially the B Vitamins would have to be included in the fortification

programme and the prices of fortified foods adequately subsidized to encourage consumption.

Food Diversification

The consumption of a varied diet, wisely chosen to include foods rich in specific nutrients is necessary. However, the success of this will depend on a broad-based Nutrition education to inform people on the selection and consumption of a variety of foods within the budget. Fruits should not be considered as snack items but a part of the meal, likewise, sizeable portions of vegetable should be consumed.

The Paradox of Life

My story goes like this:

I was born a baby like everyone else
I was well nourished and started to grow
... until things started to fall apart
as inflation set in malnutrition soared
a mixture of insufficient food and improper diet made me grow
emaciated and distorted.
Who am I then to blame for my woes?

Am I to blame the government for:

an insufficient income and inadequate health facilities the deplorable
sanitary environment and the contaminated water I drink

Or myself for not taking heed of health and environmental hazards

even when I was told that smokers are liable to die young
I did not control my appetite but delighted in sumptuous meals rich in
cholesterol which took its toll on my health.

My family would not even be spared in apportioning the blame

I was not given the necessary immunization
and enough food which I needed to grow in infancy.

I once had a lifestyle but it developed into a habit
I once had little to eat but later had too much to eat
I once fought for food now I'm fighting for life

My Certificate of death is now before my very eyes
I then ask myself:...

What will the Doctor write as the cause of Death
..Anonymous.

Charity begins at home, to reduce instalmental death traceable to poor diet on this campus, my Department is committed to offer training programmes to all food establishments on this campus to ensure that foods sold are not only safe but are dense in nutrients. I presume that such training will be a pre-requisite for issuance of catering permit on this campus.

Secondly, a basic course in Human kinetics should be made compulsory for all categories of students admitted to this University. Thirdly, smoke is a pollutant whether from cigarette or burning of refuse. "NO SMOKING" signs should be displayed in public places including lecture halls and hostels.

Growth and Longevity

Almost six decades ago, Cathcart (1940) in Glasgow, asked, "should we aim, as some enthusiasts would have us do, at feeding children in such a way as to produce the maximum growth and development of which each child is capable? If we succeed in this, are we sure that we have benefited the child?" Does maximum growth make for health and longevity?" There is certainly some evidence that it does not.

Masoro (1985) also contended; "there is potential conflict between the dietary recommendations of half a century ago, which were directed towards maximizing growth, and those of the present which are directed towards maximizing longevity. If we want a lot of one, we may have to settle for a bit less of the other".

Growth

Growth is a good indicator of health and nutritional well being especially in children. Health and nutrition problems in childhood, particularly in developing countries, arise from unsatisfactory food intake or severe and repeated infections, or a combination of the two Oluboyede and Ajayi 1984. These conditions invariably reflect the quality of life or the ability of the population to meet basic needs like food, shelter and health care. Thus, growth assessment provides an indirect measurement of the quality of life of the entire populace and a reliable means for evaluating health and nutritional status of children.

Anthropometric indices are commonly used to assess child growth and nutritional status. The indicators used include the following: height-for-age (height/age ratio) which describes linear growth and essentially measures long-term growth faltering; weight-for-height: expresses the harmony of growth and is particularly sensitive to acute growth disturbances; and weight-for-age related together with linear growth and body proportion.

Growth retardation prevalences for under-5-year-olds were taken as the proportion of weight-for-age, height-for-age and weight-for-height below -2 and -3 standard deviations (SDs) from the reference medium.

These anthropometric indices derived from the latest available data from national surveys of 112 countries in developing countries covered 87% of the total population of under-5-year-olds (about 468 million children) in 1990 (de Onis 1993). The data revealed no consistent differences in prevalence of malnutrition among male and female children. Nevertheless, prevalence rates are

consistently higher in rural than in urban areas. Also, marked variation was observed by age and region within countries. De Onis and Blossner (1998) reported that about 38% or 206 million children under 5 years of age living in developing countries were stunted in 1995. Asia recorded the highest number of stunted children both in absolute numbers and in terms of prevalence. In Africa, there were 40 million stunted children or 20% of total stunted children in developing countries (see table).

Table
Global trends in prevalence of stunting in Children
under five years of age, 1975-1995.

Regions	1975-1990		1990-1995	
	Africa	36.8	40.6	38.6
East Africa	48.3	17.5	48.0	19.4
North Africa	25.4	5.3	26.6	5.6
West Africa	36.8	12.4	37.1	14.2
Asia	42.6	162.2	41.0	149.1
East Asia	31.4	39.1	31.4	34.5
Central	52.7	94.2	49.6	86.5
South East	40.8	23.2	39.7	22.6
Latin America and Caribbeans	21.9	11.9	17.9	9.7
Oceania	36.4	0.3	31.4	0.3
Developing Countries	39.4	215.0	38.1	206.2
Global	34.6	216.0	34.0	208.1

Source: Adapted from de Onis and Blossner 1998

Conclusion

It is just not enough to sign on the dotted lines, there must be a policy to back up the protection and affirmation of the right of every child to adequate nutrition to ensure proper physical growth and mental development.

In a world of abundant resources where there is enough food for everyone, to subject our children to harsh environment and inequitable access to resources which mar their growth and development is a colossal waste of human potential which a society can least afford.

It is my submission that strategic and coordinated framework would need to be initiated along these lines:

1. There is need to popularize urgently the National Policy on Food and Nutrition and increase the awareness of the Food and Nutrition situation in Nigeria. The National Plan of Action should go before the Legislative

Arm of Government with dispatch for proper funding and empowerment by the three tiers of Government for implementation.

2. The Government needs to put into operation, relevant National Plan of Action that will enhance unlimited access to good quality food and provision of accessible and affordable health care as well as reduction of environmental hazards.
3. (a) It is also expedient that the economic, social and nutritional situations of women should be improved since they are the primary care givers.
(b) Adequate family support should be provided within the family to promote exclusive breastfeeding and immunization of children against preventable childhood diseases. Furthermore, uninterrupted power by NEPA would provide support for establishment of breastmilk bank. There is an urgent need for the Government to enunciate and implement a policy that will improve sanitation and housing and overcome overcrowding.
4. Considering the negative effects of some of our lifestyles like:
 - (a) **Smoking:** There is need for Government to come up with a policy that will not only prevent smoking in public places but to put an outright ban on tobacco advertisement in the media.
 - (b) **Alcohol:** Promote public awareness on the ill effects of alcohol consumption on quality of life and possibly ban the consumption of alcohol in public places.
 - (c) **Physical Activity:** Establish more recreation centres with exercise facilities in all communities. Exercise should be regarded as an essential part of life for all ages. Employers should provide exercise facilities and administrators should be compelled to participate to burn off excess and ugly fat. Exercise not only improves efficiency of respiratory capacity, it also improves cardiac functions and increases efficient blood flow to all muscles.

FERTILIZERS: NIGERIAN FARMER'S DILEMMA

G. O. Obigbesan

Department of Agronomy

Introduction

Throughout the world, food production is fundamental to human survival, and fundamental to agricultural production is soil fertility. Food security and poverty alleviation are inseparable phenomena, which can only be judiciously addressed by self-sufficiency in production. Adequate food production based on natural soil fertility alone is the practice of the past. Today, all levels of modern agriculture depend on the application of some plant nutrients.

This is the sixth inaugural lecture from the Department of Agronomy; the Fifth was delivered by our renowned Professor of Soil Physics on "Works of Water on Earth" which centred on soil and water management and conservation for crop production. It is a unique privilege and honour for me to be called upon to deliver today's inaugural lecture on behalf of the Faculty of Agriculture and Forestry.

The farmer remains the centrepiece of our research efforts in the Department of Agronomy. Today's lecture has, therefore, been chosen, in my discipline of plant nutrition, to focus on a production input of vital importance to farmers, a factor indispensable for achieving bountiful yields of top quality, so as to eliminate hunger, alleviate poverty, attain self-sufficiency and provide excess for export.

The central theme of this lecture is Fertilizer. A sound knowledge of plant nutrition forms the basis for fertilizer science. NUTRITION may be defined, as the supply and absorption of chemical compounds needed for growth and metabolism, while the chemical compounds required by an organism are termed NUTRIENTS. Plant nutrition is concerned with the nutrition of cultivated crops with a view to influencing their quantitative and qualitative yield. The first part of this lecture deals with the historical development of crop nutrition and fertilizer science, the second part considers the plight of Nigerian farmers in the

use of fertilizers, while the third part respectfully welcomes this important audience to share my own personal experience and humble contribution. The lecture concludes with suggestions and recommendations.

Historical Perspectives

Development of the Science of Plant Nutrition

From time immemorial, mankind has been concerned with the maintenance of fertile soils for food production. The story was told of a conversation between the planets, Saturn and the Sun, probably before the last eclipse of the moon. The planet Saturn asked the Sun "How do you feel about Planet Earth?" The Planet Sun responded drily "I am sad. It can't even manage its SOIL, WATER and NUTRIENTS properly". That celestial conversation probably triggered the recent development of the global Soil Water and Nutrient Management Programme (SWNM).

The Incas of Peru used dead fish in the plant hole to grow better maize yields. About 10,000 years ago, legumes were introduced in Mesopotamia to improve the yields of other crops and shepherds led their flocks across barley fields to stabilize and fertilize the soil. The cattle Fulani, the nomadic pastoralists of Nigeria still operate this method of soil fertility maintenance. While Medieval Europe introduced crop rotation to avert crop failures and resolve serious food problems, the traditional method of restoring soil fertility in Africa is through bush fallowing in a system of shifting cultivation or land rotation.

We would recall that around 350 BC the Greek philosopher Aristotle propounded the humus theory that plants grew by feeding on humus which they absorb from the soil through their roots and after the plant dies it decomposes and forms humus, which is then absorbed by plants (Fig. 1). This view held sway for over a century.

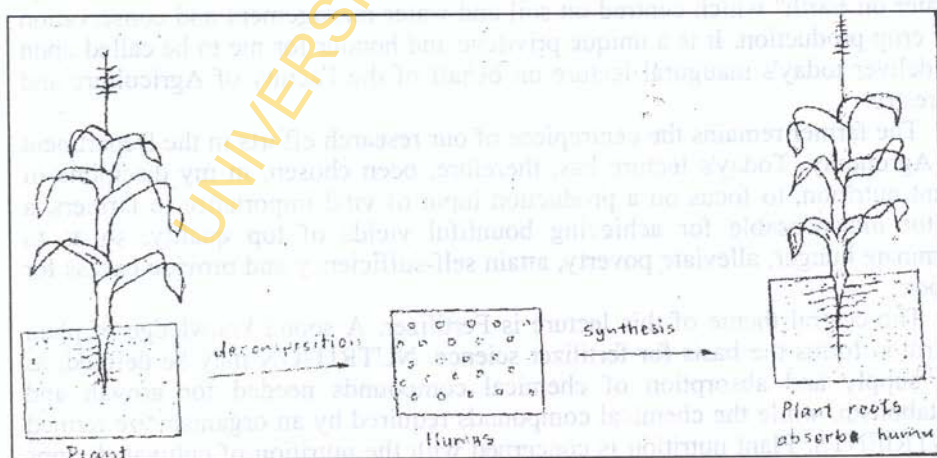


Fig. 1: Humus Hypothesis according to Aristotle

The development of the knowledge of plant nutrition was painfully slow over the centuries until the application of chemical sciences to Agriculture. Nicholas of Cusa (1401-46) suggested that plants absorb constituents from the soil through water uptake. Van Helmont (1577-1644) described the first classical experiment in plant nutrition. He grew a 5-pound willow branch in a pot containing 200 pounds of oven-dried soil, watered it for five years to a tree weighing 169 pounds and concluded, though erroneously, that the 164 pounds wood, bark and roots had arisen from water alone. In a water culture experiment, Woodward (1165-1728) discovered that plants grew better in water containing dissolved solids than in distilled water. With the advances in science towards the end of 18th century and the elucidation of the chemical and physiological basis of plant growth, the application of chemical sciences to practical Agriculture (Agricultural Chemistry) became initiated in the 19th Century. Thus notable scientists, such as, Lavoisier (1743-1794), a French scientist, who is well known as the founder of modern chemistry, who administered the '*coup de grace*' to the phlogiston theory, conducted numerous experiments on his farm. While Scheel (1770) asserted that plants excrete carbon dioxide (they pollute the air), Priestley (1775) discovered that plants liberate oxygen (they make the air fresher) and Ingen-Housz (1779) who showed the effect of light on gaseous exchange, postulated that oxygen is liberated only by day (light).

Woodward (1699) and De Saussure (1804) originated the water culture approach to study plant nutrition; while Sachs (1860) developed the basis of modern water culture techniques. The qualitative elucidation of photosynthesis that plants require carbon dioxide from the air and water beside ashes from the soil was also credited to Saussure (1804). Research on plant nutrition and soil-plant interrelations reached a high point in the work of Jean B. Boussingault (1802-1887) who conducted carefully planned field experiments on his farm for 36 years between 1834 and 1871. He, thus, introduced the methodology of modern field experimentation and also discovered that leguminous plants assimilate and fix atmospheric nitrogen. It was in 1886 that German investigators, Hellriegel and Wilfarth, ultimately discovered that it is the bacteria in the nodules of the roots of leguminous plants that fix free nitrogen from the air.

Carl Sprengel (1787-1859) postulated that a soil may be favourable to crop growth in almost all respects – "yet may often be unproductive if it is deficient in one single element that is necessary as a food for plants". Here was a clear statement of the "law of the minimum".

Fertilizer Use Development

With the publication in 1840 of his famous book "Chemistry in its Application to Agriculture and Physiology", the great German chemist, Justus Von Liebig (1803-1873) and a foremost chemist of his time, after whom the University of Giessen, my *alma mater*, was named, finally laid to rest the humus theory of Aristotle. He established the mineral nutrient concept that the organic matter of the soil (humus) constitutes a source of nutrients which plants absorb through their roots (Fig. 2).

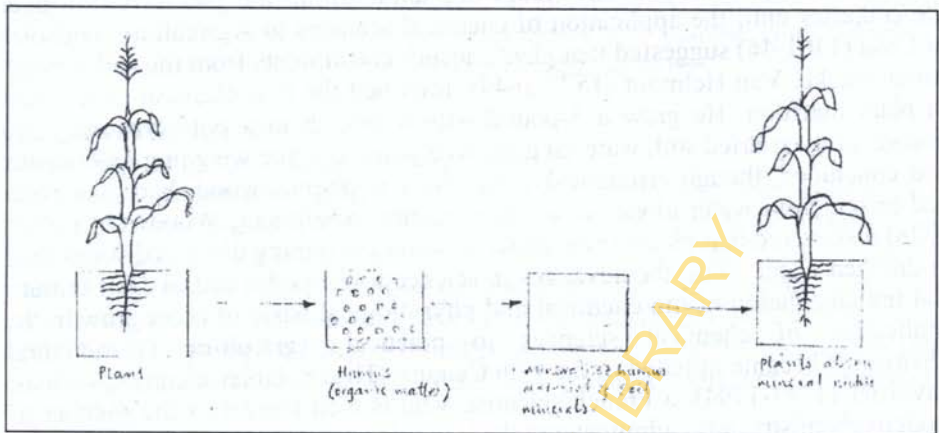


Fig. 2: The Mineral Nutrient Concept as of 1840

This concept won acceptance for the mineral theory of fertilizers and drew attention to the possibility that artificial fertilizers could be used to supplement the mineral content of the soil. This concept also inspired extensive investigations carried out in Britain at John Lawes Rothamsted Estate by Lawes (1814-1900) and Gilbert (1817-1901) which paved the way to new knowledge of soils, crops and livestock. The dramatic effects of artificial fertilizers on British soils stimulated similar work in other countries of Europe and elsewhere (Table 1).

Table 1: Historical Development of Modern Fertilizers

1830	Chilean Nitrate of Soda imported to Europe
1840	Beginning of Regular import of Guano (bird droppings) from Peru
1842	Superphosphate patented in England
1855	Superphosphate as first fertilizer from the factory in Germany
1860	Potash from underground mines
1879	Development of Thomas-Phosphate Process
1890	Ammonium sulphate introduced
1903	Saltpeter (sodium nitrate)
1906	Nitrogen synthesis in calcium cyanamid-process
1913	Synthetic ammonia by Haber-Bosch process
1916	Production of rhenaniaphosphate
1987	Ammoni and urea by NAFCON
1976	Single superphosphate by Superphosphate Fertilizer Company, Kaduna

An understanding of the role of major nutrients in plant nutrition and the benefits to crop growth when plant nutrients were added to the soil in the form of fertilizers led to the development of a commercial form of soluble calcium

phosphate, the superphosphate by Lawes in England which was patented in 1842. The experimental appraisal of fertilizers, originated by Lawes and Gilbert at Rothamsted, has continued to the present day. By 1840 it was recognized that:

1. Mineral substances are not just found by chance in the plant, they are essential components of the plant.
2. Plants require ten elements (COH.NPSK Ca Mg Fe). All except COH is derived from salts in the soil.
3. Different plant species need different quantities of nutrients.
4. Many soils lack some nutrients, which can be restored through applied fertilizers.
5. The plant as a nutrient does not require humus, however it is important as nutrient source.

Soil Fertility Investigations in Nigeria

Research on soil fertility maintenance in Nigeria dates back to 1925-1933 with experiments on leguminous crops at Ibadan and fallow trials with pigeon pea (*Cajanus cajan*) and gamba grass (*Andropogon gayanus*) at Samaru (Faulkner 1934) as well as at Yandev during 1938-1940. Farmers however, could not understand or accept the economics of a practice where no actual cash returns were realized.

Attempts were made to replace the legume fallow system with farmyard manure (FYM), animal dung, poultry droppings and household refuse, including human wastes. The bulky nature of FYM (requires 20 tonnes per hectare), cumbersome transportation, tasking labour requirement in the application coupled with low mineral nutrient content (6.1 %) and slow mineralization and release rate, discouraged its widespread acceptance as researchers found its adoption to be rarely practicable.

The first record of mineral fertilizer use in Nigeria was in 1937 when it was demonstrated that response of cereal crops to FYM was matched by the use of single superphosphate (SSP) containing quantities of phosphate equivalent to that in the organic manure. This, with the series of soil fertility studies at Ibadan (Vine 1953), standard DNPk experiments at Samaru (Obi 1959), fertilizer studies in Eastern Nigeria (Irving 1951) and others in the Middle Belt (Watson and Goldsworthy 1964) marked the beginning of fertilizer consumption in the country. Agronomic studies on fertilizers were carried out in Eastern Nigeria in Cupertino with Messrs Albatross Superfosfaatfabriken who arranged for preparing the mixtures; there was also the FAO/Freedom from Hunger Campaign Fertilizer Programme in the country from 1962 to 1971 set-up with trials and demonstrations. Notable scientists from our universities and research institutes made significant contributions on soil organic matter, soil microbiology, soil physics, and soil fertility and plant nutrition to extend the frontier of knowledge in soil fertility maintenance and fertilizer use in Nigeria over the past six decades. The activities of the late sixties culminated in an FAO/NORAD/FDA sponsored seminar on fertilizer use development in Nigeria, held at Ibadan in April 1974.

Considerable data on fertilizer response are now available in Nigeria, generated from researches also by National Accelerated Food Production Programme (NAFPP) minikit trials, the Agricultural Development Projects (ADP), the lamentably short-lived National Fertilizer Centre at Ibadan and later the International Fertilizer Development Centre (IFDC).

Fertilizer Use Development in Nigeria

Why should we blame Nigerian farmers on their sub-optimal use of fertilizer nutrients when besides individual publications at state level, up-to-date information on fertilizers and their use on all crops in all parts of Nigeria was not made available until 19 years ago, precisely 1980, with the publication "Fertilizers and their Application to Crops in Nigeria" (FDA 1980). The first National Seminar of Fertilizer Use Development was held in Port Harcourt in 1987 followed by another on Organic Fertilizer at Kaduna in 1991.

Fertilizer Production and Distribution Service in Nigeria

The procurement, pricing, subsidy and distribution of fertilizer was centralized in 1977 after the launching of "Operation Feed the Nation" (OFN) Programme in the 1976/77 crop season. Prior to this time, each state government imported its own fertilizers, which resulted in price discrepancies, and little or no control on the quality of fertilizer type and packaging material. This created congestion at the seaports as orders arrived at the same time following indiscriminately huge importation and heavy subsidy.

In order to reduce importation, the Government of Nigeria approved plans for the domestic production of fertilizers (Table 2). The Federal Superphosphate Fertilizer Company (FSFC) based in Kaduna was commissioned in 1976 to produce single superphosphate (SSP) from phosphate rock and sulphur and the National Fertilizer Company of Nigeria (NAFCON) based in Onne (Port Harcourt) was commissioned in 1987 to produce anhydrous ammonia from natural gas (Table 3). The National Fertilizer Company of Nigeria (NAFCON) also manufactures granular Urea and NPK of various grades.

Table 2: Fertilizer Procurement Structure Tonnes in Nigeria (1988- 1995)

Year	Import	Local sources	Total supply	%Local supply
1988	384,500	365,500	750,000	49
1989	400,000	500,000	900,000	56
1990	706,000*	608,000	1,314,000	46
1991	400,000	600,000	1,000,000	60
1992	610,000	800,000	1,410,000	57
1993	645,000	745,000	1,390,000	54
1994	850,000	800,000	1,650,000	49
1995	-	835,000	835,000	100

*Includes World Bank funded imports

Sources, FPDD Reports

Table 3: Basic Raw Materials for Fertilizer Production in Nigeria

Fertilizer nutrient	Raw material	Sources	Estimated reserves
Nutrient	Natural gas provides hydrogen; air supplies nitrogen	Niger Delta oil province	1,200 billion M ³
Phosphorus	Phosphate rocks	Dahomey Basin (Ogun State – 1921 Lullemedor Basin (Sokoto State) – 1976-1978 Anambra Basin (Imo State) – 1979 Niger Delta Basin (Delta State) 1986	100,000 tons - 5 million tons
Sulphur	Pyrites Marcasite Tar sand Gypsum	Ogun Ondo Edo State Sokoto basin Imo, Ogun, Anambra Cross River States.	70 million tons extractable from 40 billion barrels of heavy oil
Calcium and magnesium	Limestone Marble Dolomite (CaMgCO ₃)	Igbeti (Oyo State Kwara (Elebu) Niger (Kwakuti) FCT (Burm)	
Kaolin (fertilizer filler)	Kaolin Clay (86.7%) Quartz 13.3%	Ubulu-Uku	
Micronutrients	Zin-carbonate, FuS (Sphalerite)	Benue Abakalili Area	
Zinc, Copper	(Smithsonite) Pb-Zn deposits	All over Nigeria	
Boron	Tourmaline with pegmatites	All over Nigeria	
Molybdenum	Molybdenite Mos ₂	Nassarawa-Egom Tibochi Hills Ikere-Ekiti	

Unfortunately, the National Fertilizer Company of Nigeria (NAFCON) imports phosphoric acid and potash while Federal Superphosphate Fertilizer Company (FSFC) also imports phosphate rock and sulphur. Consequently, this situation contributes to the high cost of production and poor farmers are required to pay high prices for fertilizers.

Farmers' Dilemma Over Resources, Production Technology and Resources Management

The main medium of crop nutrition, the soil, constitutes the farmers' most important production capital. Most Nigerian soils, however, have low inherent fertility and fragile physical structures prone to degradation and erosion. Due to predominance of low activity clay (LAC) particles which result in low buffering capacity against acid formation and low ability to retain nutrients (that is, low cation exchange capacity) against removal by percolating rain water, they vary widely in their mineral nutrient reserves.

Soils: low fertility.

According to FAO's classification, 63% of Nigeria land area consists of low productivity soils, only 6% is of good productivity and virtually no soil of high productivity potential. This classification is based on the physical and chemical properties of the soils and ease of management. Our resource poor farmers must, therefore, contend with and overcome this constraint if they are to produce meaningful yields. The scope of expansion of agricultural areas is limited by land tenure system, explosive demographic growth and non-agricultural land development uses (roads, townships, industrial estates, petrol stations, etc.). The farmer is therefore compelled to cultivate continuously the same piece of land which in some places is hotly contested by his nomadic kinsmen who are always in perpetual search for grazing areas. Moreover, new crop technologies particularly improved varieties being made available are usually fertilizer-intensive. Fertilizer use has a dual purpose of feeding crop plants with nutrients and replenishing the soil (to maintain soil fertility) and environment to make up for nutrient losses due to leaching, fixation and surface wash.

Given the above scenario, the Nigerian farmer has an uphill task and, therefore, must use fertilizers to ensure the production of substantial yields. Nigerian farming population is dominated by illiterate and old generation peasant farmers whose number dwindles by day and who could not be expected to sustain medium-scale farming of about 12 ha, talk less of large scale 100-1000 ha. The efficient use of fertilizer by illiterate farmers remains enigmatic as only 25 percent of agricultural graduates have taken up agriculture as a profession. The dilemma facing Nigerian farmers in their ploy to use fertilizers could be grouped into two broad categories. The first category is the farm-level constraints to fertilizer use associated with:

- (i) Agricultural production technology – inadequate knowledge of fertilizer type, as well as the time, rate and mode of fertilizer application, and the growing of low yielding, non-fertilizer responsive crop varieties.
- (ii) Resource endowment of Nigerian farmers – lack of access to credit in spite of existing Nigerian Agricultural Co-operative Bank (NACB) and low purchasing power.
- (iii) Socio-economic factors affecting the attitude and behaviour of farmers.

Until recently, On-Farm-Adaptive Research (OFAR) with farmer-participatory approach was lacking. A farmer might reject or modify the recommended fertilizer application rates.

The second group of obstacles is characterized by constraints on the supply of fertilizers and are associated with

- (i) importation
- (ii) production.
- (iii) (iii)marketing and distribution
- (iv) research and extension
- (v) soil testing.

Importation

Fertilizer import bills into Nigeria skyrocketed particularly with the launching of various agricultural programmes such as NAFPP,(1973), ADPs (1975), RBDAs (1976), OFN (1976) Green Revolution (1979), DFRI (1986). The huge importation of fertilizers, however, did not mean their ready availability to farmers. What happened?

Production

Local production of superphosphate since 1976 and ammonia, including urea and NPK fertilizers since 1987 within Nigeria has also been inadequate to meet local or national demand (table 4). What happened?

Table 4: Local Fertilizer Production Capacity in Nigeria

Company	Year Commissioned	Product slates	Installed capacity (MT)	Capacity utilization (%)
FSFC; Kaduna	1976	SSP Sulphuric acid	100,000 40,000	20
NAFCON, Onne	1987	Ammonia Urea DAP NPK:25-10-10 27-13-13 20-10-10 20-10-05	300,000 450,000 300,000	100
F & X: Kaduna	1989	NPK:27-13-13 20-10-10 20-10-10+S+Zn 20-10-05+10 Ca	150,000	30
Agro-nutrients; Kano	1993	NPK:27-13-13	100,000	20
KASCO; Kano	1993	NPK:27-13-13	10,000	25
NAFCON Bulk blending plant; Onne	1995	NPK:27-13-13 20-10-10 12-12+2mGo 12-12-17+7MgO	200,000	*

*Started test-runs 22nd April, 1995.

Marketing and Distribution

Inconsistent pricing and subsidy policies and vexatious distribution systems have with time made fertilizers a scarce commodity. Fertilizers were not available at the crucial time of need by farmers. For instance, this year's (1999) allocation of 117,000 tonnes of fertilizers to 36 States was done in mid-August (Ref: *New Nigeria*, 20th August, 1999). A 50 kg bag of NPK-15-15-15 which sold for ₦1,500 in 1998 was priced at ₦900 in 1999, thanks to President Obasanjo's new policy of "milk of life" to restore subsidy.

In spite of heavy subsidy of up to 82-85 % over the years, except in 1985 (35%) and 1995 (no subsidy) consumption of plant nutrients is abysmally low at 9-11 kg of nutrients/ha compared with 91, 94 and 231 kg of nutrients/ha in Asia, North America and Western Europe, respectively. IFDC (1988) estimated that 31, 54 and 23-kg fertilizers per hectare are utilized in the north, middle belt and southern zones of Nigeria, respectively.

As rightly noted by Falusi (1987), fertilizer to the individual farmers is just like any other input in their farming enterprises. The farmer's costs and returns are determined by the technical efficiency of fertilizer used in each crop or crop combinations, the price of fertilizer applied and the price of crops produced therefrom. Farmers must be convinced that the returns (unit gain) from the use of external input are sufficiently high to motivate them to invest in the restoration of the fertility of their farms. This is real dilemma.

Research and Extension

Ogunfowora (1987) observed that the operative fertilizer research and extension policy aimed to encourage balanced nutrient use consistent with agronomic requirement of crops in different agro-ecological zones had been restricted to certain crops. He also noted that lack of funding had not allowed a continuous evaluation of fertilizer recommendation packages through research and demonstration. As of today (1999), the establishment of statewide ADPs has laid a solid foundation for effective nation-wide fertilizer

extension activities. Invariably, adverse reports about the quality of some fertilizers on the market were of concern to farmers. Thus a study by the International Fertilizer Development Centre (IFDC-A) in 1995 in West Africa sub-region found that 58 % of fertilizers sampled were underweight as regards weight shown on the bags.

The chemical composition of the products such as sulphate of ammonia, NPK-15-15-15 and single superphosphate also gives researchers some concern as the nutrient element content sometimes falls far short of the analysis indicated on the bags. Farmers are advised to beware when next they purchase bags of fertilizers.

Need for Soil Testing Service

The efficacy of fertilizers in stimulating increased crop yields is now well recognized by Nigerian farmers. However not every arable land will respond to fertilizers, for there are indeed some soils which give adequate yields without fertilizer application, and, therefore, fertilization of such soils will amount to a waste of resources.

The question arises as to how to identify such fertile soils in order to advise the farmers correctly. Soil testing for chemical and physical properties has to be done. It is basic for fertilizer recommendations. Without soil testing a farmer who employs a general blanket fertilizer recommendation would be unable to correct the yield limiting nutrient deficiency peculiar to his farmland with grave consequences of acidification and yield decline.

My Contributions

The foregoing considerations inspired my own humble contribution to soil fertility management and fertilizer use in Nigeria. I had the privilege of a seven-year foreign scholarship at Justus Von Liebig University Giessen in then West Germany to study Agricultural Chemistry in the Institute of Plant Nutrition. I was permitted to present my Diploma Thesis on "Die Anpassung Von Dungemitteln, Dungungsverfahren und Ausbringungsverfahren an tropische Verhaeltnisse-am Beispiel Nigerias" (The suitability of fertilizers and fertilization techniques for tropical conditions on the example of Nigeria) in 1967 and my doctorate thesis focused on "Untersuchungen Zur Frage der P-Versorgung mittelafrikanischer Boeden und P- Wirkung verschiedener Phosphatdungemittel" (Investigations on the phosphorus status of soils of West and Central Africa and the effect of different phosphate fertilizers) in 1970.

My research has focused on the assessment of nutrient status of soils in the humid tropics in relation to fertilizer nutrient needs of arable food crops, maize (*Zea mays*), yams (*Dioscorea species*) and cassava (*Manihot esculenta*), as well as plantation crops (cocoa (*Theobroma cacao*), plantain (*Musa paradisiaca*) and coconut (*Cocos nucifera*)). I have also monitored and continue to monitor the role of fertilizer nutrient elements on the yields, chemical composition, quality and disease tolerance of improved crop varieties of cassava, white yam and water yam that were released to National Food Production Programmes in the country. Nigeria is richly endowed with local raw materials for fertilizer production. The assessment of the potentials of Nigerian phosphate rocks for direct use as sources of phosphorus and calcium for crop production grains, forage grass and oil palm seedlings in selected agro-ecologies also constitutes an aspect of my research thrust. I wish to highlight just a few.

Evaluation of Soil Nutrient Status for Crop Production

Towards accurately establishing the hunger status of the soil in a farmland, we adopted various diagnostic techniques. Among the tools we employed in our soil testing programme is the Electro-Ultra-Filtration (EUF) equipment designed for soil fertility and plant nutrition studies.

The EUF-technique extracts nutrients from the soil solution through electrolysis and ultrafiltration by simultaneous extraction of cations and anions at different voltage levels. It simulates the action of plant roots in nutrient absorption from the soil environment (Fig. 3).

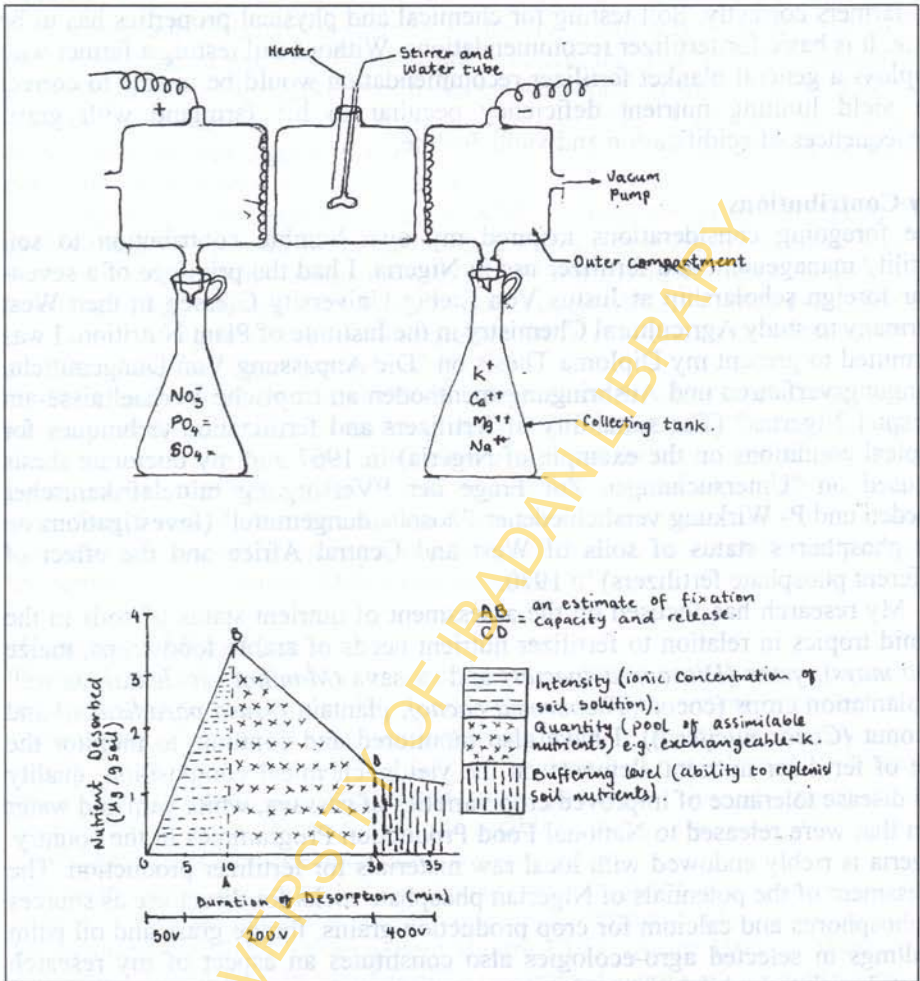


Fig. 3: EUF-Equipment extracts soil nutrients to ascertain fertility status

We are, thus, able to determine the nutrient intensity, quantity and buffering capacity of the soil simultaneously. In several studies (Nemeth, 1979; Obigbesan and Mengel; 1981a, 1981b; Obigbesan, Akinrinde and Kayode, 1986), we demonstrated the high predictive value and usefulness of the EUF technique for soil fertility investigations and fertilizer recommendations.

This EUF-Equipment was generously donated for my use through a fellowship award by Alexander-Von-Humboldt Foundation of Germany and we have been able to train scholars at undergraduate and postgraduate levels. Among our products is currently a Senior Lecturer in our own Agronomy Department. We have calibrated the EUF-Equipment for soil testing and fertilizer advisory purposes (Tables 5 and 6; Fig. 4).

Table 5: Calibration of EUF-Extractable Nutrients for Maize grown in an Alfisol

Plant Nutrient	EUF ₁₀ -nutrient data rating	EUF ₁₀ -nutrient values ($\mu\text{g g}^{-1}$ soil)	Corresponding nutrient of earleaf (% in dry matter)
N	Low	<11.00	<2.19
	Medium	11.00-22.00	2.19-2.53
	High	>22.00	>2.53
	Optimum	31.50	3.05
P	Low	<0.435	<0.33
	Medium	0.435-0.520	0.33-0.37
	High	>0.520	>0.37
	Optimum	0.640	0.45
K	Low	<20.70	<1.78
	Medium	20.70-23.55	1.78-1.80
	High	>23.55	>1.80
	Optimum	27.42	1.79
Ca	Low	<22.00	<0.43
	Medium	22.00-25.80	0.43-0.44
	High	>25.80	>0.44
	Optimum	30.11	0.44
Mg	Low	<6.60	<0.23
	Medium	6.60-12.80	0.23-0.32
	High	>12.80	>0.32
	Optimum	12.65	0.32

Table 6: Evaluation of EUF-K data for cassava crop on an Alfisol

EUF Extraction time (min.)		Ranking-order (low, medium, high g k/g soil)		EUF K-level for optimum root yield	
1.	5	10	11-15	15	16.8+
	Rel. yield (%)	57-73	88-96	98-99	
2.	5	10	11-14	15	17.3++
	(R.Y)	61-84	88-95	99.2	17.1
3.	10	25	26-35	40	42.9+
	(R.Y)	72-82	84-98	99	
4.	10	25	26-35	40	46.8++
	(R.Y)	65-80	82.97	98.8	44.9
5.	30	40	41-55	60	69.3+
	(R.Y)	58-83	84-95	97	
	30	40	41-55	60	69.7++
	(R.Y)	60-81	74-97	98	69.5

+ Fresh root

++ Dry weight

Source: Akinrinde, Obigbesan and Okeke, 1983)

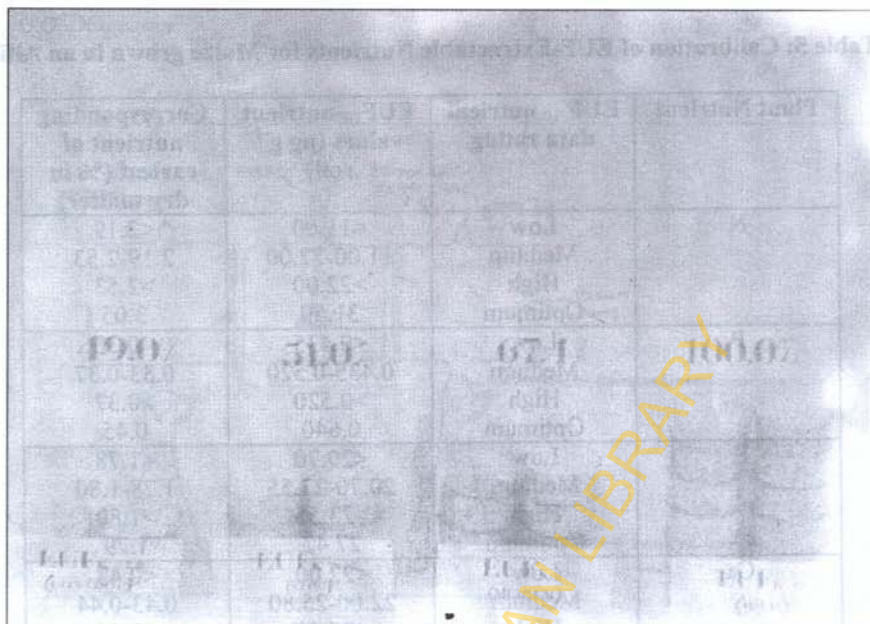


Fig. 4: Calibration of EUF-K soil test values for maize yields in field experiments

In our other works on soil testing for plant nutrition we have elucidated the micro-nutrient status of tree crop plantation soils of South West Nigeria, the importance of zinc and copper in cacao production and the safe and toxic application rates of boron for cacao seedlings for the benefit of cacao farmers (Chude and Obigbesan 1982, 1983, 1984). We have also identified the critical nutrients needed for the establishment of coconut plantations in Coastal Plain Sands such as found in Badagry area (Amalu and Obigbesan 1990; Obigbesan and Amalu 1994).

Role of Fertilizers in Crop Yield and Quality

The role of soil and fertilizer nutrient elements in the quality, storability and disease infestation of farm/crop produce did not attract the attention of early fertilizer researchers on food crops in Nigeria even though by the 1960s there was enough information to encourage the establishment of fertilizer recommendations on the basis of fertilizer response zones in the different ecological areas (Hartley 1937; Doyné *et al.* 1938; Obi 1959; Mann 1963; Amon and Adetunji 1969; Goldsworthy 1966). Even though farmers recognize and accept that fertilizer input would boost their crop yields, many farmers would decline to apply fertilizers to yams, claiming or arguing that chemical fertilizers would impair the quality attributes of tubers such as taste, colour and shelf life of harvested tubers. Some would even swear that yams fertilized with the popular sulphate of ammonia did not store well nor pound well and farmers in Kabba area complained that yams grown with 125 kgN/ha sulphate of ammonia blackened on cooking. These complaints could be attributed to the misuse of fertilizer

elements arising from lack of knowledge of the appropriate fertilizer nutrient ratios and type of fertilizer suitable for their soils. Similar observations of darkening of potato flesh as a result of K deficiency are well documented and the application of K fertilizers minimizes the proportion of tuber darkening. From our experiments at Eruwa in 1977 and 1978, we established that yams might not need P-fertilizer doses beyond 30 kgP/ha as they were able to utilize P efficiently at low concentrations (0.07 ppmP) in the soil solution due to mycorrhizal association (Vander Zaag, Fox, Kwakye and Obigbesan 1980). Unfortunately, food crop farmers are yet unable to take full advantage of the mycorrhiza input to reduce fertilizer costs because of the complex technology.

Results of our investigations on the role of fertilizer and soil nutrients revealed that incomplete nutrient application (nutrient imbalance) adversely affects yield and quality. For yams, optimum yields were obtained (15-38 % higher yield) with combined application of 60 kg N and 30 kgP/ha in the Savannah zone of Western Nigeria. Higher N rates led to significant yield reduction and subsequently accelerated the sprouting of yams during storage while adequate P rates suppressed sprouting thereby promoting the shelf life (Kpeglo, Obigbesan and Wilson 1981). Our recent findings (Adeniji, Obigbesan, Asiedu and Bokanga 1998) confirm that application of nitrogen alone reduced the quality, while a combination of N.P.K.-Mg improved the general acceptability of yam tubers when pounded or fried (1999).

Our data in Table 7 revealed for the first time ever, that yams are greater depleters of soil nutrients than cassava, removing about four times as much N and at least twice as much P and K as cassava that was reputed to be a voracious depleter of soil nutrients (Obigbesan and Agboola 1978).

Table 7: Nutrient Removal by Yam Crops Through Tuber Harvest

Yam species	Fresh tuber yield t/ha	Dry matter yield t/ha	Nutrient removed, kg/ha				
			N	P	K	Ca	Mg
<i>D. alata</i>	35.9	9	12 8	16.9	162	2.8	7.9
<i>D. cayenensis</i>	33.5	11.6	10 5	14.8	139	2.9	10.1
<i>D. rotunda cv efuru</i>	39.5	12.1	15 5	18.2	176	3.9	10.7
<i>D. rotunda c.v. Aro</i>	20.4	7.2	82	10.5	91	2.1	6.6

It is my significant contribution, in collaboration with an erudite professor of nematology to elucidate the spread and host preference of the serious yam pest, *Scutellonema Bradys*, under different soil fertility regimes. We found that increasing N application from 60 to 90 kg/ha escalated the nematode population

in white yam (*D. rotunda*), while P did not favour nematode buildup (Obigbesan and Adesiyun 1981). This has led to a caution to farmers that application of incomplete nutrient has deleterious effects on produce quality.

Cassava Nutrition: of Yields, Starch and Cyanide

The nutrition of root crops was hitherto a neglected field of study in Nigeria as breeding only dominated the scene of early improvement research (Ekandem 1967). There was therefore no official fertilizer recommendation for cassava production in Nigeria before we took off. My work on cassava unravelled the N and K needs of currently recommended cassava varieties, identified the fertilizer responsive (TMS 60506) and non-responsive (TMS 53101) types so that farmers would save their money on fertilizer input where necessary. I have provided far reaching and practically useful information on root quality, starch and HCN content, for industrial processors of food and textile and nutrient removal by specified cassava cultivars released to National Food Production Programme by the National Seed Service for large-scale growers. Although it can be cultivated in impoverished nutrient deficient and marginal soils where other crops will fail to produce reasonable yields, golden cassava responds very well to generous doses of N, K and P even when applied to a preceding crop of maize (*Zea mays*). By allowing the crop to grow up to 15 months, the starch yield was more than doubled and about thrice that at 9 months. The TMS 53101 produced maximum starch yield with 60 kg N while the improved 60506 type needed 90 kgN/ha. In co-operation with a renowned plant pathologist, we were able to demonstrate that adequate K application (90 kgK20/ha) significantly reduces bacterial blight, *Xanthomonas manihotis*, a serious and devastating disease of cassava (Adeniji and Obigbesan 1976) in Nigeria and the tropics.

Nitrogen, an essential nutrient that is most limiting in crop production proves to be indispensable for high yields. My research has established a salient fact that when high N level results in high HCN in cassava leaves and roots, but that thorough processing as is done traditionally reduces the cyanide in the end-product (*gari*, *lafun*, etc.) to negligibly low and tolerable levels (Obigbesan 1983). This fact was demonstrated to the world body of root crop scientists in Lima, Peru in 1983.

Issues of Cassava Cyanide

The cyanogenic character of cassava is not in doubt; the importance of cassava in agricultural and economic development and in food security is also indisputable. However, the literature is replete with reports on health implications of chronic cyanide toxicity in animals and humans that feed on high cassava rations. These are attributed to the breakdown products – cyanohydrins and hydrogen cyanide (Fig. 5).

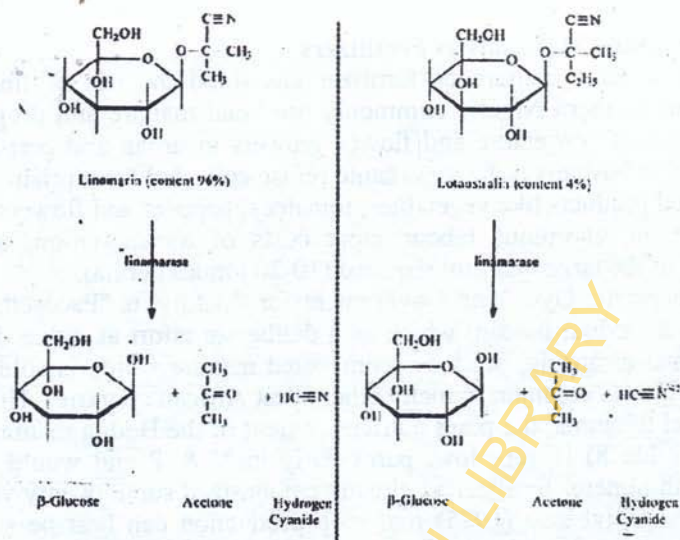


Fig. 5: Structure and Hydrolytic Bye-Products of Cyanogenic glycoside in Cassava

Our National Root Crop Research Institute, Umudike and the IITA, Ibadan with whom I closely collaborate, are concerned with cassava safety and have produced low cyanide cassava varieties TMS 30001; TMS 4(2) 1425; NR 84175; NR 84204. When, therefore, in mid-to-late 1989 Nigerian newspapers came out one after another with screaming horrible headlines such as:

"Boiled cassava is dangerous" (*Nigerian Tribune* May 29, 1989)

"Killer gari now in the market" (*The Vanguard*, July 13, 1989) "Four kids die after a meal, cassava wreaks havoc in family" (*The Daily Champion*, October 11, 1989).

It was incumbent on us to inquire:

"Who's giving gari a bad name?" (*Vanguard*, October, 1989)

In collaboration with Professor O. L. Oke of Obafemi Awolowo University with sponsorship by IITA, I had the privilege to organize a national workshop involving all stake-holders – farmers, plant breeders, agronomists, biochemists, processors, sociologists, toxicologists, medical consultants and journalists. The workshop examined the long-term and short-term effects of such reports on the cassava-based industry, the economy of Nigeria and the food security of the people. Besides the clinical presentation of reported cases of cassava meal poisoning at Lagos University Teaching Hospital LUTH and Adeoyo State Hospital, Ibadan, the fresh gari samples I collected from poisoned victims did not contain intolerable levels of cyanide. The workshop communiqué concluded that reported deaths were not due to cyanide and allayed the fears of the populace to "keep eating your gari but ensure thorough processing of cassava roots".

Use of Local Raw Materials as Fertilizers

The use of organic manure as fertilizer has stood the test of time. Farmers especially in northern Nigeria commonly use kraal manure and droppings from roaming animals. Vegetable and flower growers in urban and peri-urban areas make lucrative business utilizing organic refuse collected from urban wastes. The highly priced products like vegetables, tomatoes, peppers and flowers adequately compensate the enormous labour input costs of transportation, sorting, and application of the large quantity required (10-20 tonnes per ha).

I commend the Oyo State Government for floating its "Pacesetter Fertilizer Company" at Bodija, Ibadan, which as a deliberate effort at waste disposal and environmental cleansing, produces composted manure which is sold to farmers state-wide. This is common in many other West African countries. However, and here is a real dilemma, the plant nutrient content of the Bodija manure Grades A & B (see Table 8) is very low, particularly in N & P and would need to be fortified with mineral fertilizer as already emphasized some twenty years ago by Agboola and Obigbesan (1975) that crop production can best be sustained by integrated management of crop residue, organic manure and mineral fertilizers.

Table 8: Nutrients Composition of "Pacesetter Company" Organic Fertilizer

	N	P	K	Ca	Cost of 50kg bag to the farmer	Unit cost per kg nutrient	
	(% dry wt*)						
GRADE A	1.16	1.48	1.82	3.62			
GRADE B	0.94	0.28	1.15	1.19			
	Kg Nutrient per 50kg bag				Total, kg		
GRADE A	0.58	0.74	0.91	1.81	4.04	₦350.00	₦86.6
GRADE B	0.47	0.14	0.58	0.59	1.78	₦300.00	₦168.5
NPK -15-15-15	7.5	7.5	7.5	-	22.50	₦950.00	₦42.2

The Department of Agronomy has collaborated with the Raw Materials Research Development Council (RMRDC) and NARP to adopt local raw materials for use as fertilizers. I have been leading a team of Phosphate Research to study the agronomic efficiency and soil ameliorating potentials of Ogun Rock Phosphate and Sokoto Rock Phosphate for direct use as fertilizers by resource poor farmers. Our efforts are yielding fruitful rewards in the efficacy of ground phosphate rocks applied directly to forage grass (for livestock) maize and even polybag oil palm seedling designated for distribution to farmers of Community-based Technology Transfer Centre (CTTC) (Figs. 6,7,8,9, and 10).



Fig 6: Maize responds better to ground rock phosphates than SSP in an acid soil (Dystric Nitrosol, Benin Fasc. pH4.8/3.8)



Fig 7: Incontrovertible response of Pennisetum species (millet) to Sokoto Rock Phosphate in an Ayepe soil (Typic Kandialf/Ferric Luvisol, pH, 6.8/5/9)



Fig 8: In P-deficient Alfisols, ORP and SRP produce bountiful forage grass yields



Fig. 9: Incontrovertible response of polybag oil palm seedlings to Ogun Rock Phosphate in an Ultisol



Fig. 10: Superior performance of oil palm seedlings fed with local rock phosphates compared imported SSP in an Alfisol

Conclusion

In this lecture, attempt has been made to highlight the development of the science of plant nutrition as basis for fertilizer use development and soil testing as a desideratum for fertilizer recommendation to farmers. I have spotlighted the dilemma facing Nigerian farmers who cultivate increasingly infertile soils to produce less food for meeting the needs of this nation. My research efforts were also spotlighted.

It is my submission, that Nigerian farmers in the next millennium would have no option but to use fertilizers for sustainability and productivity. As rightly observed by Breman, the Director of IFDC-A (1999), "an improvement in soil fertility can lead to greater food security, a drop in food prices, an increase in exports, the control of degradation of resources and desertification, a slowdown in urbanization and migrations and finally, a reduction in the change of global climate."

Since the achievement of self-sufficiency and food security depend on sustained soil productivity, the salvation of this country will depend on the fertility of our soils and souls. Government is, therefore, enjoined to invest in basic infrastructure especially transportation and energy systems in the rural areas. Government should ensure that sufficient price incentives exist to make fertilizer use profitable for farmers. Farmer education on fertilizer use technology should be intensified. Since Nigeria possesses basic raw materials needed for fertilizer production, a more patriotic move should be made to develop and exploit the available ones such as Tar sand, Ogun phosphate and Sokoto

phosphate rocks, for fertilizer manufacture instead of costly importation from Togo and Morocco. Investment in Soil Testing as a holistic programme at established institutions should be embarked upon without further delay for fertilizer advisory purposes.

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10

SAFE FOR ALL: GIVE THE MAN MEAT

David O. Alonge

*Department of Veterinary Public Health
and Preventive Medicine*

Introduction

Ever since Eve tempted Adam with the forbidden fruit, food has played an important role in the life of man. Buddha affirms that hunger and love constitute the generic force of all human history and according to Massayeff (1956), civilization cannot develop until alimentary needs have been satisfied.

This is the second lecture from the department of Veterinary Public Health and Preventive Medicine since the department was established in the 1974/75 session. The first lecture was delivered by Professor G.O. Esuruoso who is the founding father of the department and the first African Dean of the Faculty of Veterinary Medicine.

As an undergraduate student of this university resident in Independence Hall in 1967, Peter, one of the porters, often taunted Geology and Veterinary students. He shouted at a Geology student: "Go siddon, your friend dey study medicine, you dey study stones". He would quickly turn to a few of us veterinary students asking if indeed we were doctors because we never went to University College Hospital, Ibadan to complete our training. Many may still wonder, even as a new millennium arrives, who a veterinary doctor is and what is the scope of his functions and services to humanity. He is:

A doctor of animals; trained to produce animal protein directly or indirectly for the human public. Moreover, according to an American senator, Will Rogers: "***The veterinarian is the best doctor in the world. He can't ask his patients what is the matter, he's just got to know***".

Those of us who specialize in veterinary public health are dedicated to ensure a complete physical, mental, and social well-being of humans through the

application of veterinary medical science, resulting in extending life expectancy and delaying the inevitability of death in man. By our training, veterinary public health veterinarians are biomedically literate, biostatistically numerate and socio-economically cost-conscious. We are the windows of veterinary medicine to the human world.

With the creation of the Federal Ministry of Environment, Nigeria has joined the rest of the world in the fight to save our environment. There is now more public concern about the implications of animal wastes and animal food processing wastes being dumped into the environment.

In the USA, 60 million pigs produce an estimated 100 million tons of faeces and urine a year into the environment (Meadows, 1995). Public Health Veterinarians are working everywhere to find a balance between producing livestock and protecting the environment.

The topic of today's inaugural lecture is of interest to all mankind. By the end of this century, 80% of the world population will be living in Africa and the other third world countries and a significant number of these will have large food deficits (FAO 1990). On a worldwide basis, cereals (maize, rice, sorghum, and millet) supply more than 50% of human requirements for energy. Animal products, meat, milk, eggs and animal fats supply 17% of the energy requirements and 32% of the protein. However in the countries of Australia, New Zealand and North America, for example, the amounts of protein available per head per day is 30-40.0 gm compared with 4.5g in Africa and 4.8g in the Far East (Bender 1992).

On October 13 1999, the world population reached the 6 billion mark. Out of these, about 2 billion people are chronically undernourished. About 500 million of these are famine-starved, with skeletal limbs and swollen bellies, with an imminent danger of death. About 2.5 billion people are dying slowly, dying because of ignorance, local taboos and religion rather than by famine. They are dying of malnutrition rather than starvation. Dying sometimes in the mid of plenty and according to the United Nations Children's Fund (UNICEF), dying at an astonishing rate of 28 children per minute because of malnutrition and attendant diseases. Many of the world's starved do not only live in the sprawling urban slums, of Ajegunle and Foko and in other rural areas but also on the University of Ibadan campus, Bodija estate, Ikoyi, Asokoro-Abuja and other GRAs of Nigeria. Many lecturers and professors do not earn enough to eat well.

Nutrient deficiencies produce a wide variety of illnesses; in fact, nutritional deficiency contributes to much of the ill health in Nigeria. The most important forms of malnutrition in Nigeria are protein-calorie malnutrition (PCM). The two clinical forms of PCM are nutritional MARASMUS and KWASHIORKOR. According to Latham (1996) Marasmus is due primarily to an energy (calorie) deficiency; in kwashiorkor, protein deficiency predominates and leads to a slow rate of growth, to poor development, to increased susceptibility to infections, and eventually to permanent physical stunting.

Forty percent of all the malnourished are children and chronic malnutrition is particularly devastating to the young. Most of the rest of the malnourished are women. Millions of emaciated mothers are giving birth to emaciated babies,

many of whom soon die. According to WHO (1984) 19.7% of babies born in Africa are below 2.5kg. This is a reflection of the devastating consequence of malnutrition during and after pregnancy. Such babies are three times more likely to die in infancy than those who were born weighing more than 2.5kg. Even when they survive, their chances of healthy growth and development are greatly reduced. Life expectancy which averages 70 years in the developed countries averages 50-52 years in Nigeria and lower in other developing countries.

There is a problem. The present world population of conventional meat animals i.e. the cow, sheep, goat, pigs and poultry cannot feed the human population today. Even by using today's advanced methods of breeding and feeding and production of livestock, enough meat will not be available for many people who would like to eat it (World conference on animal production, 1983). There is the need therefore to look at other sources of meat and fish.

What is Meat?

In his book on Food Hygiene, Alonge (1992) defined meat as "freshly dressed or treated tissues, mainly skeletal muscle from warm blooded animals suitable for use as food". All other types of meat must be so qualified, for example, meat from snake is snake meat, or from dog is dog meat and from elephant is elephant meat.

Types of Meat

Edible meat is in four categories and these are:

- Red meat i.e. beef, pork, goat meat, mutton and lamb;
- Poultry - broilers or fryers, turkey and duck meats;
- Seafood - fish, prawns, crayfish, lobsters, crabs and other shellfish;
- Venison or bush meat — deer, antelope;
- Nigerian meat products — *Kundi*, *Kilichi*, or *Balangu*, *Tinko*, *Randa*, *Banda* or *Tsire*, meatballs or *asun*;
- Meat analogs — Today, with the advent of high technology, meat imitations or meat analogs are manufactured to simulate the flavour and texture of meat, fish or shellfish. The use of meat imitations will increase in future, as population grows and conventional sources of protein become more scarce.

Sources of Animal Protein

Meat comes from a few dozen out of the 3000 mammalian species. The human diet is diverse. Some tribes, like the traditional *Inuit* of the Arctic region, the *Masai* of East Africa and the *Fulani* of Nigeria derive most of their foods from animal sources. The seal and polar bear are important in the diet of the *Eskimos*; the Kangaroo is eaten by the Aborigines of Australia and the whale in Norway and Japan. Mankind eat a wide range of foods of both animal and vegetable origin. Many are even pure vegetarians.

Conventional sources of meat include the cattle, lambs, sheep, goats, swine, camels, horses, rabbits, hares, game animals like antelopes, deer, buffalo, also

poultry, ducks, geese and turkeys. Unconventional sources of meat include guinea pigs, frogs, pigeons, pheasants, crabs, turtle and termites. Others are the giant rat (*Cricetomys gambianus*), squirrels, porcupine, snails, bats, rats, mice, snakes, rainbow lizards, alligators, beetles, palm grubs, locusts, grasshoppers and birds. Dried caterpillars called *monimoni* in Ibadan is particularly good in vegetable soup.

The importance of game meat has erroneously been focused mainly on large game such as antelope, deer, buffalo, etc. In fact, in terms of their contribution to daily diet, the more important are the smaller wildlife species. Across West Africa, bush meat consumption is high especially in the tsetse fly infested forest zones where bush meat provides up to 84% of the total meat consumed. In 1979, Professor Ajayi of the Department of Wildlife, University of Ibadan, confirmed that the large rodent called grasscutter or cane rat (*Thryonomys swinderianus*) is a delicacy.

Meat consumption is based on availability, price, religion, and cultural beliefs. Those rejected for various reasons in one culture are fully accepted in others. In Nigeria, the amount and type of meat eaten vary with income. Meat is held in high esteem in most communities. It has prestige and value and it is often regarded as the central food around which meals are planned in rich families and 5-star hotels. Various types of meat are often made the basis of festivals and celebrations. Without ram meat, *Ileya* festival is not complete. From the popular as well as the scientific point of view, meat is a food of high nutritional value.

In 1988, when the issue of alternative sources of meat for hungry Nigerians was first raised, the Nigerian press went to town with sensational headlines and cartoons. Headlines like "Eat rats and lizards for protein: the new balancing diet for the masses", "Oba alleged to have been driven from his palace by rats: he has missed millions of Naira from a lucrative trade", and "Hungry? Have a lizard" were flashed across newspapers in Nigeria.

These may sound funny but the fact is that the food situation in 1999 is worse than what it was in 1988 when I made public the idea of alternative sources of protein. It was not a funny case for that woman in 1988 who had four children two of whom showed clear manifestations of Kwashiorkor. The poor woman had only ₦20.00. Should the woman use her ₦20.00 to buy liver and kidney for the children or convince her husband to go to their village and catch rats or find any of the alternative sources of protein to save the children? Which option is more practicable? You need not take any of my suggested alternative sources of protein, if it is not conducive to your general well-being for any reason whatsoever especially, if you have enough money to buy cow hide (*ponmo*).

Flesh that is Toxic or Unsuitable for Man

I will be misleading this audience to give the impression that all meats are suitable for man as food. Ichthyosarcotoxic fishes are marine organisms whose flesh, skin or viscera contain naturally occurring poisons which when eaten will produce biotoxification in man. Biotoxins are present in the fillet and liver of some sharks and rays, the gonads and liver of puffer fish contain

tetradotoxin. Murray eels and raffish contain neurotoxins. Outbreaks of paralytic shellfish poisoning are common in fish-eating communities. Shellfish accumulates saxitoxin, a highly potent poison that is not destroyed by cooking. Community elders and kings in the past would rather commit *hara-kiri* by going into their inner chambers and eating a piece of tiger's liver than face the shame of accusation of any wrongdoing by their people.

Nutritional Value of Meat Products

Give the man meat, the man you see, is the meat he eats!

Protein is a critically important part of diet. Dietary protein is broken down into amino acids during digestion. Cells build up new proteins from these amino acids to serve specific functions. Proteins play a role in virtually every cellular function. For instance, proteins regulate muscle contraction, antibody production, blood vessel expansion and contraction to maintain normal blood pressure. No wonder, the 1999 Nobel Prize for Medicine was won by Dr Guenter Blobel, a German scientist who discovered how proteins find their rightful places in cells.

The most significant contribution which foods of animal origin make to human nutrition is in the high quality proteins they supply (table 1). In addition to providing the essential amino acids, which are the units from which tissues are synthesized, proteins also serve in the form of nucleoproteins and enzymes. Proteins are molecules essential to maintaining the structure and function of all living organisms.

Table 1: Comparative Sources of Protein

Conventional Sources of Meat	% Protein	Unconventional Sources of Meat	% Protein
Beef	18	Rabbits	20.4
Goat meat	19	Guinea Pigs	22
Pork	16	Hares	22
Lamb	17	Giant Rats	20
Mutton	18	Grasscutter	21
Fresh Fish	19	Snakes	20
Dried Fish	47	Pigeon & Ducks	18
Eggs	12	Crabs	17
Ostrich meat	22	Turtle	16
Guinea fowl	18	Pheasants (aparo)	18
		Winged Termites and beetles	20
		Dried Caterpillars (Monimoni)	53

There are 23 amino acids 10 of which are classified as essential and 13 semi-essential or non-essential. Proteins come from both animal and plant origin. Animal proteins contain more of the essential amino acids and a higher nutritive value than do the vegetable proteins. A table of comparative biological values of some animal and vegetable sources of protein shows that beef and chicken have higher protein efficiency ratio and net protein utilization values than beans and soybeans (table 2).

Table 2: Biological Values of Vegetable and Animal Proteins

Protein Efficiency Ratio (PER)		Biological Value (BV)	Net protein Utilization (NPU)
Soybean	2.0	76	62
Dry Beans	1.4	59	44
Beef	2.3	72	70
Chicken	2.4	75	73

Source: Rao, M.N., FAO World Animal Review, 1973.

Factors which in addition to essential amino acid composition in determining the quality of proteins, are availability of amino acids and the digestibility of the proteins. Animal proteins are more digestible and there is a higher degree of availability of amino acids in animal proteins. Animal proteins possess a significant supplementary value to vegetable proteins most of which are deficient in the essential amino acids, Lysine and Methionine.

Increased production and consumption of animal products are the only rapid and efficient solution to the problem of protein malnutrition in the developing countries.

Fats are found in meat as deposits under the skin, as in pigs and poultry, and stored around the organs like the kidneys and intestine. Small amounts of fat are visible between the bundles of muscle fibers, which give the typical marbling seen in meat from cattle hump. There is a need to maintain sufficient fat in meat to ensure good eating quality and a minimum fatness level is often required. Because of the inter-muscular fat in cattle hump, the meat (*Ike malu*) is tender, succulent and very palatable and of course more costly.

The amount of carcass meat obtained from animals varies with the type of animal. The meat part of a cow is 34%, 16% bones, 16% organs, abdominal and the intestinal contents 16% and the hide or skin is 6%. The organ meats are liver, heart, brain, pancreas, tripe, feet, tail, testes, intestines, cheek meat, head meat and fat — these are collectively called the offal.

The nutrient contents of the offal are richer than lean meat in iron and copper and Vitamin B complex. The liver is particularly rich in Vitamin A, B₁, B₂, B₁₂, niacin and Vitamin C, while the kidney is a rich source of Vitamin B₁, B₂ and B₁₂. The lungs and the spleen have high contents of Vitamin C. Ears and feet (*Bokoto*) have a high protein content but much of this is collagen and of poor nutritional value.

Medical scientists incriminated meat as one of the sources of low-density lipoproteins cholesterol (LDLc) which leads to coronary heart disease (CHD) in man. The dietary goal should be reduction of cholesterol intake by selective intake of certain meats with low level cholesterol and by decreasing intake of other types of meat. However, the benefit of eating good meat to man out-weighs any suggestion of eliminating meat from man's diet. The health hazards are often due to man's ignorance, gluttony and overeating (A man weighing 68 kg should not consume any more than 109g of meat per day). While the cholesterol debate

continues, the U.S. Food and Nutrition Board has concluded that evidence does not warrant specific recommendations about dietary cholesterol for the healthy person, who does not need to be concerned about fat intake (Salunke 1996).

The ostrich is really the king of all birds. The family pattern of the ostrich confirms this. The family pattern of the ostrich is polygyny in which a cock lives with a "head hen" and two auxiliary hens. The head hen tolerates the other two hens and all lay their eggs into a common nest before dismissing the two junior hens. The cock then sits on the eggs for 42 days. It is the largest living bird, the tallest at 10 feet (3 meters) and weighs about 330 kg. At the peak of the Roman Empire, ostrich flesh was the most prized meat of the emperors. Today, in Europe, USA and South Africa, ostrich meat is the best and the most costly meat in the world. It is reputed to be cholesterol free.

The best meat in the carcass of a cow is the sirloin steak. It is tender, lean and palatable when properly prepared.

In the animal body, if you want meat that is fat free, go for the heart muscle, once the fat on top of the heart is trimmed off, the heart muscle itself has no fat. The heart muscle had to be fat free, tough with a high quantity of myoglobin (the muscle O₂ carrier) since the heart is expected to work continuously for about 70 - 120 years in man.

Let every common man eat snail meat. If he has no money to buy, he can at least pick some snails in the bush near his hut. Snail meat tastes nice and does the body a lot of good. Snail meat contains a protein content of 88.37 gm/100 g. It is low in fat content at 1.64%, and low in cholesterol with only 20.28mg/100gm. Snail meat contains high calcium levels (185.7 mg /100g), phosphorus (61.24 mg/100g) and iron (Fe). It is a low energy food at 64 calories per 100g, which is good for diabetics (Olatokun 1999).

Those who eat cow leg (*bokoto*) and cow hide (*ponmo*) should have consolation in the fact that they do not need to be afraid of over-weight or cholesterol because they are already on a weight reducing diet. Cow leg [*Bokoto*] and *ponmo* have only 0.7% fat, 99 calories and about 18% low grade protein.

Eat sun-dried or lightly smoke-dried fish, you will have 68.6% protein and only 3.5% fat. Most fresh fish (except the fatty *Clarias - Eja Abori*) has only 50-60mg/100g cholesterol. Fish fillet contains a lot of polyunsaturated fatty acids; and according to Professor Agbedana in his 1997 inaugural lecture some fish are rich in polyunsaturated fatty acids and eicosapentanoic acid (EPA) which is therapeutically applied for lowering blood cholesterol.

Fresh marine shrimps and prawns are good with 18.7% protein and only 1.77% fat. However, avoid shrimps caught in Lagos Lagoon because they are heavily contaminated with Hepatitis A virus. Fresh Hake (*Panla*) is another good fish with 29.5% protein and 2.6% fat.

Of the insects, smoke dried palm grubs (*itun*), (*Rhychophorus spp.*) give high energy, 24.3% protein but very high fat of 55%. The protein content is surpassed by dried caterpillars (*monimoni*) with 53% protein and high energy content of 392 kilocalories.

Data available point to the fact that the total meat available to Nigerians is very low at an average of 11.2kg per person per annum. If every Nigerian has a

fair share of this, never will there be any fear of cholesterol and coronary heart disease.

However, since Nigeria is a looter country, the smart ones loot either the meat or the money to buy the meat. The result is that the "big man" eats 10 times the normal share of meat due to him, he grows rosy cheeks, thick neck, and comes down with chronic heart disease (CHD) to the bargain.

The good news is that the average Nigerian who lives at a modest survival level have no fear of coronary heart disease since in any case he eats, on the average, less than 5gm of meat per day. At the local bukataria, he orders gari, vegetable stew and when asked for the number of pieces of meat, he usually shakes his head - none or at best asks for cow hide (*ponmo*) or a tiny cut of *oku eko* (frozen fish).

What is definitely not healthy as one gets older is sheep brain with 2,200mg/100g cholesterol, so also are sheep and pig kidneys and liver which have relatively high cholesterol at 400-410mg/100g. If you must eat deep oil-fried broiler chicken, take the pains to remove the skin.

For the rich ones, eat veal (fillet of calves) — it has 21.1% protein and only 27% fat. Rabbit should be the meat of the people, it is easy and cheap to rear at home on weeds and table left-over with a guaranteed 22% protein and only 4% fat.

Perhaps the best meat around the house is that grandmother's chicken. It is not big but full of flavour with little or no cholesterol.

Safe and Wholesome Meat

One of the main services of the veterinary public health veterinarian is to ensure that meat and meat products for the public are free from defects. Veterinary examination of the carcass and organs to assess whether they are fit for human consumption is carried out immediately after slaughter and dressing.

Meat inspection is not intended to turn bad meat into a good meat product. The cattle, sheep and goats at the farm level are the raw materials for the production of meat. If the raw material is bad, the product cannot be good. On the farm, animals should be properly fed and housed. All sick animals should be treated; only healthy animals should be sent for slaughter. Meats from sick and undernourished animals are watery, gelatinous and of poor quality. Such meats do not keep well; they shrink and give bad flavour after cooking.

We ensure that inspected and passed meat derived from healthy, properly slaughtered animals reach the consumer in clean, unspoiled and wholesome state. Therefore unhygienic transport, exposing the meat to heat, dust and bacterial contamination nullifies all previous hygienic measures taken from the farm gate to the abattoir. Never should meat meant for human consumption be carried in the boot of a taxicab, for example.

Apart from prevention and control of diseases of animals transmissible to man, public health veterinarians play parts in protecting public health during wars, disease emergencies, volcanoes and atomic reactor blowouts. In nuclear accidents, grasses are contaminated by radioactive fallout, the cattle comes along to eat the grass, and the dangerous radioactive elements on the grass are passed

into the milk. Veterinarians determine if such milk is fit for human consumption. In war situations, refugees always move with their pets and animals, vets play major roles in such situations.

Meat Preservation

While I advocate tapping other sources of meat, what is available must be preserved in good condition for future use or must be preserved in the production areas for sale in distant market locations.

The ingenuity and experience of man have led to a situation today that provides the means of securing his food supply in a great variety of ways. Highly significant in this supply system is the ability to prevent deterioration of food so that it is available at times after production and in places distant from its source.

Post harvest food losses are very high especially in the developing countries where experts have reported production losses of 40 to 50% in grains, yams, fruits, dried fish and meats.

As the human population worldwide has drastically increased passing the 6 billion mark 2 weeks ago, foodstuffs especially meat, have become more scarce and precious. Therefore, it will become more necessary than today to prevent spoilage of available meat. In this regard, I have spent most of my research career working to develop meat preservation technologies that are applicable to the Nigerian situation. Three of such methods include:

- Smoke-Drying of meat
- Clay meat ball
- Irradiation of dried meat in a controlled environment

Smoke - Drying of Meat

Meat was processed as early as prehistoric times, probably by drying in the sun and later by smoking and drying over wood fires. Homer, in 850 BC recorded procedures for smoking and salting of meat. Smoke-dried meats in Nigeria are known as *Kundi* (Yoruba) or *Banda* (Hausa) and *Biltong* in South Africa. The early man who was a hunter hung his kill over his fire to keep flies off it. He soon noticed that smoked meat remained edible a little longer and had a more agreeable taste and flavour. Today, virtually all types of meat and meat products, are smoked. Among the traditional meat processors, smoking is particularly popular because the cost and the technology to maintain energy consuming preservation methods of refrigeration and freezing are beyond their reach.

The firewood, the basic material for smoke production is made of 50% Cellulose, 25% hemicellulose and 25% Lignin. Smoke is the result of destructive anaerobic distillation of wood followed by partial oxidation.

Hamm (1977) and co-workers analysed wood smoke and found that smoke is a fine mixture of gases, liquid and solid particles originating from thermal decomposition of wood at temperatures ranging from 200°C to 500°C.

The gases are methane, nitrogen oxide, carbon monoxide and hydrogen. The liquid or colloidal phase contains some 219 compounds including 45 phenols, 70 carbonyls i.e. ketones and aldehydes, 20 acids, 11 furans, 13 alcohols and esters,

13 lactones and 27 polycyclic aromatic hydrocarbons (Forster and Simpson 1961). The solid or particle phase consists of charcoal, fly ash and condensed long-chain tars.

Smoking Procedure

Most of the work I am about to describe was carried out at the Federal Meat Research Institute, Kulmbach, Germany where we analysed the Nigerian Kundi

Small pieces of meat weighing about half-a-kilo were set over a wire net placed on a locally fabricated half-drum oven (*adogan*). Pieces of hardwood were set on fire below the meat. The fire was allowed to glow red. The temperatures were taken at two points using a high temperature Nickel-Chromium thermocouple thermometer. The temperatures of the smoking fire (the glow temperature) range between 634 and 1160°C. The smoking temperature i.e. the temperature around the meat during smoking averaged 192°C.

According to Alonge (1987), smoke drying to a level that the meats can be stored ordinarily for over 6 months took 6-8 hours. Smoke-dried meats were then stored without refrigeration in paper boxes. The meat pieces were examined and analysed monthly over 6 months to determine the factors that help extend the storage life.

What keeps the meat good over the storage period are smoke deposits, the high smoking temperatures with the resultant microbial killing effects and dryness leading to a reduced water activity (A_w) value of 0.70 and a slight acidic environment of pH 6.85 (Alonge 1987).

Taste and Flavour of Meat

Many people love the taste and colour of *suya* and kebab. The light golden yellow colour of properly smoked meat is due to carbonyl-amino acid reactions. The more carbonyls we have in the smoke, the higher the intensity of the colour. The "smoky" taste of *suya* is attributed to the phenolic fraction of smoke. The phenols are formed by pyrolysis of lignin, the two main components of phenol being guaiacol and syringol. The palatability or sweetness of freshly smoked *kundi* and *suya* was measured by Dipeolu and Alonge (1995) (table 3). Guaiacol is responsible for the sweet, sharp, and dry taste of smoked meats. The amounts of total phenols in relation to guaiacol were determined to be between 8.7 and 77.5mg/Kg.

Table 3: Taste of Meat and Components of Phenol

COMPONENT OF PHENOL	TASTE OF SMOKED MEAT
Guaiacol	Sweet, sharp, dry taste
Syringol	Peculiar fresh, smoky flavour
4-Methylguaiacol	Burning but pleasant and sweet
i-Eugenol	Sweet, fruity, mild taste
o-cresol	Unpleasantly smoky sharp but sweet
Dimethylphenol	Charred sharp sweet and dry

Polycyclic Aromatic Hydrocarbons (PAH)

As a public health scientist, I was more interested in the carcinogenic polycyclic aromatic hydrocarbons in smoke, which are transferred into the meat during smoking. The types and the average amounts of polycyclic aromatic hydrocarbons in *Kundi* were determined (table 4). The thin-layer chromatographic method was used for the separation while the quantities were determined by Spectrophotofluorometry. Twelve polycyclic aromatic hydrocarbons (PAH) were determined in *Kundi* including two highly carcinogenic chemicals — Benzo(a)pyrene and Benzo(c) phenanthrene.

Table 4: Polycyclic Aromatic Hydrocarbons in Nigerian Smoke-dried Meats

	PAH	Amount (µg/kg)	Carcinogenicity Rating
1	Benzo(a)pyrene	0.85-66.91	+++
2	Benzo(c)phenanthrene	0.80-11.60	+++
3	Benzo(c)fluoranthene	3.40-21.70	++
4	Benzo(j)fluoranthene	5.30-8.20	++
5	Ben(a)anthracene	1.10-14.70	+
6	Chrysene	2.20-30.80	+
7	Ideno(cd)pyrene	1.40-5.50	+
8	Benzo(e)pyrene	1.90-10.00	+
9	Cyclopenta(cd)pyrene	0.40-5.50	-
10	Benzo(k)fluoranthene	1.90-10.30*	-
11	Benzo(ghi)perylene	1.90-5.20	-
12	Triphenylene	0.50-1.10	-

- +++ = Highly Carcinogenic
 ++ = Moderately Carcinogenic
 + = Low Carcinogenicity
 - = No Evidence yet

It is pleasing to note that *Kundi* meat that is smoked to a light brown colour at temperatures below 400°C is free of any polycyclic aromatic hydrocarbon. However darkly smoked meats at over 600°C glow temperature have large deposits of polycyclic aromatic hydrocarbons (Alonge 1988).

During storage in the market stalls, *Kundi* usually absorbs moisture from the environment thereby allowing spoilage and contaminating zephophilic toxigenic fungi to grow on them. The fungi that were isolated on stored meats include *Aspergillus flavus*, *Aspergillus niger*, *Eurotium amstelodami*, *Penicillium* and *Fusarium* species. All these species usually produce toxins, and other groups of cancer causing chemicals. *Kundi* meats growing fungi were screened for the presence of aflatoxins, all samples were negative (Alonge 1986).

Please permit me to digress a bit on an issue which the Federal government of Nigeria needs to take an immediate positive action if this country is ever to start and maintain any technological development.

I have two postgraduate Ph.D students who have been sweating to find solutions to some environmental contaminants causing cancer and diseases in Nigeria. They are finding things very difficult, the government of Nigeria

believes that we should steal other nation's technologies rather than develop technologies applicable to our own environment and climate.

Those of us who have spent years in various western laboratories have stolen nothing. We have legally acquired these technologies, sometimes beating the white boys in their own game. We came back home hoping to set up our own laboratories and eager to use the knowledge acquired to train young Nigerians to solve our peculiar problems. We need such laboratory equipment including a high powered liquid chromatograph (HPLC), a mass spectrometer, reagents and constant electricity.

Sadly, we are still waiting for the miracle of a visitation panel report to recommend to government to buy basic research equipment for our laboratories. Like Fela's song, "laboratory equipment *nko? E no de*". *Abi e dey?* What an illusion?

The Clay Meat Ball

I grew up as one of eight children of a peasant farmer and petty trader mother. After working in our father's farm in the mornings, the afternoons were usually free for us to conquer our environment until dark. We picked fruits and snails; we set traps to capture rats; and fished in a nearby river; we also poached termite hills to capture the termite queen. The termite queen is usually completely enclosed in a round clay case with some perforations for aeration and feeding. We usually cooked the termite queen in its clay ball in hot ashes below the fire made to cook the family dinner. That was in the early 1950s.

In 1975, I went to New Zealand, a country where you have more animals than human beings. I was taught the principle of meat canning. Between 1991 and 1993, I remembered the delicious queen termite we baked in her own clay shell. What I learnt from the termites is that meat can be preserved in clay balls combining the principles of canning with the ingenuity of the worker termites that protect their queen in a clay ball.

As carried out by Alonge (1993) meat pieces were wrapped in fresh banana leaves and pottery clay was molded round each piece and cooked in hot ashes. In my folly, I attempted to be modern and started by wrapping the meat in aluminum foil. The attempt failed and I had to revert to ordinary banana leaves. This method has now been perfected to cook and dry meats inside clay balls for long term storage over many years.

It is gratifying to report that this project was one of the projects selected in Switzerland in 1993 by the Rolex "Spirit of Enterprise" awards committee as a "science and technology project that seeks to achieve innovative steps forward in research, experimentation and application".

Use of Ionizing Radiation to Preserve Meat

In 1986, in a continued quest for technologies that can preserve more food for Nigeria's ever increasing population, a fellowship of the International Atomic Energy Agency, took me to RIKILT in Wageningen, Holland. There I learnt the intricacies of using gamma rays to preserve all types of food, including meat.

Food irradiation is a deliberate treatment of food product by exposing it to

machine-generated x-rays at a maximum of 5 Mev or 0.8 picojoule, or electrons at or below 10 Mev or 1.6 picojoule or to gamma-radiation from a radioactive cobalt-60 or cesium-137 with an average 1.25 and 0.66 million electronvolts (Mev) respectively (WHO/FAO 1988).

In these studies, traditionally smoke-dried beef in Nigeria were air freighted to Holland within four days of production. On arrival, they were vacuum-packed in a special plastic foil. The packaging material is an FP 1550 laminate made of 15 μ m polyester coated with 50 μ m polyvinylidene chloride and 50 μ m polypropylene terephthalate. The packs were treated in a ⁶⁰Cobalt gamma-irradiated chamber to a dose of 3kGy. Packs of meats were stored ordinarily for months at room temperatures.

At this stage of the development of the technology, I wrote an epilogue:

If you can't see it,
If you can't taste it,
If you can't detect it,
You may eat it.
Alonge (1990)

However, it is the right of the consumer to know and choose to eat any food item that has been irradiated. Because of this, the WHO/FAO (1988) ruled that any food item irradiated must be labelled with the radura logo. In 1990, I therefore set out to develop a microbiological method to identify meats that have been irradiated.

Investigations were carried out to identify irradiated chicken using the synergistic killing effects of sodium chloride, heat and irradiation. In a model study, frozen chicken was treated with 8% NaCl solution plus heating at 55°C for 15 minutes and irradiated to a dose of 4kGy. The cfu reduction by 4 log cycle of the natural *Lactobacilli plantarum* load in the chicken was significant enough to differentiate between irradiated and un-irradiated frozen chicken (Alonge 1990).

Though this technology is one of the peaceful uses of atomic energy, consumers are concerned about safety. The safety of the technology and the foods treated have been fully investigated by the joint FAO/IAEA/WHO Expert Committee on the wholesomeness of irradiated foods. The committee concluded that "the irradiation of any food commodity up to an overall average dose of 10kGy presents no toxicological hazard; hence toxicological testing of food so treated is no longer required". (IAEA 1981).

I am happy to announce that using this high technology, I have succeeded in preserving Nigerian *Kundi* for 10 years without refrigeration and without spoilage.

Conclusion

In my research career, I have maintained an ability to see the horizon as well as the immediate foreground. I have pursued the new and more difficult technologies, while some of the age-long traditional methods of meat presentation and preservation have been polished.

Hunger and malnutrition are still with us. There is a hunger epidemic in Nigeria today; people are picking dustbins to survive. The President of Nigeria confirmed this on October 6 1999 when he said that 65% of Nigerians live below poverty line. The children of Nigeria today and the future development of the country are at risk. Many Nigerian children who have untreated kwashiorkor today will surely die from lack of food, even before they attain the age of coronary heart disease. This is, according to Agbedana (1997). Without food there is no life, no hope, no society and no future. Those who survive kwashiorkor today will suffer from mental retardation and will never be the brilliant scholars that will develop the new technological tools to solve the problems of Nigeria in the new millennium.

People who are generally malnourished cannot achieve feats, be it physical fitness, intellectualism, scientific, technological and spiritual development. This is probably why most Nigerian athletes who won medals at the Olympics and most of the footballers who score goals in the world cup matches are those based in Europe and the USA where they are well fed.

Recommendations

The declared policy of the present government is poverty alleviation. The following should be the major components of the programme towards the achievement of a sustainable national nutrition security.

1. Food security, resulting in adequacy and stability of food supplies, and economic and physical access to food.
2. Drinking water security, resulting in a reduction in intestinal infections and in the incidence of such diseases as diarrhoea and hepatitis.
3. Minimum income security, giving all Nigerians the requisite purchasing power for balanced nutrition by making sure that all Nigerians are gainfully employed.
4. Nutrition intervention, leading to the protection of old and infirm persons, pre-school age children, pregnant and nursing mothers from undernutrition and malnutrition.
5. Nutrition education, culminating in a widespread understanding that every family should solve the problems of malnutrition affecting them through eating what good food and meat that is available.
6. Population stabilization, leading to a proper balance between population growth and resource availability.
7. Sustainable livelihood security for the poor. The government and the rich in the society must promote development plans that would benefit the poorest sections of the Nigerian community.

Faced with these realities, the following practical steps must be taken, and very fast too. To survive as a nation, let us look inwards. Nigeria is endowed with abundant human and animal resources. The following constitute some interim and long-term solutions to some of our food problems.

Oil for Food Exchange

Nigerians are hungry. Worldwide, it is an acceptable practice that famine-stricken populations must be provided with emergency food assistance to alleviate their immediate suffering. The government may immediately go into negotiations with Australia, New Zealand and Argentina who are presently overproducing meat and milk under an "Oil for Meat" or "Cocoa for Milk" exchange programme. The valid and durable solution is investment in sustained agricultural development for local food production. We have had enough of politics, all we are saying: give us food now!

Keep Personal and Family Small Meat Animals

Livestock for use in developing countries like Nigeria should, like computers, be getting smaller and becoming more "personal". Mainframes such as cattle cannot solve the widespread shortage of meat because they require too much space and expense for the landless and the poor. Miniframes, such as sheep and goats, should now play increasing roles in providing protein for the people. Tiny, "user-friendly" species like rabbits, guinea pigs, grasscutters, guinea fowls, pigeons and snails should now be reared at the family house level.

In 1974, a survey by Sellers *et al.*, of 769 houses in towns and 506 households in villages in the old Western state, showed that 58.4% of households kept goats, 88% had chickens, 9.4% had sheep and 4.32% had pigs. In a similar survey by Bakare (1992) at Ibadan and environs, the number of households keeping goats had dropped to 35%, chicken 19%, sheep 14%, and rabbit 8%. Today, less than 10% of households keep any form of livestock. Apart from being financial securities on feet, household livestock are ready food and financial securities in the time of want. People usually fall back to these animals at the time of festivals to entertain visitors and even sell them to pay their children's school fees. City dwellers should not be left out. Those who have fenced yards may raise sheep and goats and a few chickens, those in sky scrappers may easily raise guinea pigs in their kitchens.

Promotion of Massive Poultry Production

Massive poultry production is the fastest and easiest way of bridging the gap of our serious nutritional protein deficiency. Poultry are sources of protein with the shortest gestation period. Broiler meat can now reach your dinning table in as little as six weeks while a modern hybrid layer is capable of producing 300 eggs in 52 weeks. According to Agbato (1999), a major poultry farmer in Nigeria, to achieve rapid and cheap poultry production, the Federal government should fund a programme of indigenization and acclimatization of pure line poultry breeds. The result will be superior performance of layers and broilers in our hot and humid environment. Government should also remove custom duties and other taxes from imported inputs as a form of subsidy to produce cheap poultry products.

Flood the Market with Maize

There should be a special programme to produce more maize. In maize lies the ultimate solution to our hunger and malnutrition. More maize means more food

for man (maize can be converted into more than 80 dishes) and more feed for the livestock. Overnight the dead poultry industry will rise and new love for pig rearing will grow and feed supplements to the Fulani cattle herdsmen will supply us more beef. As an interim measure, the ban on maize, especially yellow maize should be lifted immediately to make maize available for man and animals. The good news is that genetically engineered variety of high protein maize called "QPM"-Quality-Protein Maize may be grown in Nigeria.

Eat What is Available

To outsiders, the idea of eating small animals seems repulsive but we should realize that shortage of meat is one of the most serious food problems of developing countries. Small animals that are prolific, tractable, and easy to feed, house and handle could easily be the solution to the problem. Meanwhile, let us take our eyes away from the dwindling and highly costly beef, mutton, pork and fish and look at some cheaper but unconventional sources of meat. At present, in some African countries, unconventional and game meats account for 70% of meats eaten in Ghana, 60% in Botswana while in Nigeria it is only 20% of the total animal intake.

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OUR GASPING CITIES

Layi Egunjobi

Centre for Urban and Regional Planning

Introduction

My professional preoccupation is planning. Interestingly, planning is what everyone does consciously or unconsciously, explicitly or implicitly. The writing of a letter (a simple activity) to a friend would have been preceded by such thoughts as why, how, and when, before going into the real act of letter writing. A trip from Ibadan to Abuja certainly entails such organizational details regarding timing, resource requirements and choice of accommodation on arrival at Abuja. Or consider yet another human activity like establishing a new university; the prospective proprietor would go into such considerations on the need for an institution, enrolment possibilities, curriculum development, manpower requirements, finance, location, physical development, equipment, etc. All these require thinking ahead. These futuristic tendencies entail giving rational considerations to the determination of goals to be achieved, the resources to be expended, what strategies to adopt, what time frame as well as monitoring and evaluating the proposed actions. This, in essence, is planning.

There are various forms of planning. In broad terms, these may be economic, physical, corporate, or strategic planning. I belong to the realm of physical planning which is basically concerned with ordering of structures and activities in space in a rational and environmentally sustainable manner to achieve health, convenience, economy, safety, and beauty. Physical planning takes place at various spatial levels. At the most micro scale may be found a housing environment or a petrol filling station. At a higher scale may be found a neighbourhood, or an industrial estate. Yet, at a higher scale is planning at the settlement level ranging over a village, town, city, metropolis, conurbation and megalopolis. Of course, physical planning takes place at regional level and even at the national level.

As earlier noted, the goal of planning centres on the quality of human life. Where, therefore, a person cannot lay claim to such human desires as well-being, peace, security, happiness and satisfaction, it is either an evidence of lack of planning with its twin brother – management or a manifestation of inefficient planning where it exists.

Let me make this unsavoury remark to start with. Although physical planning is an incredibly challenging professional and intellectual pursuit, a planner in this part of the world requires a lot of courage to be able to raise up his head as belonging to the planning profession. Or how often do you entertain such queries from visitors entering a typical city as Ibadan when they ask: 'Are there no planners in this country?' A query such as this is borne out of unpleasant experiences people are faced with including noise, epileptic urban services, uncollected wastes, inaccessibility, air pollution and insecurity. The issue of urban planning has always set me wondering why some animals and insects appear to be better planners than human beings.

I have casually observed termites in one of their cities between Jebba and Mokwa in the middle-belt of Nigeria. Termites, as we know, belong to the large order, *Isoptera*, of social insects that live in highly integrated colonies. The colonies are multi-storey structures built under, on and over, the land. They are of various heights and sizes. A distribution of the colonies in space appears to have exhibited a pattern whereby those of almost equal heights are found at averagely equal distances apart. It is amazing to watch the heights and sizes of these colonies in proportion to the size of those insects. What you might call 'termite scale' in this instance is many folds higher than the 'human scale' that we consider marvellously high when human size is related to a forty-storey building in the heart of New York. More amazing is the obvious fact that the multi-storey colonies have no manufactured reinforcement materials; yet, they stand the annual rains and fires. I have watched the king and the queen, the reproductives, the soldiers, the alates and the workers – all demonstrating a sense of collective responsibility. The question keeps on ringing why man has not been so successful living in agglomerations of human heads that are called cities.

Perhaps a comparatively relevant question is why some cities function as well-oiled machines, while others just struggle to provide basic services? The title of my lecture is, 'Our Gasping Cities'. My exhortation is specifically on Nigerian cities. As organic entities, cities have the attributes of existence which may be lived with or without hindrances, with dignity or indignity, with happiness or sorrow.

My submission is that our cities are not only ailing, quite a number of them are on the verge of breathing the last breath. At the same time, I sincerely believe that given the right physician, our cities will be brought back to consciousness and could eventually survive the new millennium.

In developing this thesis, the second part of the lecture tries to set the contextual boundaries from a historical perspective. The third part focuses on the growth and development characteristics of Nigerian cities highlighting their various yet to be addressed pathological and physiological problems. The

concern in section four is proffering explanations to the observed phenomena regarding Nigerian cities and their people. The last substantive part i.e. section six, tries to answer the big question, 'will they survive?'

The Nature of Cities

Talking about the nature of cities presupposes that we know what a city is or that, at least, there is agreement on what a city is supposed to be. On the contrary, there is hardly any such consensus. The problem arises because, one, there are various sizes of substantial concentrations of population over the earth surface. Two, settlements vary in the special functions they perform. Three, their forms or morphologies vary quite markedly; and four, they grow so fast and merge into other settlements thereby making their boundaries difficult to determine. It is no surprise therefore that the term 'city' is associated with various meanings, depending on whether it is defined by demographers, geographers, politicians, economists, sociologists, or historians. To the student of Greek and Roman history, for example, it means not only the walled town such as Athens or Rome but the territory surrounding it, the inhabitants of which enjoyed the privileges of citizenship – in other words, a city state. (See *The Encyclopedia Americana*, International Edition, Vol 6, 1974).

Perhaps a somewhat universal definition of a city is a settlement with a relatively dense aggregation of population of considerable size in which the conditions of life can be described as 'urban' in contrast with the rural life of the open country. Here again, the question of what is 'urban' arises. In order to sharpen the focus on this definition, we may borrow from Whyne-Hammond (1979) who associates 'urban' with 'diversity of function'; that is where all types of occupations, industries and services are represented. Cities are therefore much larger than towns and have a greater number of functions including finance, industry and administration.

The beauty of physical planning in this regard lies in the fact that while it recognizes the functional relationships between and among cities, it pays particular attention to the peculiar identities of individual cities. It goes further to preconceive what the identity of a new city is expected to be. Every city is unique. So, we can talk about:

newborn baby cities, doddering old-man cities, cities in a hectic whirl of youth, poor guttersnipe cities, fat millionaire cities, quiet studios cities...

(adapted from Whyne-Hammond 1979)

How did cities develop over time? The life and achievements of cities are prominently represented in the earliest pages of recorded history. In the ancient world, estimates of scholars put the population of Athens at the height of its glory at a range of 40,000 to 140,000; Jerusalem at 30,000; and Carthage at not more than 300,000. Following the Barbarian invasions beginning in the 4th century A.D., cities virtually disappeared from Western Europe for a period of several hundred years known as the Dark Ages. Constantinople, at the extreme eastern

limit of Europe, was the only European city to survive the Dark Ages with a population of 100,000.

There followed an Urban Revival period which saw the rebirth of cities consequent upon the impetus which trade received in the 10th century. This period was so remarkable that by the 16th century, there were six European cities – Constantinople, Paris, Naples, Venice, Milan and Lisbon – with more than 100,000 population.

The era of modern cities, however, appeared to have crowned the phenomenon of urban development. Transportation and trade are the factors that explain the urban revolution of this period. The age of exploration and discovery beginning in the 15th century with far reaching advances in navigation replaced local trade with world trade. With the development of mechanized means of land transportation beginning in the 19th century, and later of air transportation, urban complexes like New York and London witnessed astronomical growth where workers could live far from work, amusements and shopping, and goods could be moved to and from cities.

In the 1960s, cities were scattered over the world and, at least, 40 cities representing all the continents, had populations exceeding 2,000,000. This 'age of the city' has become the characteristic form of existence for a majority of people especially in the US and Western Europe. Today, the population sizes of the world's 100 largest metropolitan areas, according to the Population Crisis Committee varies between 2,350,000 (Pune, India) to 28,700,000 (Tokyo-Yokohama, Japan).

Looking through history from the classical era through the medieval and renaissance periods to modern times as sketched above, it will be seen clearly that the history of cities is almost as old as history itself. But cities in history did not come about their locations, functions and forms by accident. They are results of planning thoughts, ideas and visions. For example, Plato in his *Republic* developed his view of an ideal state. It is his belief that the city should be limited in size "in order to maintain its integrity and unity" (Mumford 1973). Much more idealistic in physical description is Plato's ideal city as described in *Laws* where he envisaged a self-reliant entity with sufficient land to feed its population. Plato's ideal city once achieved is not subject to further changes; rather, the pattern is supposed to be static and maintained by punitive measures.

One other Greek visionary thought is that of Aristotle. In the pages of *Politics*, he put forth what he considered as the structure of an ideal city. He saw the city as an avenue to forge commercial interests as well as ensure adequate security. In his planning thought, Aristotle was able to relate the institutional arrangements of the state with the ideal physical forms of its cities. However, like Plato, Aristotle's ideal city could only be sustained by strict social controls – albeit in disguised forms in what was supposed to be democratic city-states.

These philosophers of ancient Greece may have influenced Sir Thomas More in 1516 when he first used the word 'utopia' to describe an imaginary, ideal country. His ideal society was an epitome of the perfect environment. In this state, all men are equal, prosperous, educated, wise and morally upright. The location of the island of utopia is in the middle of the ideal country – the

commonwealth of utopia. There are 54 spacious green cities in the land each cited at an average distance of about 40 km. from one another. More gives a detailed description of one of the 54 cities: Amaurote, the capital city of Utopia lies by the side of a hill, or rather a rising ground. Its almost square figure lies adjacent to a river called Anider. A bridge built of stone links the city to other cities within the commonwealth. The city is compassed with a high and thick wall with towers and forts, as well as a broad and deep dry ditch round the three landward sides with the river making up the fourth side. The city roads are broad and well protected from the winds. The houses are uniformly built and they all have gardens behind them. The gardens are so meticulously kept that they all produce plentiful fruits and beautiful shrubs.

Looking through the utopian philosophies of the early Greeks and that of the exponent of the tradition – Thomas More – one is struck by the close bearing they have with cities and city planning. It has in fact been asserted that “indeed, the first utopia was the city itself” (Manuel 1973). Put in other words, utopia is “essentially the apotheosis of the city” (Tillich 1973). This has important implications for planning as the problems of settlements have in the main been almost synonymous with the problems of cities.

A characterization of cities over time and in space coupled with the philosophical and practical attention devoted to them are clear indications of their importance in the way they affect our lives. Cities are capable of affecting, and indeed do affect, our lives both positively and negatively. These have been described as the “pretty” and the “ugly” faces of cities – a sort of two sides of the same coin (Egunjobi 1997). The “pretty” face presents cities as centres of innovation, generators of revenue and formidable markets contributing significantly to the overall development of countries (see Beauce 1990 and Harris, 1990). On the other hand, the “ugly” face depicts cities as “parasites” on the rural environment where deterioration in living environment ushers in diseconomies, and where ill-health, social disorder originate and predominate.

At the end of the day, we are prompted to conclude that cities are inherently neither good nor bad. The essence of this neutral school of thought is that cities are like fire which can be used or misused. This neutral view has been aptly summarized by Christopher Morley’s *Where the Blue Begins*:

All cities are mad: but the madness is gallant
 All cities are beautiful: but the beauty is grim.
 (Quoted from Whyne-Hamtnond 1979)

Nigerian Cities at Risk?

The issue at stake is the determination of the extent to which Nigerian cities are beautiful or mad, pretty or ugly, livable or unlivable? In considering this question, it is instructive to start by asking individuals in this lecture theatre to imagine his/her own ideal city. I can see my own ideal city flowing with milk and honey. In this city, everyone is gainfully employed. Everyone has equal access to all basic needs. Rights of the individuals are recognized and protected; and there is cooperation and peace. May we call this “*The Global Paradise*”.

In another one moment, imagine another city called 'The Hell on Earth'. This is a direct opposite to the life I first imagined – something akin to what you find in the book of Revelations, in *The Holy Bible*, where all the dwellers of this city enjoy are pains, suffering and regrets.

If we assume these two cities as representing two extremely conditions, then there must be, theoretically speaking, one thousand and one varying conditions lying between the two. The one nut we want to crack is having an understanding of where Nigerian cities as a group lie along this continuum, left or right, or a little to, or further away from, the centre?

But before delving into this, it is important to know a little bit about the growth, distribution and characteristics of the Nigerian cities. It is an established historical fact that urbanization in Nigeria predates the British colonial administration. Estimates of population of towns by the early explorers, missionaries and merchants, as collated by Mabogunje (1968), indicate the existence of substantial human settlements in this part of the world during the nineteenth century (Table 1). During this period, Sokoto in the north, Ibadan and Abeokuta in the south-west had populations of 100,000 and over. Others with substantial population sizes include Zaria, Oyo, Kano and Ilorin. These settlements had developed from commercial and trading activities as well as administrative centres, religious points, defence posts or combinations of these functions.

Table 1: Nigerian Towns with Population of over 20,000 in the 19th Century

Town	Population	Period/Year
Sokoto	120,000	1825-1827
Ibadan	70,000-100,000	1856-1891
Abeokuta	60,000 - 100,000	1851-1867
Ilorin	70,000	1853-1856
Iwo	20,000 - 60,000	1856-1890
Osogbo	60,000	1890
Zaria	40,000-50,000	1825-1827
Ede	20,000 - 50,000	1856-1890
Kano	30,000 - 40,000	1822-1824
Ijaiye	30,000-40,000	1853-1867
Oyo	25,000-40,000	1856-1878
Ogbomoso	25,000 - 40,000	1856-1883
Lagos	20,000-40,000	1856-1864
Ijebu-Ode	13,000-40,000	1890-1891
Oke-Odan	24,000-30,000	1890-1891
Deegoo	30,000	1822-1824
Argonou	30,000	1822-1824
Baebaegie	20,000-25,000	1825-1827
Dikwa	25,000	1851-1855
Iseyin	15,000-24,000	1852-1956
Wawa	18,000-20,000	1825-1827
Tabra	18,000-20,000	1825-1827
Ado	20,000	1879
Koso	20,000	1825
Epe	20,000	1879

Source: Mabogunje 1968.

The colonial administration by the Township Ordinance classified towns across the country into three categories. Lagos which was the capital, was the only first class town; eighteen others were classified second class, while another twelve fell into the third class category. This tended to have influenced colonial administration's decisions on investment in infrastructural facilities and services. Thus Lagos, the only first class town, was the first to be served with electricity in 1896, while other second class towns such as Port-Harcourt, Enugu, Kano, and Abeokuta were served in the early and mid-1900s. An important influence of colonial administration on urbanization in Nigeria is that it brought about changes in the structure of cities. It introduced western town planning tradition through the designation of Government Reservation Areas (GRAs), which developed side by side with the traditional residential areas.

Compared to the indigenous urbanization era and the colonial period, the most dramatic pace of urbanization occurred after independence, from the early 1960s. Post-colonial administration continued in a more forceful way the policy of concentrating public investments on the already urbanized and fast-growing centres especially Lagos (the national capital then), Ibadan, Kaduna, Enugu and Benin-City (regional capitals then) and a few others including Port-Harcourt and Kano. Private sector investments also, of course, followed this trend. The post-colonial administration also pursued the policy of administrative decentralization which saw the inherited three regions in 1960 increased to 36 states in 1992 each with a capital "supporting regional universities, technical colleges, other institutions of higher education, hospitals, and other services requiring large population thresholds" (Salau 1979). In addition, the post-colonial period saw the establishment of a few new towns; some resulting from economic development projects such as the construction of dams, and others for administrative purpose. Notable in this regard is the building of Abuja in the middle-belt of the country as an alternative national capital to Lagos.

Resulting from the public and private investment and other decisions, the share of urban population increased from 5 percent in 1921 to 33 percent in 1984. In more specific terms, those centres with populations of 100,000 or more rose in number from only 2 in 1931 to 62 in 1984. The 500,000 category of cities were only 2 according to the 1963 population census; by 1984, there were 14 of such cities.

The conclusion that clearly shows itself is that even though more Nigerians still live in the rural areas, the pace of urbanization has been dramatic showing extraordinarily high rates of 5-10 percent per annum. A first visible aspect of this is the rapid expansion of Nigerian cities' areal extent. For example, Lagos which had a population of only 7,400 in 1911 and covered an area of no more than 4 square kilometres had grown in population to 665,246 in 1963 and by 1978 had increased in areal extent to 879 square kilometres incorporating numerous outlying fishing and farming villages (Aina, Etta and Obi 1994). Thus, this city has multiplied itself in area more than two hundred times within a six and a half decade period. This sprawling tendency is observable in other cities including Ibadan, Port-Harcourt and Kano.

A crucial aspect of this is that city growth is largely uncontrolled; and like a carelessly tended or totally neglected yam plot which necessarily does not bring forth the required yield even with adequate rains and fertile land, the cities are diseased by such infections as slum housing conditions, limited coverage of urban services, unreliable service provision, general environmental deterioration, confused transport systems, incessant flood and fire disasters (Egunjobi 1986b). This is to say that our cities are not only at risk, they are already manifesting signs and symptoms of ailments at varying stages of severity. An elaboration of these and the way they impact on the quality of life of urban dwellers is the concern of this section of the lecture.

In discussing conditions of human life in the cities, we shall adopt the approach of viewing the city environment at three levels: these are the housing environment, the neighbourhood environment and the wider city environment – borrowing from Hardoy and Satterthwaite (1989).

With respect to housing in Nigerian cities, there are the twin problems of quantitative and qualitative deficiencies. The rate of housing formation which is consequent upon movement of rural migrants into the cities is far higher than the rate of housing construction. A sharp perspective of the problem is provided by an estimate of urban housing deficit for Nigeria which in 1990 was put at 7.7 million dwelling units (Toure and Fadayomi 1992). The housing crisis is worsened by high cost of building materials and inaccessibility to urban land ownership. The immediate result of this problem is homelessness on the part of the very poor, and environmental health degrading shelters for the not-too-poor. This in financial terms implies a huge investment in housing which, of course, is one out of many sectoral demands.

Since it is difficult to match the supply with the demand for housing, there is always a qualitative deficiency. To illustrate, the proportion of households in one room apartments in the cities varies between 41.2 percent in Sokoto to 76.3 percent in Lagos. According to an inter-continental study by the Population Crisis Committee (1990), which looked into conditions of living in the world's 100 largest metropolitan areas, the average number of persons per room in Lagos is 5.8. These are clear indications of overcrowding (Fig. 1) which are associated with such health problems as tuberculosis, meningitis and influenza (WHO 1992). Most of the houses are not provided with essential utilities and services (Fig. 2). Findings from a study of three sampled cities (Ibadan, Kaduna and Enugu) show that the proportions of households with in-house pipe-borne water connection varies between 65 percent and 69 percent. However, the proportion that has water most of the time varies among these cities between 22 percent and 31 percent (Onibokun 1989). For the majority of the sampled urban population, the taps remain dry most of the time. A significant number of houses in Nigerian cities are not provided with kitchens. In effect, cooking with firewood, charcoal or kerosine often takes place in living rooms or passages. This, along with inadequate ventilation, dusty or damp floor conditions creates indoor pollution and contribute to respiratory infections with women and children more at risk as more of them spend more time in and around the home.



Figure 1: A Sea of Heads

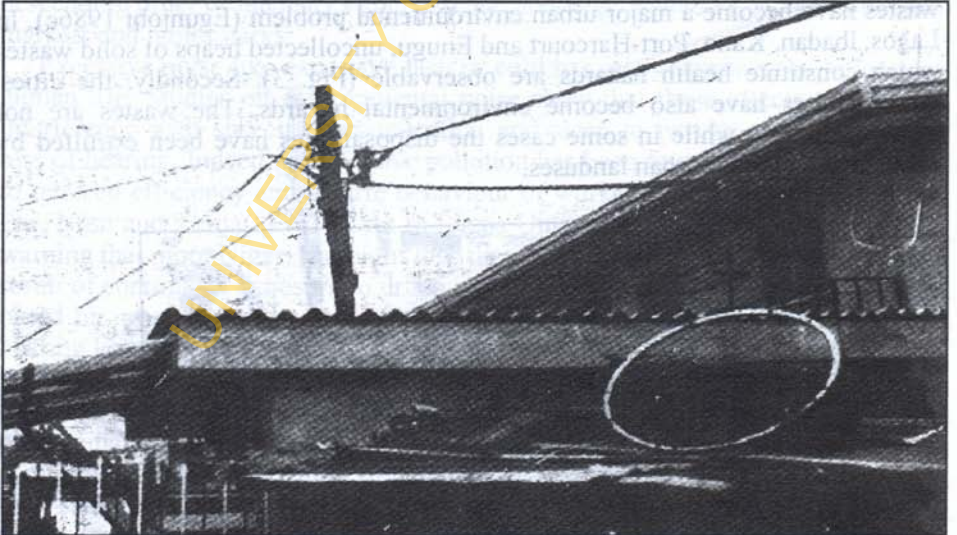


Fig. 2: Epileptic Service

The situation from the perspective of the neighbourhood environment is similar to those described with respect to the housing environment except that neighbourhood problems are viewed from a wider spatial perspective. The first observation that is made from the neighbourhood level is unhealthy locational situation of residential apartments in poor neighbourhoods. Illegal structures are erected along hill slopes as can be seen in Ibadan, Abeokuta and Enugu, or in marshy areas of Lagos, Port-Harcourt, Warri and Calabar.

The water supply situation and the disposal of waste water constitute another environmental problem at the neighbourhood level. In Lagos Metropolitan area, for instance, 60 percent of the pipes run through open drains where some pipes are burst open. The inhabitants living nearby invariably resort to fetching water from these burst pipes. This, according to a study, contributes to the intensification of the occurrence of diarrhoea (Odumosu 1993).

In our cities, a sizeable proportion of the populace defecate along local streams or drainage areas, or may simply use the open space around dilapidated or abandoned public latrines. Others use pit latrines. The general picture is that of inadequacy of sanitation facilities. Sanitary facilities are either not available, or where available, poorly maintained. In a large part of Ibadan, water is always not available to flush WCs. Pit latrines are dug without environmental considerations side by side with shallow hand-dug wells which supply water for domestic purposes. In this city, typhoid is prevalent. Between 1971 and 1973 when there was an outbreak of cholera in the city, the most affected part was the traditional core areas where population density was highest and where water and sanitation facilities were most inadequate (Adesina 1987).

Another element of the urban environment is wastes disposal. As many Nigerian cities pass the million mark in population, collection and disposal of wastes have become a major urban environmental problem (Egunjobi 1986c). In Lagos, Ibadan, Kano, Port-Harcourt and Enugu, uncollected heaps of solid wastes which constitute health hazards are observable (Fig. 3). Secondly, the cities' disposal sites have also become environmental hazards. The wastes are not treated sanitarly while in some cases the disposal sites have been engulfed by residential and other urban landuses.



Fig. 3: The Waste Invasion

The wider city environment exhibits such health problems as air pollution and water pollution on a wider scale than those observed at the neighbourhood scale. Air pollution and water pollution at the city scale are a product of industrial establishments that are springing up in the larger cities of Lagos, Fort-Harcourt and Kano. The increasing rate of car ownership among the middle and high income classes also contributes to urban air pollution while accident rates are also increasing sharply in cities.

One other problem that is felt at this scale is noise pollution. The variables through which pollutants reach us include not only the air we breathe, the water we drink, the food we eat, but also the sound we hear. In 1966, Peter Enahoro in his book, *How To Be A Nigerian*, made a satirical reference to the 'Nigerian noise' when he wrote:

In the beginning, God created the universe; then He created the moon, the stars and the wild beasts of the forests. On the sixth day, He created the Nigerian and there was peace. But on the seventh day while God rested, the Nigerian invented noise.

Enahoro has certainly got a firm grip of the Nigerian's behaviour with regard to noisemaking: but it is fair to point out that this is essentially a city problem. In fact, it appears the dictum holds that the bigger the city, the bigger the mess. A pilot study on this urban problem reveals that in the city of Ibadan, deafening sounds from record-players top the list as the most obnoxious source of noise (Egunjobi 1986a). This is followed by other sources such as the use of grinding machines, intra-city traffic, power generating plants and religious worship in a descending order of intensity. Others are the noises generated by activities in open markets and motor parks.

Excessive noise like excessive heat or cold has many degenerating effects on human life. Studies on environmental noise show that these effects range from interference with speech communication and sleep to psycho-social stress and loss of hearing. Indeed, urban noise pollution has been found to have contributed to reduced efficiency and bizarre behaviour of workers. In 1984, the head of the Ear, Nose and Throat (ENT) Unit in Lagos University Teaching Hospital gave a warning that more Nigerians might lose their hearing in the next few decades as a result of continuous exposure to urban noise (*The Guardian*, 21 March 1984). He based his warning on the increasing number of his patients who complained of hearing loss in recent years.

Furthermore, our cities suffer from inadequate intra-connectivity. City transport which serves as the sinew binding together various land uses has not only remained inefficient, it has grown over the years to be expensive and dangerous. Quite a proportion of the people of Lagos have had to cut drastically their sleeping hours to avoid being caught in traffic hold-up. They typically leave their homes by 5.00 a.m. and do not return from work until very late in the night. The rate of car ownership has since the oil boom days increased, whereas the required urban road space has not increased correspondingly.

Ibadan provides another example of the chaotic transport situation where an

estimated 50 percent of houses in the traditional core is not accessible to vehicular traffic. Yet, half of the limited available road spaces are illegally taken over by traders bearing in mind that every street in Ibadan is characterized by one form of trading activity or another.

Although the role of urban transportation is to facilitate the movement of people and goods comfortably and safely, where they are required, and recognizing that there is no alternative to mobility, what exists in our cities is a litany of inconveniences and frustration as evidenced in road congestion, pollution, accidents – all of which are fatal to the quality of life in cities.

This characterization of living conditions in the wider city environment takes us to the issue of insecurity from such crimes as burglary, armed robbery and street fighting. Every other household in the cities has been a victim at one time or another in residential apartments, on the roads and even in offices. This has constituted a formidable anxiety-based problem. It has also contributed to a high cost of living. This is because urban residents have to expend a significant proportion of their incomes in fencing their homes, in providing burglary proofing, guard dogs, lighting, metal doors, close-circuit TV and even African traditional measures – a situation which Agbola (1997) describes as "Architecture of Fear" (Fig. 4).



Fig. 4: Architecture of Fear

Lack of safety and security in the cities is not limited to crimes and urban violence. It involves such other physical hazards as fire outbreak, structurally failing houses and urban floods. These have been increasing in rates, resulting in personal property and business losses.

Looking at the various indicators we have thus far applied to assess the degree of livability in our cities, it should be possible to assign a grade of performance to the cities (see Table 2). Have they passed this simple test? Perhaps a fair conclusion in this regard is that the cities are on the verge of both physical and spiritual death. For example, one of our cities – Lagos ranks 98th on the scale of livability among the world's 100 largest Metropolitan Areas (*Population Crisis Committee* 1990). This, if the metaphor is clear enough, is the gasping of Nigerian city dwellers for shelter, mobility, utilities and services.

Table 2: Quality of Life Indicators in Lagos Metropolitan Area

No.	Indicator	Score
1.	Public Safety (murders per 100,000 people)	NA
2.	Food Costs (% income spent on food)	58%
3.	Living Space (persons per Room)	5.8
4.	Housing Standards (% Homes with water/electricity)	50%
5.	Communications (Telephone per 100 people)	1
6.	Education (% of Children in Secondary School)	31%
7.	Public Health (Infants deaths per 1,000 Live births)	85/1,000
8.	Peace and Quiet (Levels of ambient Noise) (1-10)	7
9.	Traffic Flow (Miles per Hour in Rush Hour)	17.4
10.	Clean Air (Alternate Pollution Measures)	NA
11.	Growth Rate of Metropolitan Areas in the 1980's(Average annual rate)	5.86
12.	Urban Living Standard Score (in rank order among 98 th the World's 100 Largest Metropolitan areas)	98th

Source: Population Crisis Committee, 1990.

Governance as a Pre-eminent Factor

An attempt to explain the plethora of problems which our cities are faced with leads one into a number of disaggregated factors as proffered in planning literature. These include poor funding of urban development projects, scarcity of technical and professional skills, disregard for urban development related laws and ineffective urban planning practices. These and other such factors by category fall on the laps of the private sector developers whose profit motive ambitions produce social disbenefits, and the public sector that is concerned with collective choices of goods and services. Subsumed in these two major categories are the planning professionals as a class having responsibilities for the application of laws and regulations that govern urban development functions. Although there is the apparent conflict of interests between the private operators and the public sector, there is a logic in the assertion that the latter that are found in the business of governance take the lion's share of responsibilities for building the cities and making them function for human benefit. Where this is not happening or happening lukewarmly, they have to take the blame. This is because the city is a public good and urban planning as a distinct field in the public domain seeks to protect public interest through regulatory powers (Solesbury 1574).

The pre-eminence of governance as a factor explaining the gasping cities will be illustrated with a few selected cases.

- (i) *A Big City Without A Master Plan*: One is referring to Ibadan in the south-western part of the country. The effect of this is that this city has over the years been growing in all directions without direction. The frustration of professional planners in this city, can be imagined in the absence of a standard zoning arrangement, the frame work of which a

city plan would have provided. Factories are located within residential areas. New buildings continuously spring up in the suburbs engulfing the villages and eating away the farmlands without control. There are more shops than living rooms. The situation is so much chaotic that nobody is able yet to determine the exact boundaries of the city. This confusion makes it an almost impossible task to make projections for the utilities and service needs of the city. The case being made is that lack of political will has largely been responsible for these conditions.

- (ii) *A Planned City Without Planning Discipline:* Abuja is Nigeria's showpiece of a city having been built from the scratch when "money was not a problem", and which expectedly was to enjoy benefits of the latest technology and an enlightened vision in city development. However, an urban planning and development monitoring alarm had to be raised as early as 1984 when an international meeting on new capital cities in the developing countries was held in Nigeria. The delegates noted contraventions in the implementation of Abuja Master Plan – which contraventions were defended as "necessities of replanning". The situation in Abuja has remained the same as reported in a Nigerian daily of October 1, 1999. Worried by constant abuse of building and environmental laws in Abuja, the Federal Capital Territory (FCT) Minister was determined to stop all encroachment whereby all open spaces meant for recreation were turned by people to build illegal structures (*The Guardian*, October 1, 1999). Senate Committee on FCT had earlier heard that a former Minister in charge of the Territory was responsible for distorting the development of the second phase of the plan by converting open spaces, roads and recreational areas into plots, and allocating them to people described as "favourites and lackeys" (*The Comet*, October 3, 1999).
- (iii) *Cities With Crippled Land Law:* For over two decades (1978-99), the ineffectiveness of Nigerian Land Use Law has continuously been highlighted. The law has put all land within Nigeria under public control. The objective includes equity in access to urban and rural land. Since 1978 when the law was put in place, it is the consensus of Nigerians as reflected in research findings (Egunjobi 1991) that accessing the land through public apparatus has been as difficult as ever. The paradox in this case is that it was far more difficult for some State Military Governors to acquire land for public use than to acquire for themselves. What is more, the Land Use Law hampered the preparation of layouts which contributed to haphazard pattern of urban development at the cities' peripheries. Here again, the public sector that promulgated the law without public participation (an anathema of the military regime) and demonstrated no capacity for enforcing the law, and wilfully refused to revoke or amend the law, takes all the blame.

- (iv) *Cities Where Management Functions Are Uncoordinated:* In 1987, Egunjobi and Oladoja in one of their studies of Ibadan found that 16 different agencies were responsible for the management functions of the city. The amazing observation about these agencies is that there was little or no collaboration among them. The result is that the urban populations which they all serve are at risk of the ensuing danger, inconveniences and inefficiencies. Thus, it is not uncommon to see a newly paved road by an agency, being ripped open by another agency for the purpose of installing water pipes or underground telephone cables without consultation, or an urban road rehabilitation work that unearths some already laid pipes or cables. Yet complaints and counter-complaints are often lodged as and when the tap is dry and the agency in charge of water complains about lack of electricity to pump water into the city, or when the fire fighter is unable to function because the hydrant to the site of fire incident has no water. Furthermore, it was discovered that certain provisions of the laws in respect of the agencies are either at variance with, or duplicative of one another. For example, an agency in a particular city has power to allocate spaces for erecting temporary shops whereas another agency in the same city has powers to demolish illegal structures which turn out to be the same shops.
- (v) *The City Where Political Power Reigns Supreme:* A short story based on our research on 'Politics and Development Control' suffices in this case. Consequent upon political pressure, the Commissioner in charge of Local Governments in Ibadan suspended the then Ibadan Metropolitan Planning Authority (IMPA) and ordered that a house under construction that had reached the lintel stage should not be demolished by the Development Control Departments of the Authority for contravening planning regulations (Egunjobi 1985). His rationale was that any contravener ought to have been spotted and dealt with by the Development Control Officers from the foundation stage. The ingenious minds of the political party faithfuls harped on this and erected illegal structures by accelerated process at week-ends when the Control Officers were not on duty such that part of the building would have reached the lintel level. In this case, they were out of the Control Officers' nets according to the Commissioner's private law. This obviously meant a high rate of contravention of development control laws and a sustained continuous trend of disorderly mode of urban development.
- (vi) *The Law-maker is the Law-breaker in my City:* This sound curious, but that is the case. Our conservative observation shows that between 1997 and 1999, we have built five times the number of petrol filling stations that had existed since the importation of the first vehicle into the country. However, the astronomical rate of increase in the number of stations is not necessarily the worrisome aspect of this story, but the

wanton disregard for the relevant urban planning and environmental laws. Despite the provisions of these laws that stipulate the minimum distance between one station and another for safety and health, we have observed eight petrol filling stations in a row without a single vacant plot in between any two of the stations. It is our considered opinion that these potential land mines should not have been that strategically located if public laws are made to be obeyed for the public benefit.

- (vii) *The City With Half A Million Local Governments*: In this hypothetical city, and yet typical of our cities, all sense of economies of scale has got lost. It no longer makes sense to talk of collective responsibility and cheaper delivery of goods and services communally. The true picture is that every home especially in the sub-urban areas is a self-catering entity (a local government?) in terms of provision of day and night-guards, water, electricity, waste disposal services and road maintenance. Close to the homes, of course, are proliferated private nursery and primary schools as well as health centres. This is almost analogous to the concept of ecological house where the owner may remain in-doors for months (by choice) without necessarily being in want of anything from outside the home (Egunjobi 1997). Forced ecological housing situation in this context translates into a shameful indictment of the public providers of urban utilities and services. The issue that is being considered in this respect is that there is hardly any more responsibilities left for the government to shoulder such that questions are raised as to whether government is established to serve people or *vice versa*. Certainly, it is difficult to see if there is any fundamental difference between what the ruler calls "community participation" and what the citizen sees as "governmental irresponsibility".

Will They Survive?

In an attempt to answer this question, we take into consideration the inevitability of urbanization, the peculiarity of the pace of urbanization in developing countries, as well as the positive empirical tendency that urbanization is amenable to planning. Our premise in a more precise form is that urbanization in itself is not an undesirable phenomenon if anticipated or observed. Undesirability of urbanization results from planlessness or unserious planning. So, our answer to the question posed is in the affirmative. Our gasping cities are going to survive; however, this is with the obvious proviso of the timely intervention of a qualified physician. This translates into the requirement of political will, which is a function of responsible leadership.

The intricate relationship between politics and planning has never been disputed in time or space. This is irrespective of whether planning is considered under an authoritarian or a democratic political climate. On the one hand, irresponsible political interference can, and does hinder the execution of planning proposals. On the other hand, people in public affairs can invoke political power to facilitate urban planning and management. This essentially depends on

awareness, motivation, commitment and degree of enlightenment on the part of the leader and those other leaders at various governmental levels down to the community level.

The efficacy of urban planning as an instrument for promoting and sustaining human quality of life has been amply documented. Our study in this instance shows that the more intensive the planning activities in a neighbourhood, the higher, the level of environmental sanitation status of the people in the particular area (Egunjobi, 1995). Yet, health maintenance is just one of the many goals of urban planning. Others, if we can recall, include safety, economy and aesthetics.

If by general education, or simple logical reasoning or empirical evidences, the rulers who hold political and bureaucratic powers realize that the survival of the present and future cities are essentially in their hands, they will develop by choice that culture of city planning and management that is premised on discipline and sincerity of purpose.

To end this discourse, let me quickly proffer some specific recommendations as planning challenges in the new millennium to those in politics and public affairs. This is in recognition of the light that appears to be appearing at the end of the tunnel in recent times:

- (i) It is imperative that every city and indeed all settlements including villages in the country should be covered by master plans as stipulated in the Urban and Regional Planning Law of 1992. This will save the present unpleasant situation where planners do not have reference points to make land-use decisions which has contributed to disorderly development.
- (ii) A review of Abuja Master Plan and Abuja Regional Plan is, after two decades, rightly overdue. The necessity for this stems from the need to collate and analyze those experiences learnt through genuine professional planning practice as well as through wilful distortions to the Plan to derive selfish benefits.
- (iii) There is the need for the Nigerian Land Use Law to be revised. According to our nationwide evaluative study of this law, a sizeable proportion of 71 percent of the sampled professionals and 47 percent of the general public wished to see the law amended (Egunjobi 1991). Citizens were sympathetic to the cause of the law, but were skeptical about the framing of it and the organization of its implementation. It is therefore recommended that a broad-based machinery should be set up for getting the land policy revised to make it achieve the intended objectives.
- (iv) The need for rationalizing conflicting and duplicative functions of various urban agencies, and effecting coordination to achieve efficiency has become important at this stage of our city life. More specifically, every urban region has the requirement for an Urban Planning and Development Coordinating Committee (UPDCC) to serve as a clearing house for all urban projects and management functions.

- (v) A national programme of Town Planning Education should be instituted. The objective will be basically to make Nigerians – the rulers and the ruled alike – planning literate. This will serve the purpose of enlightenment that will make those in public affairs more alive to their responsibilities, while at the same time will ensure that citizens know their rights and are ready to participate on this ground in city planning for sustainable development.

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INVESTMENT IN NIGERIAN EDUCATION: RELEVANCE, QUALITY AND GOVERNANCE AT THE EVE OF THE THIRD MILLENNIUM

Remi Longe

Department of Educational Management

Preamble

This lecture is indeed inaugural, being the very first coming from the Department of Educational Management, Faculty of Education, in the University of Ibadan.

The Department of Educational Management was established in 1976, as a result of the tripartite agreement between the Federal Ministry of Education, the UNESCO/UNDP and the University of Ibadan. The objective of that agreement is to bring about human resource generation to meet the growing needs of educational administration and planning in Nigeria.

The project tagged NIR/75/103 was the first to be so established in Nigeria and in fact in Africa South of the Sahara. This is confirmed in the National Policy on Education (1977), which specifically stressed the point to ensure adequate supply of manpower for implementing the policy. Consequently, a Department of **Educational Management** was established in the University of Ibadan. Ever since, the department has vigorously pursued the set objectives through various academic programmes – undergraduate, postgraduate, and in-service training programmes to administrative and planning officers in the federal, state and the local governments.

At this juncture, I wish to acknowledge the pioneering work of Dr. T.O. Ohikhena, who, as the first Head of the department, worked in collaboration with the UNESCO Technical Team¹, to lay a solid foundation for the Department of Educational Management, University of Ibadan between 1976 and 1983.

One of the early research projects of the department was undertaken by Professor (Mrs.) R.S. Longe (my humble self) in 1979, titled, "Factors

¹ UNESCO TECHNICAL TEAM in the persons of D.N. Nwaniki, C.N. Cumming, G.K. Pederson, A. Lulsegged, C. Conrad, W.M. Zaki, H.N. Pandit, A.S. Patwari and A.A.J. Spee.

Influencing Current Costs of Secondary Education in Nigeria". The report of the research was later adapted and published by UNESCO/IIEP in 1982 (IIEP research report 46). This was followed by Durosaro (1985), a micro planning research, titled, "Internal Efficiency of Secondary Education" which was supervised by me. In another research activity in educational administration, Ogunsanya (1981), looked at "Teacher Job Satisfaction and Productivity as Correlate of School Goal Achievement". Likewise, Ibukun (1983) conducted a study on "Leadership and Resource Situation as Contingency Factor for School Success". Akinwumiju (1986) began a study on "Gaps Between Demand and Supply in University Education in Nigeria". In more recent times, we have focused our research on the subject of "Internal Efficiency of the Education System and Gender Issues". Ajayi (1998) on "Resource Utilization", concluded that, education managers justify education as investment rather than consumption. On "Gender and Decision - making", Longe and Babalola (1999a), found that a large gender gap in Education at the primary and secondary levels in Nigeria has led to significant welfare losses. In another recent study of the relationship between women education and household democracy, Longe and Babalola (1999b), hypothesized that exposure of couples to modernizing institutions such as schools will facilitate the acceptance of the democratic system of power sharing at home.

The focus of my research all along has been in the area of Educational Planning with emphasis on **cost analysis, women education and national development**. However, on this unique occasion of the first inaugural lecture of the department, I am looking beyond this area to present in a broader perspective, **Nigeria's Investment in Education**. Consequently, I chose the topic "Investment in Nigerian Education: Relevance, Quality and Governance on the Eve of the Third Millennium".

Introduction

The decades of the 1980s and 1990s marked a downturn in Nigeria's educational system. During these decades, the country, which had hitherto experienced upward mobility in the 1970s, suffered enormous economic, political and social crises. While other countries of the world are warming up for the global challenges of the 21st century, many Nigerians as well as important international observers are becoming increasingly concerned about how to create the base for a growth path that would ensure rapid development in Nigeria. In addition to the traditional question of how the education system contributes to students' intellectual growth, a new question is being asked: 'How can the educational system contribute to national competitiveness in the coming millennium?' According to Lewin (1993) and AASA (1994) stakeholders want to know which type of education benefits society by:

- providing greater earning power;
- enriching the quality of life;

- promoting equal opportunity;
- maintaining a free market economy;
- enhancing personal fulfilment;
- ensuring world leadership;
- and preserving democracy

The human capital model argues that skills are acquired through investment in education, which adds to the overall volume of national competitiveness. However, according to Cappelli and Lannozi (1993) structural changes in the economy, changes in policy, and shifts in demographics may adversely affect the link between education and development. Studies such as that of Cappelli and Lannozi have served as a caution to many admirers of the human capital theory. Holding to the tenets of the human capital theory but without losing sight of the caution to many admirers of the theory implied in the work of Cappelli and Lannozi, this lecture pursues the thesis that **investment in education**, among other public supports for human services, is an indispensable part of any realistic programme for economic and social recovery in Nigeria.

Global Thoughts Concerning Investment in Education

The belief that investment in education boosts economic growth dates back to the time of Adam Smith. The concept however, gained global attention during the human capital movement of the 1960s. Schultz (1961) and Denison (1962), in their pioneering works, showed that education contributes directly to economic growth by improving skills and productive capacities of the labour force. Considering the economic needs of African countries following their independence in the 1960s, most of the nations, including Nigeria, quickly embraced the human capital concept as basis for defending their huge investments in education at various levels. Unfortunately, reports from the field concerning the actual economic value of investment in education in the 1960s produced ambivalent results. Consequently, in the 1970s, research on educational investment suffered a great setback.

Nevertheless, in the 1980s, the World Bank demonstrated a renewed interest in the concept of **education for development**. Hicks (1980), Wheelers (1980), Longe (1981), Psacharopoulos (1984 and 1985) and Akangbou (1986), among others reaffirmed the importance of education in promoting economic growth. In fact, in the 1990s, there has been overwhelming evidence that education is one of the keys to social and economic development.

Many studies of farm productivity, family enterprises and wage earners have demonstrated that an increase of one year in average years of education may lead to a 3 percent rise in Gross Domestic Product (GDP). As shown in the World Development Report 1990, the results of this research vary from region to region.

Obstacles to Realization of Investment Benefits in African Education

For most groups of developing countries, the effect of education on GDP is clearly positive. This result demonstrates the economic importance of investing in education. Ironically in Africa, the increase in average years of education, which in 1985 was 3.25 is expected to have a negligible positive effect on GDP. Three main reasons can explain this exceptional behaviour of education in relation to economic growth in Africa. First, Africa might have failed to attain the educational threshold for economic growth. Studies have shown that the higher the initial level of education, the greater the benefits from increasing the average years of schooling. For example, about four years of schooling is needed to attain functional literacy. Investments in education may yield substantial returns only when they are big enough to push the economy over such a threshold. Contrary to this, in the 1980s, many countries in Africa had extremely low enrolment rates, while in other African countries, enrolment rates either stagnated or fell (World Bank 1991).

Of more importance than the quantitative threshold are the issues of relevance and quality of African education as they affect economic growth. The quality of education, in this context (World Bank report 1995, p. 75) includes the learning environment and students' outcomes. From the input side, quality of education can be inferred from:

- student's capacity and motivation to learn;
- the curriculum or the subjects to be learned;
- teachers who know how to teach and can actually teach;
- time to learning;
- and the requisite tools for teaching and learning.

According to World Bank report, (1990, P. 45), education in many countries of Africa remains of poor or mediocre quality, particularly when it comes to the basic skills upon which countries will depend to meet the needs of the labour market in the 21st century. Poor quality of education in Africa is manifested through absentee teachers, emphasis on rote learning, outdated curricula, shortages of textbooks and lack of relevant materials. In addition to these, quality shortfalls in African education systems are also showing up in output indicators such as the results of internationally comparable tests. All these ills are most likely to have unfavourable effects on the expected interaction between education and economic growth in the continent.

The issue of governance cannot be overemphasized as far as the developmental impacts of education are concerned. One important lesson from the past is that the economies, which committed themselves to investment in education may fail to achieve commensurate level of economic growth owing to bad governance either at the national/state or at the institutional level. When economies and institutions of learning are badly governed, investments in education may not produce optimal result. This was the case in the Philippines

where several years of authoritarian rule, which squandered foreign borrowings, prevented people from benefiting from their greater skills (World Bank 1991 and 1999 p. 61). Perhaps, it is correct to say that the Nigerian experience of the last decade is similar to that of the Philippines considering the appalling state of education in Nigeria. It is appropriate to quote here, the concern in Akinkugbe (1994) in the *Second Obafemi Awolowo Foundation Dialogue*: “today we lament the glaring inadequacies in our educational industry: primary, secondary, special, technical, tertiary, in which there is abundant evidence of crippling inertia, criminal neglect and pervasive decay in values and standards”.

There is overwhelming evidence that education is a weapon in the fight against poverty. There can be little doubt that educating the children of the poor greatly improves their chances of escaping poverty. Since the power of all able-bodied poor is in their labour, increasing the productivity of this labour is clearly the most effective way to combat poverty. Infact, the effectiveness of education as a tool to combat poverty goes beyond productivity in the labour market. One year of receiving mother's education has been associated with a 9 percent decrease in under 5 mortality. It has been found that the children of better-educated mothers, other things being equal, tend to be healthier. Just as the education of parents has positive effect on child nutrition and of course better nutrition improves the child's capacity to learn. Studies in Kenya, among other developing countries, show that protein-energy malnutrition is related to lower cognitive test scores and worse school performance. Another study from Indonesia discovered that micro nutrient (Iodine) deficiencies reduce cognitive performance among nine-to-twelve-year old children. Iron deficiency decreases the child's alertness, which in turn affects learning (World Bank 1990, Del Roses and Marek 1996). Vitamin A deficiency has long been associated with blindness and the severity of measles. A milder vitamin A deficiency affects growth, including brain development. If the full benefits of education in Africa are to be realized, pupils must be adequately nourished and good governance, which is still rare in Africa, is needed to achieve this.

This lecture has hitherto discussed the concept that, education is necessary to promote social, political and economic growth. It has also dropped a hint that such education needs to be relevant, qualitative and well governed. Having set the general conceptual context, the next section specifically deals with Nigerian investment in education at all levels.

Investment in Nigerian Education

Hypothetically, investments in education are depressed during an economic recession and rise again as economic growth resumes. This is a recent finding of Psacharopoulos and others (1996) in a study that uses data from 1984, 1989 and 1992 household surveys to investigate the earnings/education relationship in Mexico. Table 1 shows data on Nigerian investment in education between 1980 and 1993 to test the Mexico's finding. Using the GDP per capita as the indicator of economic growth, Nigerian economy was seriously depressed between 1980 and 1988. The table reveals that the GDP, which was \$650 in 1980 reduced by

43.08 percent to \$380 in 1985 (that is within 5 years). Within 8 years, the economy has depressed by 56.92 percent from \$650 in 1980 to \$280 in 1988. In response to the economic depression, per capita education spending reduced by 55.36 percent between 1981 and 1984 and by 80.36 percent between 1981 and 1988. This implies that education spending reduced faster than national income during depression in Nigeria (see Fig. 1).

Table 1: Investment Trends in Nigerian Education

Period	Year	GDP Per capita 1987 US \$	Education spending per capita in US \$	Education as percentage of annual budget	Education spending per student in US \$
I	1980	650	3.4	5.2	190.94
	1981	530	5.6	7.8	302.55
	1982	450	4.5	7.9	82.16
	1983	390	3.9	7.4	82.16
	1984	370	2.5	8.0	n.a
	1985	380	2.5	8.0	55.59
II	1986	270	2.1	4.8	n.a.
	1987	280	1.6	2.7	n.a.
	1988	280	2.1	2.0	n.a.
III	1989	310	3.09	7.2	16.66
	1990	340	3.06	5.3	15.75
	1991	330	2.00	4.1	10.25
	1992	320	2.80	6.3	7.10
	1993	320	3.90	7.3	6.44

Note:

- (i) n.a. = not available.
- (ii) Efforts have been made to remove the effects of changes in exchange rate of Nigerian currency, through its conversion to US dollars.

Sources:

- (i) Babalola, Lungwangwa and Adeyinka (1999, I)
- (ii) IBRD/World Bank (1995) *World Tables* (Table II)
- (iii) Central Bank of Nigeria, CBN (1992, 1993) (III)

The table reveals that the fall in the share of education in the national budget did not respond immediately to the corresponding fall in the GDP per capita. In fact, there was a five-year lag between the fall in the later and the former. On the other hand, the education spending per population responded after a year. This shows the demographic effects on education investment. It is interesting to note that, in spite of the dwindling national income, Nigeria showed an unwanted commitment to education through a continuous increase in the share of education in the national budget. Nevertheless, the gains in budget share must have been eaten up by increase in population within the period. The year 1986 was a bad one for education in Nigeria. The budget share of education dropped by 40 percent from 8.0 percent in 1985 to 4.8 percent in 1986. This has been shown to

be as a result of the adoption of the Structural Adjustment Programme (SAP). By 1988, the education share has dropped by 75 percent of the 1984 figure.

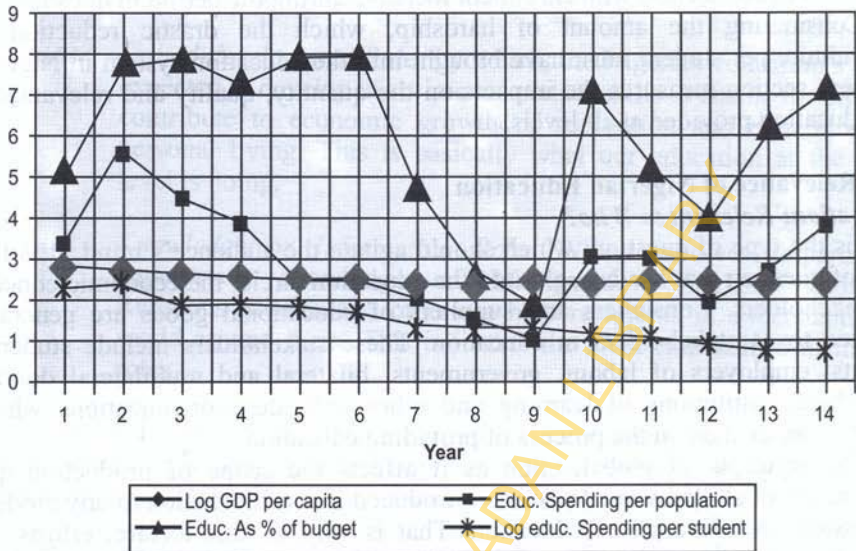


Fig. 1: Investment trends in Nigerian Education

On this table, three economic periods in Nigeria are shown. The first one spans from 1980 to 1985, which can be referred to as the pre-SAP recession period. The second one spans from 1986 to 1988, which can be classified as the SAP period, and the third, the post-SAP recovery period, is 1989 upward. The post-SAP period is characterized by growth in the economy, in the education spending per capita and in the education as a percentage of the annual federal budget. There was a 3.23 percent increase in GDP per capita within this period. The education spending per capital also increased by 26.21 percent while the share of education in the budget increased by 1.39 percent within the referenced period.

These results confirm the Mexican experience, where it has been demonstrated that investment in education increases during recovery. Nevertheless, we are quick to add that there is a difference in responses of Nigerian government during recession and recovery as far as its commitment to education is concerned. The government was reluctant to reduce education budget during recession until the adoption of SAP in 1986. Moreover, as soon as the economy picked up in 1989, the country increased the budget share of education from 2.0 percent in 1988 to 7.2 percent in 1989. The table reveals that Nigeria actually struggled between 1989 and 1993 to attain the pre-SAP share.

The story is different as far as expenditure per student in US dollars is concerned. In figure 1 it is revealed that, in spite of the government's efforts at increasing the share of education in its budget, the expenditure per student

continued to decrease at an alarming rate. The expenditure per student, which was \$302.55 in 1981 reduced to \$55.59 in 1985, through \$16.66 in 1989 to \$6.44 in 1993. One quick explanation to this outrageous cut in public spending per student is in connection with enrolment increase during the period in question.

Considering the amount of hardship, which the drastic reduction in expenditure per student must have brought into the education system in Nigeria, the next section measures the impacts on the quantity, quality and relevance of the education provided at all levels.

The Relevance of Nigerian Education

Education: Relevant to Who?

This is the type of question, which should agitate the audience's mind. It is this type of question that has brought into the education circle, the economic concept of stakeholders. Consumers and suppliers of educational goods are generally referred to as stakeholders in education. These stakeholders include students, parents, employers of labour, governments, bilateral and multilateral donors, publishers, institutions of learning and other individuals/organizations whose interests are at stake in the process of providing education.

The concepts of globalization as it affects the scope of production and distribution of skilled work force has introduced a new dimension to any modern discussion on relevance of education. That is why, in this lecture, efforts are made to revisit the traditional debate on the relevance of Nigerian education in the context of the recent international interest on globalization of education.

Relevant in What Sense?

By relevance, we refer to the extent to which education can be used by the society to realize its dreams. Following the independence in 1960, Nigeria decided to build a free, democratic, united, just and egalitarian society where there will be bright and full opportunities for all citizens. Economically, the country's desire is to be a great, strong, dynamic and self-reliant economy. It is hoped that education at the primary, secondary and tertiary levels, both inside and outside the formal school system, would contribute in no small measure, to the achievement of the social and economic goals of this nation. Relevance to the society aside, education is supposed to contribute to recipients' aspirations in life. The extent to which education can assist an individual to live a useful life in the society will determine the private relevance of such education.

Relevant in What Way?

Education becomes relevant through its following traditional roles: (the National Policy on Education, 1981):

- (a) *Attitudinal Role:* by which the education system is expected to inculcate certain attitudes in recipients in Nigeria. This is to create in them values such as national consciousness, national unity, sense of national/personal survival, respect for the worth and dignity of the

individuals, respect for dignity of labour, faith in man's ability to make rational decisions, sense of shared responsibility, and others. These are relevant values within the country's pluralistic context.

- (b) *Skilled-development Role*: by which, the Nigerian education system is expected to develop in recipients, certain skills to enable the citizens to contribute to economic growth of the nation and earn money for personal living. This is basically what our education at the tertiary level is doing.
- (c) *Knowledge or Information Role*: Which involves imparting the appropriate knowledge of Mathematics, English, Economics, Religious Studies and others to help recipients in understanding the world around them. This is in fact the most emphasized of the three roles.

The three roles of education are translated into actions through the curricula at all levels. In Nigeria, efforts have been made to indigenize the curricula and therefore, make education more relevant to the community needs.

Conflict of Relevance

In recent times, the Nigerian curricula faced a severe conflict of relevance when measured against the international expectations. The general belief at the international level is that education in developing countries, especially Africa, serves to develop students' intellectual power with little or no emphasis on how the education can contribute to economic competitiveness required in the 21st century. At the international level, two competitive strategies have been developed. One is to compete, based on low wages. This ironically, is a path the United States is presently pursuing (Faux 1992). The other strategy is to compete for higher wages. The success of this strategy lies in a national ability to create and maintain a high-quality work force. This, in effect, requires a competence-based, vocational and work-oriented curriculum. The belief is that high quality work force is the source of adaptability in a market place, which is changing at an accelerated rate.

The argument that the Nigerian curriculum is mainly of a general form and therefore does not contain substantial economic potentials has been found to be faulty. Findings indicate that the allocation of more inputs to academic education, as we have it in Nigeria, had a positive effect on economic development.

Kuroda (1995), for instance, observes that countries that allocated more inputs to academic education in 1980 grew more rapidly throughout the decade than those countries that allocated fewer inputs. The data further showed that vocational education had some structural inefficiency. This is pointing to the fact that our values are right and that our emphasis on academic instead of vocational curriculum is also right.

There is a need to be careful of the import mentality in education. The waves of globalization that are currently blowing across Africa can be dangerous if our curriculum is not adequately protected from the dominant ideology of the former colonial masters. We need to respect the principle of self-determination as far as what Nigeria considers the best values to be taught in our schools, colleges and universities. A situation where the international donors determine education priorities for the recipients does not promote real development. There is already evidence to show that Nigerian scholars are consumers of scientific knowledge created particularly by the World Bank, to shape the thinking of our people and therefore import certain cultural arbitrariness closely associated with economic dominance. Openness to foreign information is a good value but some information may undermine national sovereignty, values and curriculum. That is why we should continue to gear Nigerian education towards meeting the needs of the local communities.

Quality of Nigerian Education

Introduction

In Nigeria today, there is mounting concern about the state of schooling at all levels. This is rooted in the realization that literacy levels and academic achievement will determine individual job attainment and earnings as well as the general economic well-being of the society. Moreover, the quality of life in the society will be affected by the level and quality of social skills acquired in schools. It is wrong however, to attribute the low levels of literacy and school achievement in Nigeria to the school alone. This is because, other factors such as the home, the society, the mosque/church, government and personal characteristics are also important in child development.

Nevertheless, fingers are generally pointed at governments and schools for the low levels of literacy, academic achievement and social skills in Nigerian institutions of learning. In fact, there is a general concern about the level of material inputs allocated by governments to various institutions of learning on a per student basis, and also the level of efficiency with which fixed amounts of material inputs are organized and managed to raise student achievement in Nigerian schools.

Ironically, governments have been exempted from the quality issue in Nigerian schools on the ground of economic inability. While government is aware of the fact that technical evidence has consistently shown that school quality can be improved by increasing expenditure per student, they have argued that economic reality on ground cannot support immediate implementation of such findings. Consequently, this lecture has to focus on issues that can help to improve the quality of education in Nigeria in the short-run. Long-run issues bordering on increase in public spending on education are considered as pending ones in this lecture. Overall, seven main issues will be addressed, namely:

- (i) student's capacity and motivation to learn;
- (ii) subject to be learned;

- (iii) teachers who know and can teach;
- (iv) time for learning;
- (v) requisite tools and technology;
- (vi) acquisition and use of inputs; and
- (vii) performance standards.

Quality Problems and Related Issues in Nigerian Institutions of Learning

The pursuit of quality is the concern of teachers, parents, children, employers, governments and international communities.

Each of these parties has its own views about what constitutes good education. Consequently, it has been a difficult task to agree on what should be a good practice in our schools. This problem is further compounded by the heterogeneous nature of Nigeria as a multi-ethnic country. What is considered as a minimum entry qualification into the University of Ibadan, for instance, may be different from that of University of Sokoto. This may be as a result of the prevailing conditions within the communities in which the two universities are situated.

Even when there is a consensus as to what a good education should be, this standard is expected to be the minimum attainable. It will be foolish to suggest that schools should stop at the minimum, since it is doubtful if we can ever attain perfection in education. It is therefore left in the hands of individual institutions of learning to define what it considers as a qualitative education within the context of the minimum standards (if available) and subject to its resources, social conditions and limitations. This implies that quality of education will keep on changing from place to place and from time to time as schools continue to make efforts at caring for the stakeholders' needs.

An important indicator of quality of education is the value added to schooling. This includes the **learning gain** and the increased probability of **income-earning activity**. It also involves **research productivity** in the case of higher education. Some of the value added to schooling can be measured quantitatively (as quantitative indicators) while others can only be measured qualitatively through experiences, judgement and professional knowledge (that is qualitative indicators). The quantitative indicators, for example, might include the **attendance rate, dropout rate, repetition rate, passing rate, the number of years since the school was last painted, or the number of days in service training undertaken by staff**. On the other hand more aspects of the qualitative indicators could include **evidence of good communication with parents**, the existence of **appropriate policy documents** and the evidence of **efficient use of resources**.

Setting Performance Standards

Generally, our assessment of the quality of education in Nigeria is often based upon qualitative evidences through experience, professional judgement and knowledge.

We will combine both **quantitative** and **qualitative** indicators to discuss the quality issue earlier identified in this lecture. A logical starting point for a discussion of quality of education is the performance standards. Is there any agreed standard of performance against which we can measure the quality of education in Nigeria? The answer is "yes" and "no". Yes, because there is the National Universities Commission's (NUC) Approved Minimum Academic standards for all Nigerian Universities. The Approved Minimum Standards specified length of academic year, minimum number of teaching weeks per session, external examiner, continuous assessment, minimum number of credits required for graduation and the academic contents expected to be covered by each department in all disciplines of Nigerian universities. The NUC, in line with Decree No 49 of 1988, appointed thirteen panels to set the minimum standards. The panels, made up of between six and twelve senior members of the academic staff, headed by respected professors, were to produce draft proposals. Each panel was given a free hand to co-opt other members of the community they felt would make meaningful contribution to their work. When the drafts were ready, they were sent to every academic department in all the Nigerian universities for their critical comments on the documents. The output of this process is known as the "Approved Minimum Academic Standards for all Nigerian Universities" published by the Federal Republic of Nigeria in 1989.

After a decade, the Approved Minimum Academic Standards for All Nigerian Universities (AMAS) is yet to gain total acceptance in all Nigerian Universities. The extent of compliance with the AMAS varies between universities and departments. In most cases, it is reluctantly practised. This reflects the level of consensus reached during the process of setting the standard. In order to arrive at generally acceptable standard, there is need to involve the politicians, the professional educators and the students. The politicians are to judge what knowledge and skills they wish schools to impart to their children. The professionals are to supply the effective strategies which could be used to reach objectives and the students are to judge what skills they consider useful for them. The NUC seemed to have ignored this process of consensus building while setting the minimum standards. Consequently, the AMAS is like forcing something down the throat of a sick individual. The assimilation would then be gradual, difficult and forceful. In effect, the minimum standards have become the maximum practices in most of the universities where AMAS is currently adopted with some seriousness.

In spite of these problems, the university system is far ahead of other education sub-systems in Nigeria as far as standards of performance are concerned. Right now, various education authorities decide on what standards of education they consider good for their people within their areas of jurisdiction. In most cases, the standards are unilaterally set by the politicians with little or no consideration for the involvement of other stakeholders.

Nigeria is ripe enough to set standards of performance for education at all levels. The process can be through a general conference on educational development. The conference can involve politicians, professional educators at

the school and ministry levels as well as parents, students and other important groups in the society. Moreover, we cannot objectively measure the quality of education where there is no standards of performance against which we can compare the existing practices. The first thing therefore, is to set a national minimum standard of performance at all levels of education in Nigeria.

Improving Students' Quality

As important as the existence of performance standards in education is, students' capacity and motivation to learn can make or mar a good schooling system. Home and school are the two main socializing agents as far as student's willingness, ability and readiness to learn are concerned. Studies (Lombard, 1994; Schaeffer, 1987; Bryant and Ramey, 1987) comparing the effects of home and school influences conclude that more than 60 percent of difference in student achievement can be attributed to differences in individual and family characteristics. Unfortunately however, most Nigerian parents are finding it increasingly difficult to provide adequate family supports for their children particularly during the formative age.

There is a high prevalence of poverty that has resulted in acute nutritional and health problems among Nigerian school children. Temporary hunger (a situation where a child is made to miss at least one of the meals, a situation jokingly referred to among students as 0-0-1, 1-0-0, 1-0-1) has become household norms in Nigeria. The effects of this on the level of attention paid by school children to learning cannot be overemphasized. Temporary hunger can affect student's concentration in school, while chronic malnutrition, micronutrient deficiencies, parasitic infections and physical impairments can lead to less regular attendance, grade repetition and also to more dropouts.

In recent times, there is a rising concern about child labour, street trading with children leading to withdrawals from schools. These have combined with the nutritional and health problems to reduce the ability of some Nigerian children to achieve any measure of success in schools. Once the foundation is weak, the superstructure is bound to be weak. As the Bible says "if the foundations are destroyed, what can the righteous do?" (Psalm 11:3). The quality of Nigerian education system is closely linked with the level of preparation of Nigerian children right from the home. It is therefore important to introduce school-based interventions that will complement the unmet needs of the deficient children before a permanent cognitive damage is done. Such interventions, could for instance, be directed toward the physical, emotional and cognitive development of the rural and poor children, particularly during their formative ages. Without doubt, educational investments that are geared toward school health and nutrition programmes have the potential to boost learning and achievement among the poor. Family support programmes, which focus on parent's literacy and sensitization can also go a long way to help parents to endorse schooling and discourage child labour.

Improving Teacher's Quality

The quality of teachers is as important as the quality of the students when we refer to quality of education in Nigeria. Longe (1984) pointed out that as a result of social, political and economic situations, it has gradually become difficult to find teachers who know and are motivated to teach their subjects in Nigerian public schools. Most of the teachers at all levels of education in Nigeria are poorly prepared. Those in the service are rarely exposed to new theories, techniques, demonstrations and practice. This is because of lack of well-designed continuous in-service training. Feedback to teachers through research findings are absent.

However, there are some distance learning outfits, which are meant to upgrade the teachers on their jobs. These are in form of external degree programmes, part-time programmes, crash-programmes and others. The quality of these programmes is still doubtful since little emphasis is often placed on teaching practice.

Ironically, the students themselves do not complain because they want cheap certificates. Government is economically handicapped and therefore cannot condemn proliferation of satellite study centers which are more or less money-making centers for host institutions in Nigeria.

Improving the Quality of Instructional Time

Availability of knowledge teachers is an essential ingredient of quality. However, the quality of time available for teaching and learning these subjects is important with respect to quality of education in Nigeria. Do teachers have quality time to teach? Do students themselves have sufficient or quality time to learn? What demand has the present economic situation in Nigeria imposed on teacher's time? Considering that home-work forms an essential as well as integral part of quality in education, do students have enough time to attend to assignments? These questions require answers. Nigerian schools have experienced incessant closures in recent times. These closures are as a result of strike actions, student crises, fuel shortages, political disturbances and social upheavals among others.

Many teachers have been squeezed between devalued income and increasing private responsibilities. There have been evidences of divided interest and loyalty among teachers especially in the public schools. Cases of absenteeism have increased among teachers and students. All these have affected the quality of education adversely. It is important to point out the effects of lack of public utilities such as electricity, water, transport system, postal and telecommunication systems on the quality of time available for teaching. Lack of telephone, for instance, has serious effects on the commuting time by teachers, students, and inspectors of education. The commuting time is further wasted as a result of poor transport system in Nigeria. Time scheduling in Nigeria's schools has been made very difficult since the enabling environment is generally not predictive. Generally, the actual time spent is usually less than the expected time allocated to teaching.

On a global standard, primary schools are expected to spend about 880 days of teaching per year. It is rare to find public schools that spend such a quality time on instruction in a single year in Nigeria. It might be wise for us to adopt a flexible scheduling of school days, weeks and year to ensure that different schools meet required international specification for time of instruction.

Improving the Quality Control Systems

Quality control has to be emphasized in order to improve the quality of education in Nigeria. School inspection has to be improved at the primary and secondary school levels. Longe (1986) advocated for the return of the colonial type of school inspection in Nigeria. This is because studies have shown that the difference in performance between teachers in public and private schools is as a result of the differences in the supervisory modes. The system of accreditation, moderation and external examination at the tertiary education level should be taken more seriously to enhance the quality of graduates being produced. This is more so since the quality of higher education is not being controlled through external examination. Which means, the control of the quality of the higher education depends on how faithful each institution is in subjecting itself to accreditation, moderation and external assessments. Having suggested the essential ways by which the quality of education can be improved in Nigeria, the last part of this lecture opens a Pandora box containing an age- long debate on the type of autonomy accorded institutions of learning.

Governance of Nigerian Education

Introduction

Governance, in this lecture, is restricted to the manner by which the public education system in Nigeria is being controlled. This definition is necessary in order to point out the effects of political structure on the education systems. As earlier stated in this lecture, the experience of the Philippines, where several years of authoritarian rule which squandered their foreign borrowings, showed that, when economies are badly managed, investments in education may go waste. There is need to exercise caution with respects to the direction of association between governance at the supra level and that at the institutional level. It is not an unusual thing to see a democratic government being wasteful while an authoritarian one is not. It can therefore be spurious to jump to a conclusion that once Nigeria has experienced several years of authoritarian rule like that of Philippines, investments in Nigerian education must have gone waste. The examination of the relationship between the leadership style at the governmental level and the corporate performance of various institutions of learning in Nigeria are a topic for future discussions. The focus here is on the examination of the state control of education with the hope that such critical appraisal will lead to possible policy changes in Nigerian education.

Models of Governance

The model of governance of education can be discussed from two extremes. That is; decentralization and centralization. As far as decentralization and centralization of education are concerned, Nigeria has exercised various degrees of authority and responsibility for education since her independence in 1960. Shifts in patterns of educational governance, particularly at the primary level, are paradoxically currently a cause of uncertainty and turbulence for many of us in the education business. In fact, the governance of Nigerian primary education has been characterized by one step forward and two steps backward. Nevertheless, this type of confusion is not peculiar to Nigeria alone. In the United States of America, for example, education was very much a local affair up through the late nineteenth century. In the early twentieth century, school administration became centralized under the leadership of education professionals in the districts (local) and states. This was aimed at correcting abuses of the earlier decentralized system. Now, the centralized system in the United States is coming under attack as being too bureaucratic and unresponsive to local needs. According to Fiske (1996), a movement favouring decentralization through vouchers, charter schools, and school-based management is gaining ground, not only in America, but also in the developing world.

Governance of education is a political issue. Its discussion requires a thorough understanding of the concept of decentralization – the meaning, the type, the dimensions, the advantages and disadvantages. It should be noted that we should not confuse political decentralization with administrative decentralization. Political decentralization is concerned with allocating power to make decisions about education to citizens or to their representatives at lower levels of government. On the other hand, administrative decentralization involves assigning responsibility and authority for planning, management, finance and other activities to lower levels of government without losing the decision-making power.

Since different amount of power can be decentralized, it is important to differentiate among de-concentration, delegation and devolution of power (Fiske, 1996). De-concentration is a shift of management responsibilities from the central to lower levels in such a way that the central ministry remains firmly in control. On the other hand, delegation involves lending authority to lower levels of government, or even to semi-autonomous organizations such as churches. Delegation of power is usually done with the understanding that the delegated authority can be withdrawn if abused. It should be noted that while de-concentration involves responsibility without authority, delegation implies responsibility with revocable authority. Unlike in de-concentration, people with delegated power are allowed to take decisions and use their discretion where necessary. Devolution of power concerns a permanent transfer of authority over financial, administrative and pedagogical matters to lower levels of government. Many governments are sceptical about devolution of power in education since it is generally believed that education is a political tool that can be misused by political opponents.

Balancing between Decentralization and Centralization

The choice of the mix of decentralization and centralization is not an easy one. The governance model adopted in a country can be determined by factors such as national priorities, international social order, group interests and economic trends in a country. Central to the model of governance adopted in a country are its economic strength and political will. Chad, Togo and Uganda are examples of 'weak countries' where government inputs are lacking. In these countries, semi-autonomous (religious/racial) groups have long operated some schools. Indonesia is a 'fairly strong country' with military dominance. In Indonesia, various Islamic religious groups operate substantial numbers of schools. Prohibiting these schools is a difficult task and the authorities have to tolerate their existence. However, government grants are used to strengthen the power of the state and to encourage the schools and their owners to take a positive stance toward the ruling regime (Bray 1996).

Azerbaijan is a weak state in which the government is trying to maintain legitimacy despite major religious and ethnic tensions. Encouraging semi-autonomous groups to operate their own schools could strengthen religious and ethnic divisions and exacerbate already serious political tensions. Singapore is a strong country with enormous resources, authority and a robust self-image. In spite of its strength, Singapore encourages financial decentralization of education because it recognizes that such activities help generate interest and commitment to the educational process. This is in spite of its earlier experience when the country felt threatened by the notion of racially-based community bodies organizing their own schools.

There is a strong move in support of decentralization of the school system in Nigeria. Ade-Ajayi (1994) advocated for decentralization in the school system, with more community involvement and less of the heavy hand of government bureaucracy. In the same vein, Ogunsanya (1998) suggested the abandonment of the policies of centralization, regulation, and control for the policies of genuine privatization and liberalization. Such decentralization, Ade-Ajayi concluded, should in no way impair the structure of national system of education in making educational opportunities available to all on the basis of equality and merit.

Nevertheless, there is increasing evidence that households are already contributing, directly or indirectly, to the costs of education. The debate has now shifted to household's participation in school management and autonomy of institutions of learning.

Household in Governance of Education: A Change to Be Considered

This section points to a change in the right direction in the governance of education across the world. Nigeria may want to re-appraise its present practices and see if lessons can be drawn from the governance gap identified herewith. We are conversant with household's participation in educational financing in Nigeria. The country is yet to involve parents and students in the governance of schools and universities. We are familiar with the concept of Board of Governors of

secondary schools in Nigeria, but are they actually governing these schools. Longe (1984) suggested a participatory planning model that will involve Nigerian parents, communities and students in the decision-making process and in the implementation of programmes at the school level.

The involvement of students in the governance of institutions of higher learning is still seen as inimical to a good tone of a school in Nigeria. It requires boldness to suggest such student's involvement in university governance especially in a period when students of higher education are allegedly associated with violence and occultism.

Nevertheless, schools are communities of truth, made by truth and for the promotion of truth. What then is the truth about household involvement in governance in education. The truth is that governments in several countries of the world are currently making every effort to encourage school-household partnership in educational development. Mauritius and Jamaica for example have set up a social mobilization campaign (SMC) to stimulate active parent/community participation in school governance. In Mauritius, government's funds are being used to encourage parent-teacher associations (PTA) in school governance. The case of School Development Boards (SDBs) in Sri Lanka legislated the establishment of SDBs with the purpose of promoting community participation in school management. Each SDB consists of representatives from the school staff, parents, past students, and well wishers. The Board is chaired by the school Head. The SDB is made up of ten subcommittees to decide and implement school projects. The ten subcommittees are:

- Educational development to improve academic curricula and mode of teaching;
- Co-curricular activities to promote extracurricular activities;
- Moral development to promote cultural, religious and moral activities;
- Physical resources to develop infrastructures such as building and maintenance of physical resources;
- Library and educational equipment to improve facilities;
- Schoolbooks, midday meals and uniforms to decide on school requirements;
- Welfare and community relationship to strengthen welfare activities;
- Communications to interact with media and the community;
- Finance to utilize and disburse school funds;
- Student personality development to develop the personality of the pupils and the school.

This initiative is faced with problems. The main problem is in connection with the capacity of parents, community members and students to make informed decisions on educational issues. The common solution adopted in New Zealand, Jamaica, Botswana and Uganda, to mention a few, is community training. In

New Zealand for example, parents trustees were trained; in Jamaica, parents were trained on how to manage schools; in Botswana, trainings were organized to empower parents, especially in the rural areas to become effective in the school Boards. In Uganda, Action Aid (AA) was put in place to train PTA and members of the school management committees.

If these initiatives are adopted in Nigeria, parents and students can be empowered to become watchdogs to stimulate the right attitude to work among the teaching and management staff of our schools and universities.

Let teachers at all levels be aware that students, parents and members of the community are watching them and at the same time reporting their activities to the authorities through an official procedure. I believe people will work. Teachers will be regular, punctual and more effective at work. Consequently, academic achievement will be improved. In a similar vein, a watchdog activity from the side of parents will cause schools to be on their toes. Fraudulent practices, ineffectiveness and inefficiencies can therefore be reduced to the bearable minimum. Moreover, parents who are involved in school management will be willing to support the school financially.

Autonomy of Institutions of Learning: Another Change to be Considered

Autonomy of institutions of learning is an age-long debate, especially in Nigerian higher institutions of learning. Government usually frowns at such debates on the ground of the adage that says "who pays the piper dictates the tune". It is important for our government to note that school autonomy is not the same as either local financing or administrative decentralization, although the three are often confused (World Bank 1995:126). Fully autonomous institutions have authority to allocate their resources (not necessarily to raise it). This includes the authority to deploy personnel and to determine such things as the timing of school day, the duration of the school year, and the language of instruction to fit local conditions. Moreover, teachers must have authority to determine classroom practices within the limits set by a broad national curriculum. Once a teacher has been told ahead of time that examination is coming up on a specified date, the teacher should be left to use flexibility in classroom practices. Though grossly abused, this is what we do in Nigerian universities, but it is yet to be extended to the lower levels of education. Teachers should be monitored and supported by standards, learning assessments and school inspectors (such as head teachers). School staff must be accountable to the local community to provide a check and balance situation in an autonomous institution of learning.

There is a wide gap between the ministry and the schools in Nigeria. It takes time (days, months, and years) for schools and ministries to communicate. Many times, schools operate without supervision, without check, and without control.

The autonomy of institutions, we are suggesting here is not the type of *laissez-faire* supervisory mode currently being practised in our public schools. We are suggesting the type in operation in the international non-governmental organizations such as the UNICEF. In these organizations, staff operate flexible

time within the limits of the institutional standards concerning the number of hours that should be spent per day and the targets of performance that must be reached at the end of a given period.

We in the Department of Educational Management, University of Ibadan have consistently channeled our research efforts on issues affecting the education system in Nigeria. The results of our research projects some of which have been mentioned in this lecture often point to possible changes in the Nigerian Education System. However, most of these research reports are left on the shelves unused. It is not encouraging that research — research-based recommendations are hardly ever consulted. On this, I use this opportunity to make a fresh appeal that the government makes a firm commitment for the use of research reports.

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13

MYTH IN HISTORY: A CLASSICIST VIEW

J. A. Ilevbare.

Department of Classics

In June 1966, Professor John Ferguson, wrote in the Foreword to AFRICA IN CLASSICAL ANTIQUITY:

This volume of papers reflects one of the central interests of the Ibadan University Department of Classics. It is natural that, in Africa, we should study ancient Africa; the field is fascinating, the opportunity vast, and work in English scanty.

That book was one of the first fruits of Ibadan efforts in reshaping, perhaps, rewriting the history of Africa in Classical antiquity. It was also the other side of the coin to the Renaissance a decade earlier of African and Nigeria history in our Department of History. Before then, African history, ancient and modern, to European and North American public, unfortunately including their scholars, was little more than British, French, German, Spanish and Portuguese Colonial or Empire History.

Africans were said to be savages, lacking real history and civilization of any significance. And what was known of their past is said to be shrouded in myths and irretrievable from the dark past. Hence, Africa was called the dark continent. With the glorious trail blazed by the Dikes and Ajayis, Esan in his comparative study of *Ifa* and the Greek oracle at Delphi (1959) brought new relevance of Classics and the Classical Studies nearer home to Nigeria and at the same time demystified Africa. The next two years, the wind of autonomy blew over U.C.I. The academic curriculum of the department was revised to give prominence to Ancient Greek and Roman Culture. Ancient North Africa came more and more into focus. The process of re-examining, re-interpreting North African history to strip it of myth had begun. Ibadan Department of Classics School of African History was born. The speaker before you is a product of this school.

The focus of this lecture is not mythology *per se*. It is not the intention to trace the history of ancient North Africa and its development from myths nor to classify the various and varying faces and phases of myths in history. This talk will be restricted to aspects of, and examples drawn from, the history of North Africa from 500 BC. to 500 AD., highlighting the interplay of myth and historical facts in an attempt to strip them of their prejudices, fantasies and imaginations and bring to bear on them the benefit of our colonial experience.

Like modern Africa, North Africa in antiquity experienced colonization in the time span of a thousand years; first by the Phoenicians of the homeland (1000 – 500 BC.) and then from the beginning of the 5th century, the empire in Africa and, indeed, western Mediterranean sea, was expanded and consolidated by the most powerful Phoenician settlement at Carthage built on the site of what was to become modern Tunis. Greek colonization was mainly centred on Cyrene (Benghazi in modern Libya). Their cultural influence was felt deep into Carthaginian domain to the west. The Romans ousted the Carthaginians in 146 BC. and annexed Cynereaica in the next century. The Vandal invaders came in the fifth century AD., and played a major role in undermining Roman power, thus paving the way for their mutual downfall, when the Arabs came in the sixth century. Yet, throughout this millennium neither the government of the Princes of Africa, nor their culture of farming and nomadism, nor their other institutions were annihilated. From time to time, these bounced back and continued to thrive to varying degrees until this day (cf Monceaux, *Hist. Litt.*, I, 1901, p.29). It is against this colonial background, that our discussions will unfold.

Beside this, almost all our primary sources came from the writings of these colonial masters. These authors themselves constituted the political class that provided the provincial governors, military leaders who conquered the indigenes. They were also the men of commerce and industries who exploited and expropriated North Africans. They were the same men who, at various times, came into direct contact with the natives of Africa. Though few, they wielded enormous influence, out of proportion to their numbers. Though enlightened, they often fed their peoples back home with inaccurate information, some of which bordered on the marvellous.

For instance, the acclaimed father of history, the Greek, Herodotus (fifth century BC) told of dog-headed men, apes living in communion with men. The Roman historian, Livy who wrote in the time of Augustus Caesar (27 BC - AD 14), saw the Carthaginians as men of bad faith (*Punica fides*) and treacherous to the core; the native African, the Numidian, they assumed, were fickle weather cocks; men reckless in falling in love (*praeceps in venerem*); and their kings, only too ready to go to war for the sake of a woman (Sophoniba) and, in the process, destroyed their kingdoms. But when it came to the Roman conqueror of Hannibal at Zama (202 BC) Publius Cornelius Scipio Africans, Livy suppressed the great general's weakness in the face of Spanish women while waging war in that country (Spain). Livy saw nothing wrong with his treachery in breaking off abruptly negotiations with King Syphax only to attack the prince that very night. Livy saw this action as the mark of an excellent general. All these and similar perfidy ancient Graeco-Roman apologists considered absolute virtue and utmost military skill.

Such biased attitudes were unfortunately accepted by modern western scholars of the nineteen and twentieth centuries who wrote Greek and Roman history for their kiths and kins. Both writers and readers saw themselves as great colonial masters, treading the glorious paths blazed by the Greeks and the Romans. Hence, we find in the works of these modern but secondary sources, the propagation of myths inherited from Graeco-Roman sources. They repeat the African disregard and disrespect for bonds of marriage; in their view, in a polygamous situation, true love was non-existent but dissolved among numerous women, all of them regarded as mere chattels. These claims are nothing more than echoes from Herodotus, Livy, Sallust and Caesar. However, concrete evidence shows that Sophoniba was to king Masinissa, the greatest treasure. In 203 BC, a calvary battle was fought at the Tower of Agathocles resulting in the exchange of Masinissa's mother, a Numidian woman, for a distinguished Carthaginian general, Hanno. Both examples come from the third century BC and were located in what is now Tunisia and Algeria where polygamy had been firmly established. Other women held in high esteem included, Pudentilla, mother of Apuleius in second century AD; the woman married to a local chief at Thubursicu Numidarum honoured by the entire city and recorded on an inscription of AD 100; Monica, the mother of St. Augustine of Hippo; Cyria the sister of Firmus both in the fourth century AD. And, perhaps, the mother of King Jugurtha to which we shall return below.

What emerges from the above is that the ancient African historian at Ibadan of the 1960s, 1970s and 1980s had to contend with the same problems as his counterpart writing on pre-colonial modern Africa. It is this distortion in Ancient North African history that we endeavoured to demystify and, perhaps, here lies what we profess. Before giving an outline of our efforts, a few thoughts may be spared for giving one or two reasons for the bias and myth.

The first that comes readily to mind is sociological, arising from the social situation of the earliest writers in, and carried over to later, antiquity. The horizon of the average Greek or Phoenician of 10th to 5th centuries BC was limited to the immediate boundaries of his Polis (city-state), the population of which hardly exceeded five thousand. Their outlook was further circumscribed by the sea, which was never far away from the inhabitants of the islands and numerous peninsulas and creeks of the mainland on which most cities were built. The sea was proverbial for its treachery particularly in winter, due to the ignorance of the ancient mariners. And so, whoever was able to venture beyond the immediate confines of his city-state (no larger than a village today), came back with stories about strange (not the perjorative terminology "barbaric" of today) land, padded with myths and the marvellous, to enhance the exploits of the traveller. A cursory look at the epics of Homer and Virgil; the book of Apollonius of Rhodes, the novels of Lucian pleasurably named *True Story*, the *Golden Ass* of Apuleius native of Madaura in Africa, the *Satyricon* of Petronius, the minister of the emperor Nero and Herodotus' *Histories of Egypt and the Maghrib*, to mention a few, will tell the whole story. Though no malice was harboured, no injury intended, there was an undertone of superiority complex. The main aim was to magnify the stature of the traveller and his tale.

Between early Greek historiography and travellers, tales, there was only a thin dividing line. Here oral tradition stands as a cross between history and myth. And so, in Herodotus, tales of the marvellous and historical facts were hopelessly jumbled together or placed side by side. The perplexity of the (modern not ancient) reader is relieved by the innocent protestation of the writer, that, so he was told (iv. 187)--the Libyans said so; he could not vouch for the truth; that he or the reader should opt for the most probable. No sinister motive in such distortions.

But in the hands of imperial writers (Herodotus himself must be numbered with this group in his account of the Persian invasion of Greece) historiography was made to serve a definite end: namely, the glorification of the imperial power, of families of the principal actors in the empire and, in the process, of the superiority complex of all the above. The other side of the coin, of course, is the suppression of the culture, achievements of the adversary of imperialism and investing them with opprobrium.

In many of our most important modern authorities, the traits/reasons canvassed above are apparent. So also it is in regard to modern African History. Therefore, with Thucydides, the greatest and the most objective Greek historian of the fifth century BC, in whose hand historiography achieved a height comparable to modern standards unadulterated, we may assert:

It will be enough for me, however, if these words of mine are judged useful by those who want to understand clearly the events which happened in the past and which (human nature being what it is) will at some time or other and in much the same way, be repeated in the future. (Transl: Warner)

It has indeed been repeated.

Let me retrace my steps and mention, all-be-it, cursorily some of the myths found in aspects of Ancient North African History and the reinterpretation provided (by this speaker). At this juncture, I must acknowledge my debt to the monumental work of Stephane Gsell (1903-1929), LA. Thompson, Teutsch, Monceaux, Gruen, Broughton to mention a few. The rest will be listed in the references.

Syphax, king of Western Numidia until 203 BC is said to have revolted against the Carthaginians in the early years of the Second Punic War (218-202 BC), because his Carthaginian wife, Sophoniba, had been taken from him. But Livy, recording events that took place 12 years later in 206/205, reduplicates this marriage, saying that Syphax renounced his earlier (216-213) treaty of alliance with Rome through pressures from his new bride. The assumption in the word, revolt, is that Syphax was a king subject to Carthage.

The truth is that Syphax was an independent king. He went to war with Carthage (217/216 BC) to recover some territory Carthage had taken from him. The territory he obviously got back when the war ended in 212 BC. But Syphax's treaty with Rome was allowed to linger on until 206 BC. There was only one marriage between Syphax and Sophoniba. It took place in 206/205 BC to cement

the alliance between Syphax and Carthage. The alliance was brought about by common interests of both parties, namely, the partitioning of Masinissa's Massylian kingdom. The conspiracy by Carthage and Syphax to partition the Massylian kingdom drove into the arms of the Romans, Masinissa who had, hitherto, in Spain, fought on the side of the Carthaginians against the Romans. The acceptance by Rome of the alliance of Masinissa compelled Syphax to renounce his alliance with Rome. It became impossible for both Numidian kings to remain Roman allies after one had subverted the kingdom of the other. Therefore, the woman was not the real reason for the change in alliance. The real cause was the territorial ambition of Syphax.

Similarly, Massinissa was regarded by the Romans, especially Sallust, as a vassal of Rome. By the help and favour of Rome, according to Sallust, he had recovered his kingdom from Syphax and Carthage and had annexed that of Syphax. Therefore, Massinissa held his kingdom in trust for Rome as a provincial governor. He was a teleguided puppet of Rome. So went the myth. The truth, gathered from other Roman and non-Roman sources, contradicts this fervent Roman imperialist picture. It is now known that the strategy for the destruction of Carthaginian and Syphax's Numidian forces at the camps was mapped out and executed by Massinissa. While the Romans were still basking in the euphoria of the victory on the Great Plains (203 BC) where Massinissa with his own hand captured Syphax, Massinissa single-handedly overran Syphax's territory. On the battle field of Zama (202 BC), that final confrontation between Hannibal and Scipio Africanus, it was the horsemen of, and led by, Massinissa that swung the battle round in favour of the Romans. Massinissa spent the next 54 years on the throne, leaving behind him a rich and powerful kingdom. If Massinissa needed Rome in 204/203, Rome needed him also and more so thereafter.

Whenever the Romans committed aggression and land grabbing against the indigenes, they paraded themselves as pacifiers, resettlers and civilizers. And this so-called civilizer role is consistently re-echoed by modern authorities. (Pacification and civilization were, in similar situation, to become the slogans of 19th and 20th centuries colonial powers). Hence the resistance of such tribes and nationalists as the Musulami and Garamantes (22-19 BC and AD 6); Tacfarinas (AD 17 - 24), the Nasamonians (c. AD 70 - 78); the Baquates (AD 118, 168-169, 232-234); the Mazices, the people of Lusius Quietus (98-117 AD) and Firmus, the king of the Iubaleni (AD 372). In the case of Firmus, the war was caused by Roman attempt to set aside Firmus, the rightful king, in favour of their puppet, Zammac. The puppet was seen as a traitor by his people and was killed. The Romans got the pretext they needed for war. A striking repetition of Jugurtha-Adherbal-Hiempsal episode of 118-105 BC. The imposition of oppressive taxes fuelled this war. In each of these cases, the resistance spread over very wide areas across national boundaries embracing the Gaetulians, an umbrella name used for tribes that ranged the Steppe regions south of the coastal mountains and the Saharan Atlas down to the desert beyond, stretching from the hinterland of the Gulf of Sidra and Gabes to the Atlantic ocean. As shall be seen below, the geographical extent of the revolts could not be an accident: there must be some well established bonds holding these peoples together.

My first efforts were directed at myth in the status of women, the family, and the so called bastardy of the African child, and the succession principle, especially in regard to the Numidian royal family. Herodotus fifth century BC and Sallust first century BC, followed by Ammianus Marcellinus fourth century AD, observed that Ailicans married numerous wives. According to Herodotus, Nasamonians were promiscuous; Sallust averred that their love was dissipated among the numerous wives who, one and all, were regarded as mere chattels. Livy added that the Numidian African was very quick and reckless in falling in love. Livy, Ammianus Marcellinus and the Greek historian Polybius agreed that North Africans especially the kings fathered numerous children by wives and concubines while Polybius and Sallust emphasized that some of such children, obviously by concubines and women of low births, were illegitimate. All modern authorities re-echoed these views with only a few (notably S. Gsell) attempting a rationalization. The assertions of Greek and Roman writers were readily accepted by modern scholars for, in this regard, the Graeco-Roman and modern European customs are similar and so they could not see and understand African way of life. Many wives and children were part and parcel, and at the very root, of the economy of the people based on unmechanized agriculture and pastoral nomadism. Just as was to be the case with pre-colonial Nigerian society, wealth was reckoned not only in the numbers of cattle and acres of land but also in the number of wives and children. In such a situation, no child was illegitimate.

The history of Numidia (modern Algeria) 105 BC was distorted by factions of Roman politicians who invoked this mistaken notion of bastardy against Jugurtha, king of that country at that time (118-105). In spite of the fact that even in the second century BC the Romans (Livy xxix.29) had recognized the Numidian custom that the oldest agnate male, not necessarily the eldest son of the last king, must succeed to the throne—and this obviously applied at individual family level—some politicians in Rome conspired to subvert the throne of Jugurtha first by splitting the kingdom between Jugurtha and his younger cousin Adherbal; and then, when the latter was killed in battle, by declaring war on Numidia. Jugurtha was defeated and ultimately deposed. It was alleged that Jugurtha was a bastard, too ambitious for his situation in life and so not fit to become king. This point was even stretched beyond all imagination by Sallust that Masinissa, his grandfather, had marked him out for his bastardy and debarred him from the Numidian throne!! It is noteworthy that Masinissa had been survived by forty-four sons; three of them were singled out by Polybius as legitimate, among whom was Jugurtha's father, Mastanabal. It is also worth noting that Jugurtha was recognized by his uncle and successor of Masinissa, Micipsa, as heir apparent. Micipsa, according to the confused account of the Roman historian Sallust, subsequently did him (Jugurtha) the favour of sharing the throne with Micipsa's sons born much later. All these are active distortions and myths. The truth is that Numidia was a rich client kingdom whose rich agricultural and mineral resources the Romans had exploited since the defeat of Hannibal. The exploitation had mainly been carried out privately by Roman senators (cf. Nigerian Senators) and business class (*equites*) on individual basis, for private pockets, to enhance their political, military and social status. Whoever

became the patron of the king stood to reap enormous benefits. The best way to achieve this end was to install a puppet on the throne. And this was what Jugurtha resisted and which led to his downfall.

Before concluding (this section), I wish to go a little further than anybody has ever done. If you like, this is my *floridula*, the little contribution to knowledge, today.

The myth of Jugurtha's bastardy, as shown above, was hinged on the allegation that his mother was of *low* birth!!! He was said to be the son of a concubine. It has been demonstrated above that, in North African society, bastardy did not exist. What then is the true picture? The issue may be examined from three angles: the political (or governmental), the commercial (or trading) and the sociological (or marriage practices).

First, the commercial. It is a long established fact that the peoples of North Africa had, by the fifth century BC, enjoyed trading relations among themselves for a long time. Herodotus (II; IV) showed clearly that caravan routes from Lepcis Magna (Lebda) Sabratha and Oea (Tripoli) ran to the Oases of Aujila, the base of the Nasamonians transhumants and Fezzan, the home of the Garamantes. These peoples were also in contact with Cyrene and, judging by their mobility, with the oasis in which was situated the oracle of Ammon, visited by Alexander the Great in 331/330 BC Ammon was in Western Egypt. The same Nasamonian piloted Phoenician traders from Carthage through the Saharan desert to what is generally accepted to be the River Niger port of Timbuctu in modern Mali or by some to be even Lake Chad (T & F, 1969). It is also known that other groups of Africans conducted trade by caravans running through the valley of wadi Bei el-Chebir via Bu Ngem where the Romans were to build a military fort in AD 202. Another ran from Tunis Tamalleni northward to Lebda and westward south of Lake Djerid to the Oasis of Zibans, Gemellae and from there to Dimidi. From Dimidi it hugged the southern foot of Mt. Warsenis, along the river Nahr Wassel to Tiaret plateau, River Mina, Altava (Lamoriciene), River Siga basin, to River Moulouya (Sallust's Muluccha) and beyond to Volubilis in modern Morocco terminating at Sala (modern Rabat). At various points, the route branched off into the coastal mountains to the north and Saharan Atlas and the desert to the south. By the reign of Jugurtha at the end of the second century BC, the routes had been firmly established and were to provide the Romans the main lines of military forts down to the third century AD when Roman Empire in the Maghrib attained its greatest extent. Jugurtha himself controlled several big cities fortified all over his large kingdom such as Capsa (Gafsa) in the extreme south-east oasis, Vaga (Beja) to the North-west, Cirta (Constantine) further north, Thala in the desert and another on the river Moulouya in the far west to mention a few. These forts served a triple purpose: as trading (market) centres, sites of royal palaces and so seats of provincial administration equipped with treasuries and military bases. They also controlled the various caravan routes mentioned above.

Through these cities and emporia, Jugurtha exercised political and economic control backed by strong monetary system. King Bocchus of what is now northern and eastern Morocco acknowledged the overwhelming influence and popularity of Jugurtha, not only in Jugurtha's Numidia, but also in his (Bocchus')

Moorish kingdom. For, when called upon by the Roman general Sulla to betray Jugurtha, Bocchus asserted that his subjects might revolt because of the popularity of Jugurtha among them.

The mention of Bocchus brings us to the third and last point: marriage ties and kinship group. From time immemorial (a thing which literary and archaeological evidence confirms), the institution of marriage had been used to build kinship groups to reinforce political, economic and military ties. In Classical Greece, among Athens/Corinth/Sicyon, in Rome, between Julius Caesar and Pompey; the Claudian and the Julian families resulting in the Julio-Claudian dynasty of 27 BC -AD 68. Such marriage alliances are evident in the betrothal and marriage of the Carthaginian Sophoniba first to Masinissa, then to Syphax and back to Masinissa. It is clear from the examples cited above that the practice cut across tribal and national boundaries. Bocchus married the daughter of Jugurtha himself. To the hypocritical Romans, who, pretending to be monogamous, but indeed having numerous concubines *that included slaves*, the numerous wives of Africans must also be slaves. And like Roman offspring by slaves, the children of African polygamy must in their eyes be illegitimate and of inferior civic status. This is Roman myth. In fact, the strength and stability of African society, political, economic and military, was greatly enhanced by transnational ties of marriage resulting in interlacing and interlocking networks of kinship groups which the Graeco-Roman imperialist could not see or, if they understood, swept under the carpet to boost their imperial ego and majesty. Wheataker (1994) in his recent study of land exploitation in this geographical area has shown that kinship groups all over the Maghrib were still built on such economic and military considerations during French colonial era and the people remained nomadic.

From all indications, Jugurtha's mother was neither a concubine nor of servile origin. Jugurtha's mother must have been a Gaetulian. The Gaetulians were a warlike transhumant (semi-nomadic) people, of consummate military prowess, at once mobile and guerilla in nature; whom the Roman imperial power found extremely difficult to pin down or subjugate. For to the Gaetulians Jugurtha (and indeed other princes before and after) often retreated in defeat to regroup and fight again. To repeat myself, through commerce, military suzerainty and kinship, Jugurtha exercised far reaching control over the Gaetulians, who, like the Hausa/Fulani across the Savannah belt of West Africa today, grazed their cattle east to west, west to east across ancient Maghrib. Therefore, North Africa in antiquity enjoyed more cohesion and cooperation than has hitherto been allowed. Here lies the strength of Jugurtha, of Tacfarinas, of Firmus and more recently of Ben Bella as well as Ben Keddou of Algerian war of independence.

In sum, concubinage, bastardy, the worthless status of women in polygamy, contradicting reckless abandon with which the African fell in love, the fickleness of the African and his perfidy, all these are myths in history. All have been coloured by prejudice, misunderstanding and the paraphernalia of travellers' tales and must be seen as such.

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NATURAL AND 'UNNATURAL' PRODUCTS: THE FASCINATING SPICE TO LIFE

D. A. Okorie

Department of Chemistry

Introduction

If this lecture had been given over ten years ago, the title would have been completely different and the scope narrower. The intervening years had therefore been used in further consolidating the platform which propelled me to professorship and in reaching out to other areas at a more relaxed pace. It is in consonance with these that I have chosen the broader title; Natural and 'Un-Natural Products': the Fascinating Spice to Life. As a Professor of Organic Chemistry, I would naturally be expected to treat the title from a Chemist's point of view. This I will set out to do.

The *Oxford Universal Dictionary Illustrated* (1969) defines chemistry as "that branch of science which deals with several elemental substances, or forms of matter, of which all bodies are composed; the laws that regulate the combination of these elements in the formation of compound bodies and the phenomena that accompany their exposure to diverse physical conditions". Briefly put, chemistry can be described as that branch of science which is concerned with the composition and properties of substances and the changes which they undergo. Chemistry touches almost every facet of the world that God created and the world that man has made. There is an aspect of chemistry in almost all branches of science. Hence you hear of Biological Chemistry, Medicinal Chemistry, Agricultural Chemistry, to mention just a few. Even in everyday life in Nigeria, chemistry is mentioned. Currently, in Nigeria when a man and a woman agree to move together it is said that their body chemistries agree.

Organic chemistry is the area of chemistry involved with the study of carbon compounds. The carbon atom, because of its peculiar properties, is very unique amongst all the atoms so far known. Carbon atoms can join with one another to

form compounds having long chains or short chains, or numerous rings and then join with other kinds of atoms as well. The increased knowledge of the structures of these organic compounds, as we shall see later, has led to a better life for all of us.

A spice, according to the *New Collins Compact English Dictionary* could be anything that adds flavour, relish, piquancy, “interest etc, for purposes of this discourse, to life. As a verb, the *Oxford Universal Dictionary* defines spice thus: “to season, to affect the character or quality of, by means of some addition or modification”.

Let us now return to the title of this lecture. Natural products are not products that occur freely or combined in nature, like coal which occurs in and around Enugu; crude oil present in the Niger Delta area of Nigeria or even the bitumen deposits in Ondo. These are more aptly referred to as natural resources. Natural products are compounds that can be obtained or extracted from plants, animals or organisms that inhabit the land or waters. A very good and well known example is sugar, which can only be obtained from the appropriate sugar cane or sugar beet. Sugar does not occur as sugar deposits or sugar mines. With the above comparison between say, crude oil and sugar, I believe we now can distinguish between natural products and natural resources. It therefore follows that what is not a natural product, for purposes of this discussion, is an ‘unnatural’ product.

Natural Products from Plants

As mentioned earlier, natural products are extracted from plants, animals or organisms. The discussion will be limited mainly to the products from plants, because of time constraint. Many higher plants produce economically important groups of organic compounds such as oils, dyes, resins, tannins, gums, waxes, flavours, pesticides and pharmaceuticals (Balandrin 1985). These groups of compounds are well known to all of us. They all, in their respective ways, add some value to the quality of life. I will now start with medicinal plants.

Medicinal Plants

Right from the beginning of time, man has relied on plants for the cure of many diseases and treatment of many ailments and for sustenance of life. There are a number of references to this in the *Holy Bible*. In the beginning of creation, God said in Genesis Chapter 1, Verse 29 and I quote:

And look! I have given you the seed bearing plants throughout the earth and all the fruit trees for your food.

In the book of the Prophet Isaiah, Chapter 38 Verse 21, the healing power of the plants was highlighted and I quote:

For Isaiah had told Hezekiah's servants, Make an ointment of figs and spread it over the boil, and he will be well again.

All the quotations are from the Living Bible Version of the *Holy Bible*. There have been stories and myths about how the ancient man came to recognize what plants to use and for what diseases. In some cases, it is believed, it was by trial and error and by observing animals in the field. African folklore has it that as a traditional medical practitioner (herbalist) walks through any forest, especially those around his area, most plants reveal their medicinal uses to him. Whatever might have been the source of information, the important thing is that the knowledge has been passed down in most cases to generations after. The body of knowledge is now fully documented all over the world. Chemists, pharmacognosicists, biologists and other scientists have waded into the field, to attempt to establish scientific bases for the use of these medicinal plants and obtain other scientific information. Many people in Africa, Asia and South America still patronize traditional medicine. The main reason being that the conventional Western type of health care facilities are not enough to meet the health needs of the population in practically every country in those areas, as the few facilities that are available are unevenly distributed. As Professor Salako put it in 1982, in a workshop in this University of Ibadan and I quote:

The short fall between the needs of the population and what can be provided by the hospitals and similar institutions is provided by the traditional healers who therefore occupy a very important place in the health care of West African countries. Apart from traditional healers being the providers of all levels of health care to a large group in the population who just have no alternative, these practitioners are also consulted by people in all walks of life for a variety of other reasons. To some, these healers are practitioners of last resort when all else have failed. There is also a widespread belief in many African cultures that certain diseases cannot be safely handled by Western type of medical institutions.

You might be wondering what an Organic Chemist is doing with these medicinal plants. The medicinal plant chemist and his collaborators are the scientists that work on these medicinal plants in a scientific way, with the following aims:

- (1) to confirm the medicinal uses of the plants by carrying out bio-assays of the crude extracts;
- (2) to isolate, chemically identify and characterize the active principles i.e. the compounds responsible for the reported healing action;
- (3) to, where possible, undertake a synthesis of the isolated active principles with a view to making the compounds more easily available.

It is not possible to discuss in the time allocated, all the ethnomedicinal plants and their bioactive principles. However, attempts will be made to highlight how these secondary metabolites from the plants have assisted the health care delivery system and therefore helped to add spice to life, thus lengthening life

span. The groups that will be dealt with here are anti-malarials, antifungal, antibacterial and anticancer compounds.

Antimalarial Compounds

Malaria being one of the greatest killer diseases in the continents of Africa, Asia and South America, has been very rigorously tackled in these places with the use of medicinal plants, (Oliver-Bever, 1986; Perry 1980; Morton 1981). Recent reports indicate that over 800 plant species from over 200 genera have been documented as being used in folklore for the treatment of malaria in the three continents.

In Nigeria, many plants have been used, either alone or in combination with others, by traditional medicine practitioners and their adherents. Some of the plants are *Picralima nitida* (Apocynaceae); *Carica papaya* (pawpaw) (Caricaceae); *Morinda lucida* (Rubiaceae), *Alchornea cordifolia* (christmas bush, in Sierra Leone) (Euphorbiaceae); *Newbouldia laevis* (Bignoniaceae), *Mangifera indica* (mango) (Anacardiaceae); *Ocimum canum* (Labiatae); *Azadirachta indica* (*dongoyaro*) (Meliaceae); *Cinchona officianilis* (Rubiaceae). *Azadirachta indica* (*dongoyaro*) has been the most investigated in Nigeria for anti-malarial activity (Ekanem 1978; Okpanyi *et al.* 1981; Ade-Serrano 1982). Although the research has confirmed the use of the leaves and stem bark of the plant in traditional medicine for treatment of malaria, the active principle responsible has not been identified.

Cinchona species are well known worldwide for the treatment of malaria in traditional practice. Chemical investigations of extracts from the bark of the tree led to the isolation of the alkaloid quinine (fig. 1a) as an active principle (Schwyzer 1927). Quinine remained for many years, the major anti-malaria drug, but was later on gradually replaced in the 1940s upwards by a series of synthetic drugs, 'unnatural products'. However, the new problem of resistance of certain strains of *Plasmodium falciparum*, the malaria causing parasites, to chloroquine and other unnatural anti-malarial products, has brought back the clamour for quinine and for re-introduction of quinine and other *Cinchona* alkaloids (Annon 1983).

A stereoisomer of quinine, quinidine (fig. 1b) isolated from the *Cinchona* species, was found to be more potent as an antimalarial than quinine (White 1985). Quinidine was however found to have cardiac depressant properties and was therefore dropped as an antimalarial.

One other very exciting development in the field of anti-malaria drugs from local medicinal plants was the result of the chemical characterization of extracts of the medicinal plant, *Qin ghao*, *Artemisia annua* (Compositae) which the Chinese had used for over 2000 years in traditional treatment of malaria. The active principle, Artemisinin (qinghosu) was chemically characterized as the sesquiterpene lactone endoepoxide (fig. 1c) (Liu *et al.* 1979). It has a higher chemotherapeutic index than chloroquine and possesses antimalarial properties against strains of *Plasmodium* which are sensitive or resistant to all the known and available antimalarial drugs (Warhust 1985). Some derivatives of artemisinin, like sodium artesunate (methyl-dihydro artemisinin hemisuccinate)

(fig. 1d) artemether (methyl-dihydro artemisinin) are used clinically for the treatment of cerebral malaria with a cure rate of 90% (Li *et al.* 1982).

The search for antimalarials from medicinal plants will continue as long as malaria parasites continue to be chloroquine resistant. So far the resistance seems to be towards the synthetic drugs, the 'unnatural products'.

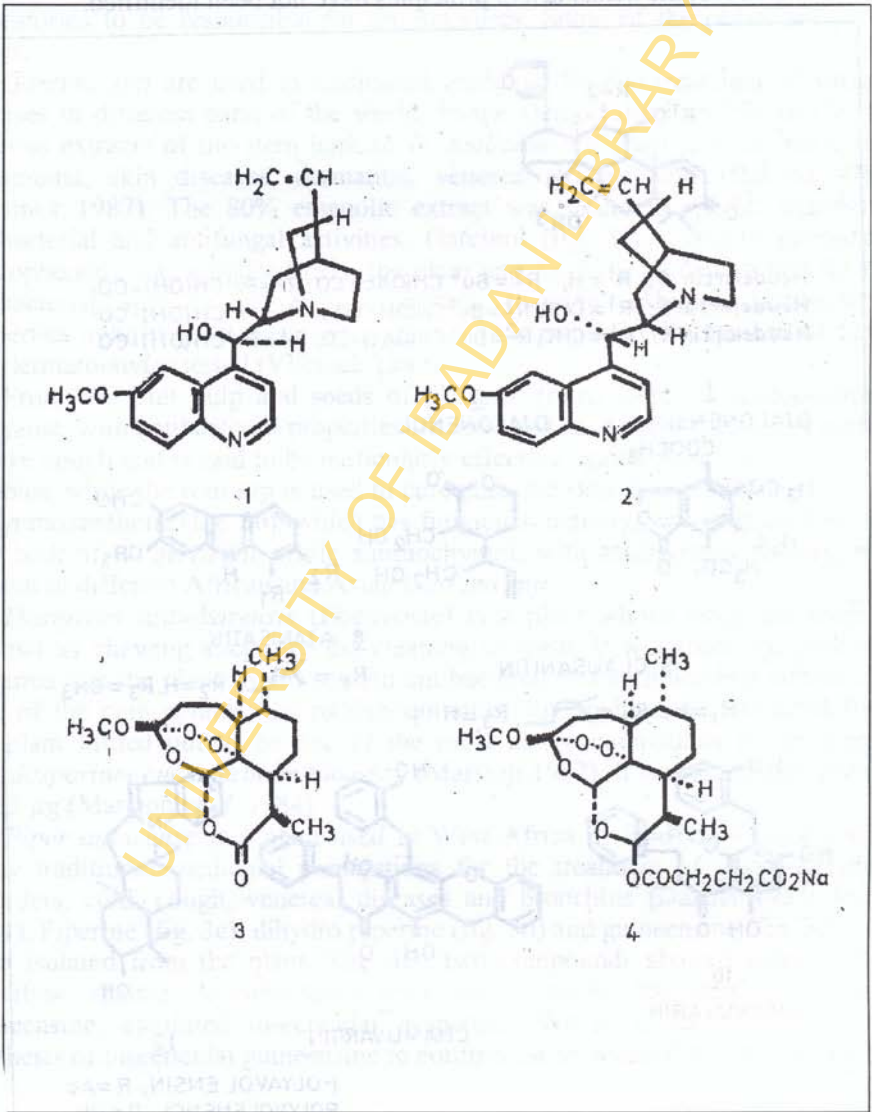


Fig. 1: Antimalarial Compounds

In our laboratories, we had chemically examined some plants which are used traditionally for treating malaria and other fevers (Dalziel 1937; Bep-Olivier 1960). They include *Trichilia heudelottii* (Meliaceae), (Okorie *et al.* 1967, 1968 and 1972); *Anthocleista djalonensis* and *A. vogelli* (Loganiaceae) (Okorie 1976 and Okorie and Onocha 1995); *Uvaria chamae* (Annonaceae) (Okorie 1977) and *Polvathia suaveolens* (Annonaceae) (Okorie 1980 and 1981). Although many new compounds' structures (figs. 2a-h) and some known ones have been isolated and characterized, the actual active principles have not been identified.

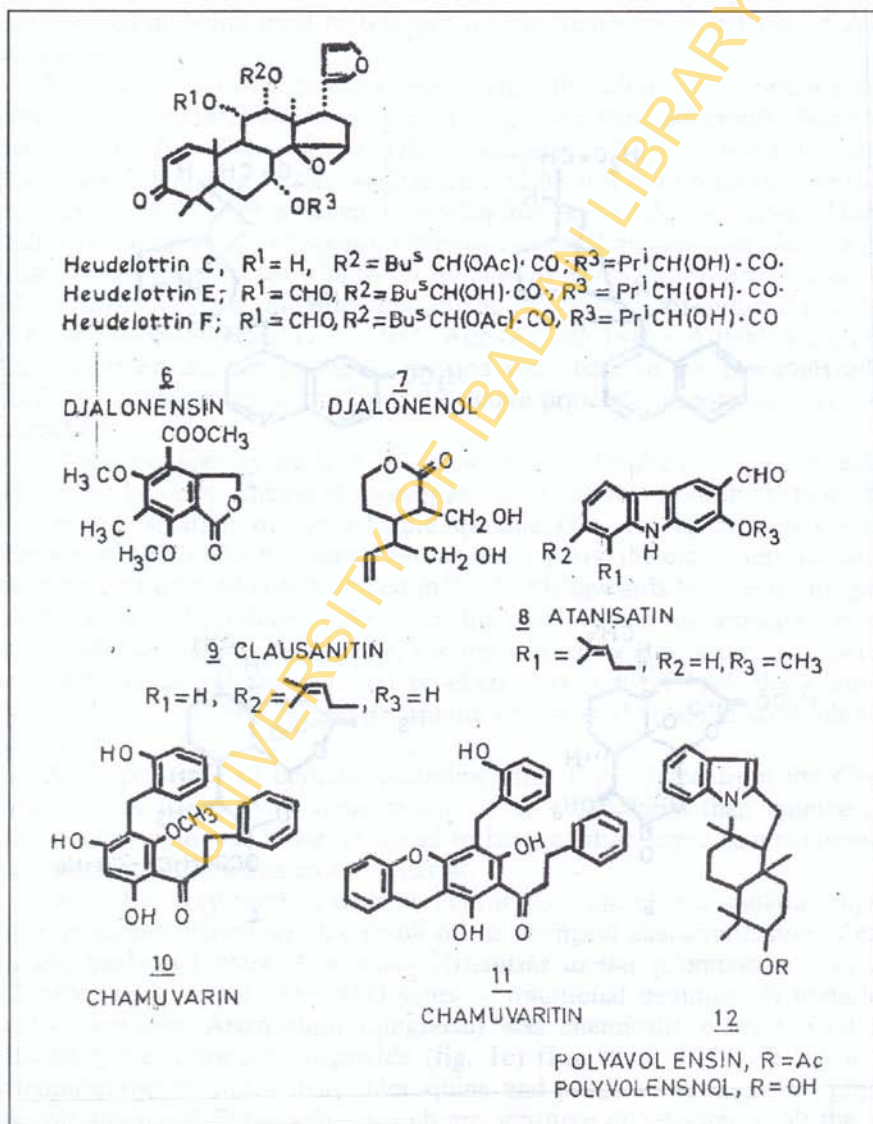


Fig. 2: New Characterized Compounds

Antifungal and Antibacterial Compounds

A number of plants have been used in traditional medicine in tropical Africa for the treatment of skin disorders, gastro intestinal diseases such as dysentery and those caused by worms, respiratory tract infections like bronchitis and the ailment generally referred to as cough. In most of the cases, the traditional medicine practitioners have claimed success. Correspondingly, the active ingredients in these plants have been extracted and have been shown in the laboratories to be responsible for the activities. Some of the plants are given below.

Garcinia spp are used in traditional medicine for the treatment of various diseases in different parts of the world. In the Democratic Republic of Congo, aqueous extracts of the stem bark of *G. huillensis* are used to treat bronchitis, pneumonia, skin diseases, dermatitis, venereal diseases etc. (Bakana 1984, Vlietinck 1987). The 80% ethanolic extract was found to exhibit significant antibacterial and antifungal activities. Garcinol (fig. 3a), a highly prenylated benzophenone was extracted from the plant and found to be responsible for the antibacterial and anti-microbial properties. Garcinol exhibited antibacterial properties against gram-positive cocci and antifungal activity against all fungi and dermatophytes tested (Vlietinck 1987).

From the fruit pulp and seeds of *G. kola*, (bitter kola), a benzophenone, kolanone, with antibacterial properties was isolated. *G. kola* is used to prevent or relieve cough and is said to be particularly effective against bronchitis and throat troubles, while the root sap is used to cure parasitic skin diseases (Dalziel 1937). A pyranoxanthone (fig. 3b), which has fungicidal activity, was isolated from the root bark of *G. gerrardii*, while xanthochymol, with antibacterial activity, was present in different African and Asian *Garcinia spp*.

Disopyros usambarensis (Ebenaceae) is a plant whose twigs are used in Malawi as chewing sticks for the cleaning of teeth. It was therefore generally assumed that the plant would contain antibacterial and antimicrobial substances. One of the compounds, the naphthoquinone, 7-methyljuglone, extracted from the plant turned out to be one of the most active compounds in the fungus *Cladosporium cucumerinum* bioassay (Marston 1987). It was antifungal even at 0.025 µg (Marston *et al.* 1984).

Piper auineense is a plant used in West Africa in foods as a spice and in many traditional medicinal preparations for the treatment of gastro-intestinal disorders, cold, cough, venereal diseases and bronchitis (Dalziel 1937; Irvine 1961). Piperine (fig. 3c); dihydro piperine (fig. 3d) and guineensine (fig. 3e) have been isolated from the plant. The first two compounds showed antimicrobial activities against *Mycobacterium smegmatis*, while the third compound, guineensine, exhibited insecticidal properties. We have carried out a total synthesis of insecticidal guineensine to confirm the structure (Okorie *et al.* 1979).

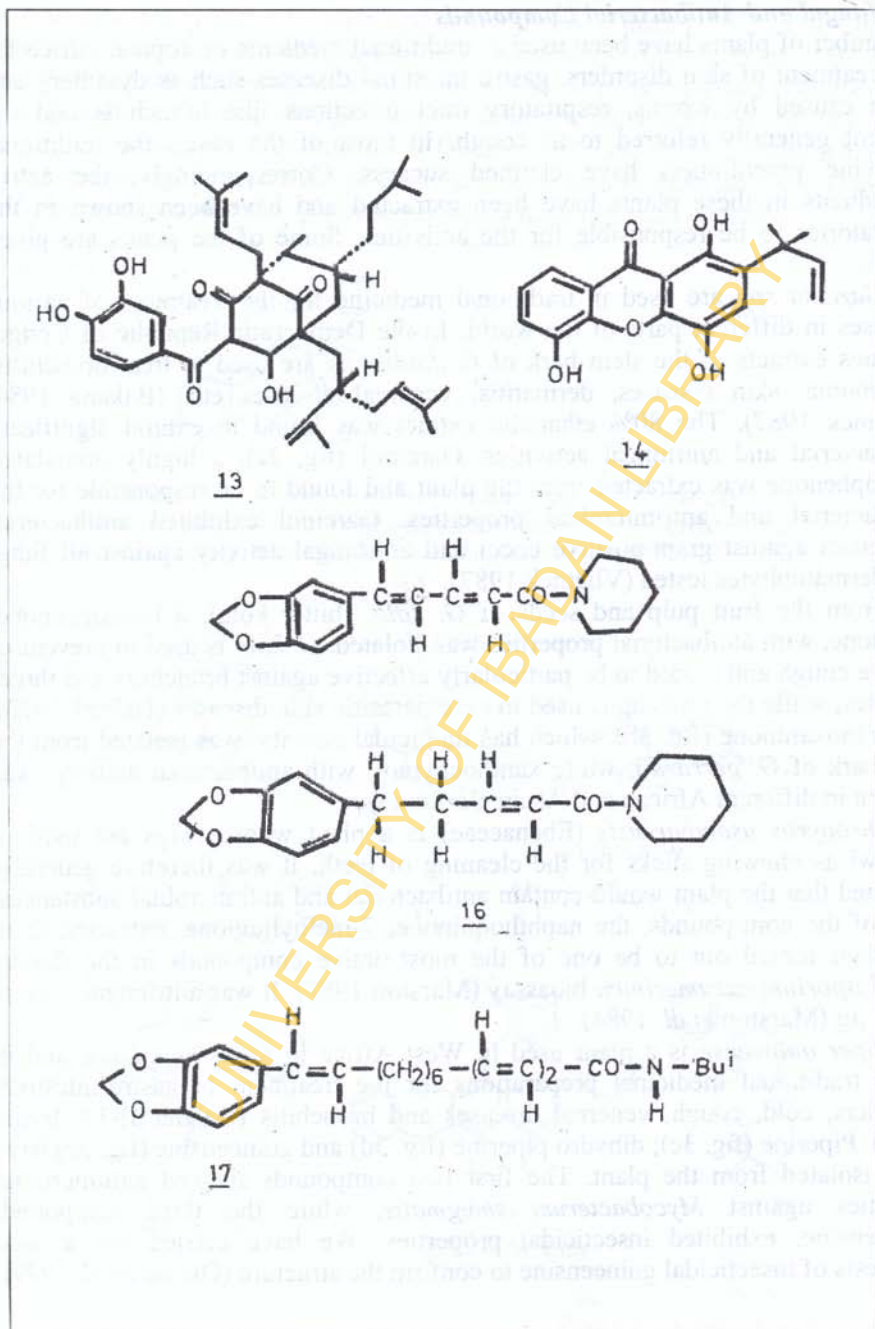


Fig. 3: Antifungal and Antibacterial Compounds

Berlina grandiflora (Leguminosae) is a medicinal plant whose bark and leaves are used for treating intestinal problems and as a purgative amongst others in Congo Brazaville (Asuzu 1993). In Enugu State, Nigeria, it is used in combination with another plant *Piliostigma thonningii* for treating intestinal worms (Asuzu 1994). One of my former students, now Dr. Nkechi Enwerem, in her Ph.D work carried out a phytochemical and anthelmintic activity investigation of the plant. She confirmed that the extracts of the stem bark demonstrated significant anthelmintic activity in the *in vivo* and *in vitro* studies. The active compound was identified as betulinic acid (fig. 4a). She went further to show that other fractions had anti fungal and antibacterial activities. The compounds responsible for the activities were found to be Lupeol (fig. 4b) and Apigenin (fig. 4c) respectively (Enwerem 1999).

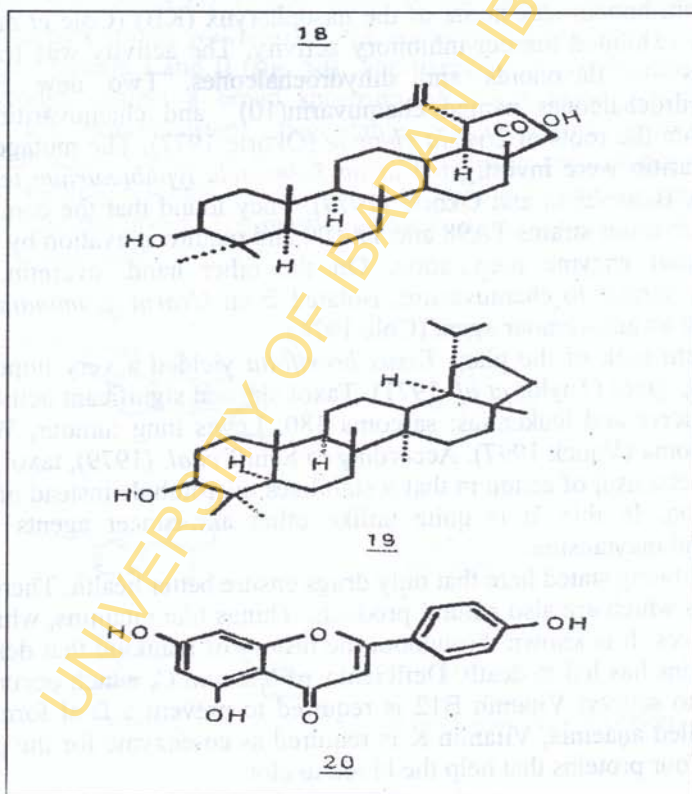


Fig. 4: Anthelmintic Compounds

Uvaria chamae (Annonacea). The ethanolic extracts of *U. chamae* demonstrated inhibitory activity against *Staphylococcus aureus*, *Bacillus subtilis* and *Mycobacterium smegmatis* when tested for antimicrobial activity. The major oil obtained from extraction of the roots, is benzyl benzoate (Okorie 1977). It is used in the treatment of scabies as an acaricide.

We have also examined a number of medicinal plants which are used for the treatment of dysentery amongst other diseases, from which we isolated and completely characterized some new compounds. The plants include *Clausena anisata* (Rutaceae) (Okorie 1975), *Uvaria chamae* (Annonaceae) (Okorie 1977), *Myrianthus arboreus* (Urticeae) (Okorie *et al.* 1984b) and *Schumanniohytum magnificum* (Okorie *et al.* 1983).

Anti-Cancer Compounds

Uvaria spp are medicinal plants used for the treatment of various ailments in traditional medicine. The roots of *Uvaria chamae* are used for the cure of fever, severe abdominal pains and as a purgative. The crude ethanol extracts of the stem bark of *Uvaria chamae* and the roots of *Uvaria acuminata* were found to show activity *in vivo* against p-388 leukemia in the mouse and *in vitro* against cells derived from human carcinoma of the nasopharynx (KB) (Cole *et al.* 1976). In short, they exhibited tumour-inhibitory activity. The activity was traced to the compounds — flavonoids and dihydrochalcones. Two new compounds, benzyldihydrochalcones named chamuvarin(10) and chamuvaritin(11) were isolated from the roots of *Uvaria chamae* (Okorie 1977). The mutagenic effects of chamuvaritin were investigated using *Salmonella typhimurium* tester strains by Uwaifo, Bababunmi and Okorie (1979). They found that the compound was mutagenic in tester strains TA98 and TA100 and require activation by the hepatic S-9 micromal enzyme preparation. On the other hand, uvaretin, which is structurally similar to chamuvaritin, isolated from *Uvaria acuminata*, has been shown to be an anti-tumour agent (Cole 1976).

The stem bark of the plant *Taxus brevifolia* yielded a very important anti-cancer drug, taxol (Taylor *et al.* 1971). Taxol showed significant activity against various cancers and leukemias; sarcoma 180, Lewis lung tumour, Walker 256 carcinosarcoma (Vanek 1997). According to Schiff *et al.* (1979), taxol has a very unusual mechanism of action in that it stabilizes microtubule instead of inhibiting its formation. In this, it is quite unlike other anti-cancer agents like vinca alkaloids and maytansine.

It is not being stated here that only drugs ensure better health. There are other contributors which are also natural products. Things like vitamins, which help to spice our lives. It is known throughout the history of mankind that deficiency of some vitamins has led to death. Deficiency of Vitamin C, which occurs in citrus fruit leads to scurvy; Vitamin B12 is required to prevent a fatal form of blood disorder called anaemia, Vitamin K is required as co-enzyme for the production of three or four proteins that help the blood to clot.

Agrochemicals from Plants

Improvement of methods of combating diseases has meant longer life for all of us. With increasing world population and decreasing arable land, starvation and severe malnourishment will be the natural end result. In Africa, where the population has been growing at an alarming rate, the food supply has to be increased for us to survive. To increase world food supply, there must be improvements in food production and methods of food preservation amongst

other factors. Food production can be increased also by adopting new methods of farming and by growing hybrid crops.

Pesticides

The food that is produced is depleted by our other neighbours and in some cases, co-tenants, the pests. These pests affect not only crops and stored grains but also transmit or harbour the organisms that cause dreadful diseases in man and livestock.

There are a number of insecticides of plant origin. The three well known plants that yield insecticidal compounds are Tobacco, Berries and Chrysanthemum. From tobacco leaves, the class of insecticides known as nicotinoids was extracted, the active ingredient being nicotine (fig. 5(a)). The rotenoids were found in the roots of leguminous plants, the active ingredient is rotenone (fig. 5(b)). From the flower heads of the genus Chrysanthemum, the class known as pyrethroids was isolated, the active ingredients are pyrethrin I and II (fig. 5c) and cinerin I and II (fig. 5d). The pyrethroids are the most active of the three groups against a broad spectrum of insect pests. All the natural insecticides are non-persistent, degradable and therefore environmentally friendly. Their short lifetime in the environment greatly reduces the probability of insects developing resistance to them by minimizing the contact time between the chemical and the insect. The main drawback of using natural insecticides is their relatively high cost.

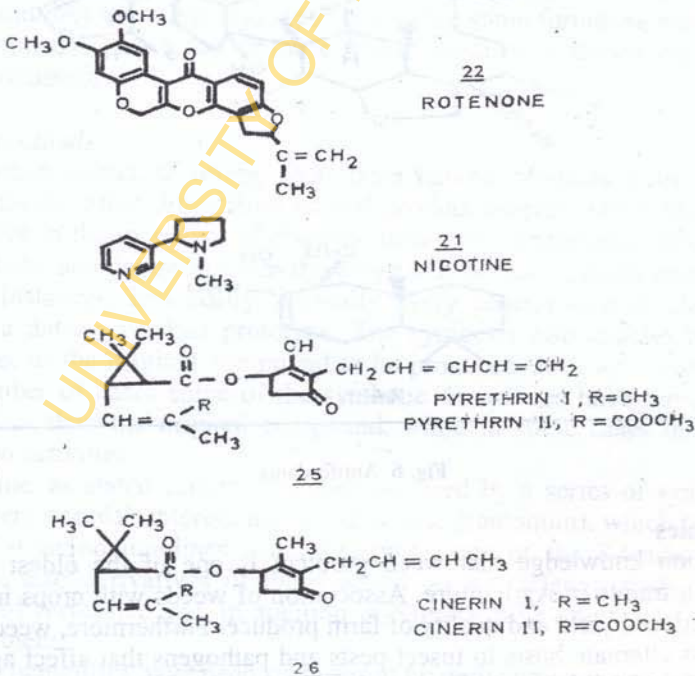


Fig. 5: Natural Organic Pesticides

As was mentioned earlier under medicinal plants, we had in our laboratories carried out a total synthesis of one of the compounds, guineensine(17) responsible for the insecticidal properties of *Piper guineensis* (Okorie *et al.* 1979).

Antifeedants

Plants usually manufacture and store a number of chemical substances which they use to defend themselves against insects, bacteria, fungi and viruses. One such group of defence chemicals interferes with feeding and the members are known as antifeedants. The most potent antifeedant so far isolated is azadirachtin (fig. 6a) from the seed of neem tree, *Azadirachta indica*. It is said that only $2\text{ng}/\text{cm}^2$ ($2 \times 10^{-9}\text{g}/\text{cm}^2$) is enough to stop the desert locust from eating (Pimentel *et al.* 1987).

Another notable antifeedant is warbuganal (fig. 6b) which, with two others, polygodial and ugandensidiol, occurs in the bark of the plants *Warburgial stuhlmanii* and *W. ugandensis* which are used in folk medicine and as spices in East Africa (Kubo 1976). Warbuganal is particularly very active against army worms *Spodoptera littoralis* and *S.exempta*.

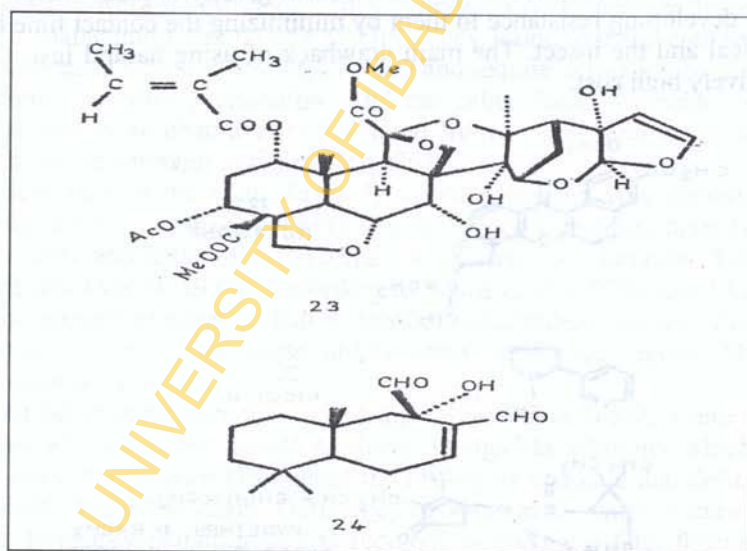


Fig. 6: Antifeedants

Allelochemicals

It is common knowledge that weed problem is one of the oldest and most difficult constraints in Agriculture. Association of weeds with crops in the field results in reduced yield and quality of farm produce. Furthermore, weeds harbour and serve as alternate hosts to insect pests and pathogens that affect agricultural produce. One of the three mechanisms by which plants interfere with each other

is allelopathy. Allelopathy is a biochemical interaction among plants. It involves the production and release of chemicals known as allelochemicals by living or decaying plant tissues (or donor plant) which interfere with the growth of a neighbouring or receptive plant. One of the former students of Professor Fawusi of Department of Agronomy and myself, now a Senior Lecturer in the Department of Agronomy, University of Ibadan, Dr. Hassan Tijani-Eniola, looked at this problem of allelopathy. In his Ph.D work, he studied allelochemicals from six of the worst weeds in arable crop production in Nigeria viz: *Euphorbia heterophylla* (wild poinsettia); *Chromolaena odorata* (siam weed), *Imperata cylindrica* (speargrass), *Cyperus tuberosus*. L. (nutsedge) and *Rottboellia coinchinchinensis* (itch grass) and their roles on crop growth and development. The following crops were used: *Lycopersicon esculentum* (tomato); *Capsicon frutescens* (pepper); *Zea mays* (maize) and *Vigna unguiculata* (cowpea). He not only found that the root and shoot extracts of most of these weeds significantly inhibited the seed germination and development of the crops to different extents, he was also able to isolate the compounds with the observed phytotoxic effects on tomato from siam weed. The compounds were identified by spectroscopic means to be a trimethoxy cinnamic acid and its isomer (Tijani-Eniola 1987).

'Unnatural Products'

The 'unnatural products' had earlier been defined as those products which cannot be obtained or extracted from plants, animals or organisms. There are very many of them and they are of various types. Using the same format as was adopted for natural products, only a few of those which constitute a fascinating spice to life will be discussed.

Pharmaceuticals

The common source of drugs, apart from natural products is by synthesis or semi-synthesis. Most drugs from natural product sources which have proved to be effective in the treatment of diseases, have been synthesized, where possible. The synthetic source ensures that the drugs will be more readily available and in a lot of instances, less costly. Virtually every pharmacological class of drugs includes a natural product prototype. The synthesis also enables a number of derivatives of the original compound to be produced. It is well known that in a large number of cases some of the synthetic derivatives have turned out to be more potent than the original compound, while in some cases the derivatives showed no activities.

Quinine, as stated earlier, had been replaced by a series of synthetic drugs like the very popular chloroquine, amodiaquine (camoquin), which belong to the group of 4-aminoquinolines and primaquine, one of the 8-amino quinolines. There are also derivatives of these which go by different trade names. The problem of resistance and, in addition in Nigeria, fake drugs, has led to multi-drug treatment.

Many penicillins have been synthesized by derivatizing the original penicillin thereby making available many more antibiotics. One of the problems plaguing antibiotic research is that of bacterial resistance. This has led to attempts to

synthesize new structural types. There is no doubt at all that antibiotic research has had a major impact in decreasing disease in both humans and animals.

There is hardly any known disease whose treatment has not been tackled with synthetic drugs. Even in those areas where medical scientists have not recorded complete success, synthetic drugs have not been lacking.

Agriculture

The 'unnatural' products input into agriculture that helps to increase food production includes synthetic pesticides, fertilizers, plant nutrients and plant growth regulators. The subgroups of pesticides which are directly linked to improve food production, food preservation and to the control of insect-transmitted diseases in humans and livestock are insecticides, herbicides and fungicides. Many of these have been synthesized. Insecticides constitute seventy five percent of all pesticides imported into Nigeria, while synthetic organic insecticides form about ninety percent of insecticides in use in Nigeria as at 1990 (Okorie, 1990). Synthetic insecticides include organo chlorines e.g. DDT, organophosphorous and carbamates. The most potent ones are those that are modelled on insecticides of natural products origin such as rotenoids and pyrethroids. They act on the nervous systems of insects. Herbicides work to control weed pests. A very useful and important group are the phenoxy compounds e.g. 2,4-dichlorophenoxyacetic acid (2,4-D). Fungicides are used to control plant diseases. Quite a number of inorganics, especially copper compounds, are herbicides. Some organic herbicides have been synthesized and are in use. Also plant growth regulators, patterned after the natural ones, have been made. As their name implies, they are chemical compounds which in small concentrations regulate the size, shape and appearance of plants.

In an attempt to understand how herbicides behave in relation to the weeds they are supposed to control and the food crops they are expected to protect a study was carried out. One of the post graduate students of Dr. Akobundu formerly of IITA, Ibadan and Okorie, now Dr. Ngozi Onyia, studied the movement and persistence of Imazapyr, a well known herbicide, in soils of the moist savannah agroecological zone in Nigeria in relation to the control of the weed, *Imperata cylindrical* L. (spear grass). This weed is an extremely aggressive perennial grass which constitutes a very serious problem to all tropical crops grown in the savannah agro-ecological zone. It is ranked as the seventh worst weed in the world (Holm *et al.* 1977). The crop chosen for the study was rice and the presence of the herbicide imazapyr was assessed by a bioassay technique. The results showed that imazapyr, at the recommended field rate, persisted in the soil only for 8 weeks after treatment. This implies that crops sensitive to it can be safely grown if they are planted at least 8 weeks after imazapyr has been applied (Onyia 1999).

Food additives

There are a number of chemical substances, most of them synthetic products, which are added to foods especially processed foods in very small quantities. They are known as food additives and can be generally divided into groups: the

preservatives, which will be dealt with later, and the others that are used to improve the appearance, texture and flavour of food. Most of these chemical substances add little or no nutritive value to the foods, but some are used as dietary supplements. The flavourings help to stimulate our taste buds and our sense of smell and therefore enhance the pleasures of eating. Examples include the controversial monosodium glutamate (MSG), vanillin and geraniol. The colourings render the food more attractive to the eye. Artificial sweeteners are added to food to make the bland and tasteless ones, more palatable e.g. glycerol, saccharin and sodium cyclamate. Chemical food preservatives are added to keep the foods from getting bad. Such compounds include sodium benzoate, lactic acid, calcium sorbate etc.

Polymers: Plastics, Fibers and Rubbers

The discussion will now shift to a series of materials, all 'unnatural products' from the chemists laboratories, which have contributed in no small way to spice our lives and every day living in a fascinating way. The repeated combination of small organic molecules of relatively low mass to form very large molecules of relatively high mass is known as *polymerization*. The products of the process are called polymers. The particular structural unit can be repeated thousands of times to form polymers which may be long chain or sometimes a complex network with cross linkages. Some notable polymers which occur in nature are starch and cellulose, but only synthetic ones will be discussed. The more important synthetic polymeric materials which we encounter in every day life are plastics, fibers and synthetic rubbers.

Let us now, for the first and only time, discuss a little chemistry — polymer chemistry for that matter. Most of the polymers that are commercially important are *addition polymers* formed from one unsaturated starting compound called a *monomer*. For example, when the gas, ethylene, C_2H_4 , which has a double bond is used as the monomer and polymerized, the double bond vanishes, new single bonds are formed between adjacent molecules to form polyethylene. The polymerization involves free radical mechanism using an organic peroxide or traces of oxygen as catalyst, or using the Ziegler process. The $-CH_2-CH_2-$ is the repeating unit and could have been repeated thousands of times. Polyethylene is flexible, begins to soften at $80^\circ C$, melts near $115^\circ C$, and it is a very good electrical insulator.

Polyethylene is the basis for many plastics having a wide variety of uses. Such plastics are used as packaging films and sheets, containers, coatings, toys, waste paper baskets, bags, house wares etc. Other important addition polymers include polyvinyl chloride (PVC) used in making pipes, raincoats; and polystyrene, used in foams and synthetic rubbers (see figs. 7a-e).

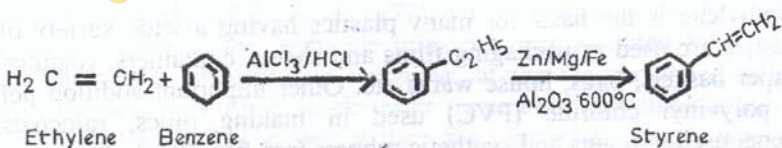
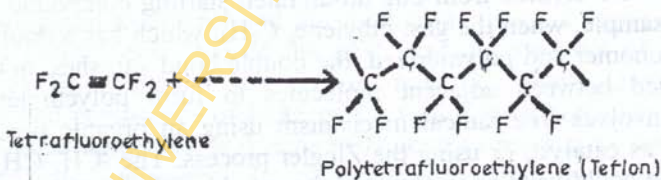
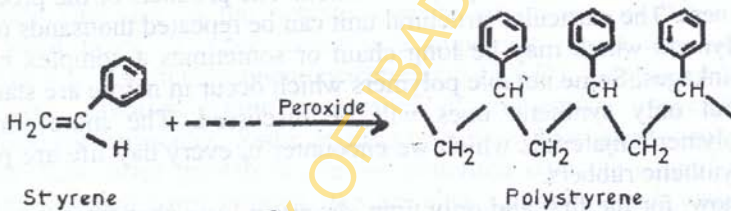
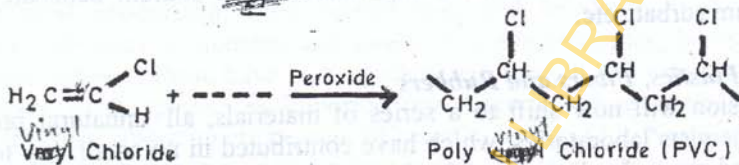
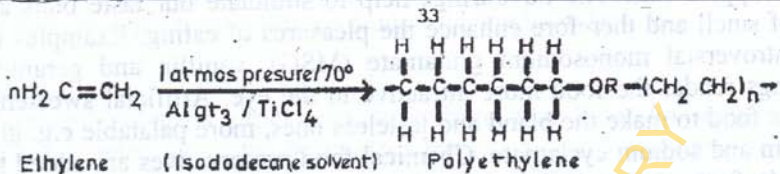


Fig. 7: Polymerization (by addition) Reactions

Apart from addition polymerization, polymers of a different type can be obtained by a condensation reaction. In a condensation reaction, two molecules are joined together and another smaller molecule, usually water, is eliminated. For example, methanol CH_3OH reacts with ethanoic acid (acetic acid) to form the ester, methylethanoate (methylacetate).

Condensation of a molecule containing two amino groups (diamine) with a molecule possessing two carboxylic acid groups (di-acids) gives an amide polymer, polyamide, commonly called nylon. For example, the dibasic acid, adipic acid condenses with the diamine, hexamethylene diamine to form nylon 66.

Nylons are used mainly as synthetic fibers to make such materials as nylon clothing, stockings and parachutes, They have a very high tensile strength, are tough, flexible and resistant to abrasion.

If the condensation reaction is between a dicarboxylic acid and a dihydroxy compound (diol), the product is a polymer, polyester. A very popular polyester, commonly called Dacron, is formed from terephthalic acid and glycol. The fiber; Dacron, possesses the characteristics needed in wash and wear fabrics, like low moisture absorption and being crease-resistant.

To complete the tripod of the materials from polymers, we will now briefly talk about synthetic rubbers. Natural rubber is formed by the polymerization of cis-isoprene, (2-methyl-1, 3-butadiene). The compound that has proved most useful in the preparation of synthetic rubber is 1,3-butadiene, Others are isobutylene, chloroprene, acrylonitrile (see figs 8a-d).

Styrene-butadiene rubbers (SBRs) formed by co-poly-merization of styrene and butadiene, are the most common general purpose rubbers, Butyl rubber, formed by polymerizing isobutylene, is used for making the inner tubes of tyres and for the linings of tubeless tyres,

Environment

Having discussed 'the unnatural products' like drugs, food additives and polymers from which it is possible to make many kinds of materials with different properties for different purposes, all of which contribute to making life a bit more pleasurable, it is only fair and proper to look at our environment. The state of the environment in which we live, work and operate in, also adds quality or, if you prefer, spices our life. By the environment, we mean our surroundings, air, land and water. If the rivers are polluted, there is the risk of an outbreak of waterborne diseases, apart from the effect of such pollution on the aquatic life that supplies us our fishes etc. To monitor the environment is a multi-disciplinary affair. Chemists have a very important role of helping to analyse the pollutants in the air, in the soil, on surface water and ground water. To do this job, the chemists will need chemicals and reagents as well as some equipments. The chemicals, reagents, solvents and indicators used whether organic or inorganic, are synthetic compounds and, therefore, are unnatural products. For a better understanding of environmental pollution, let us discuss water pollution.

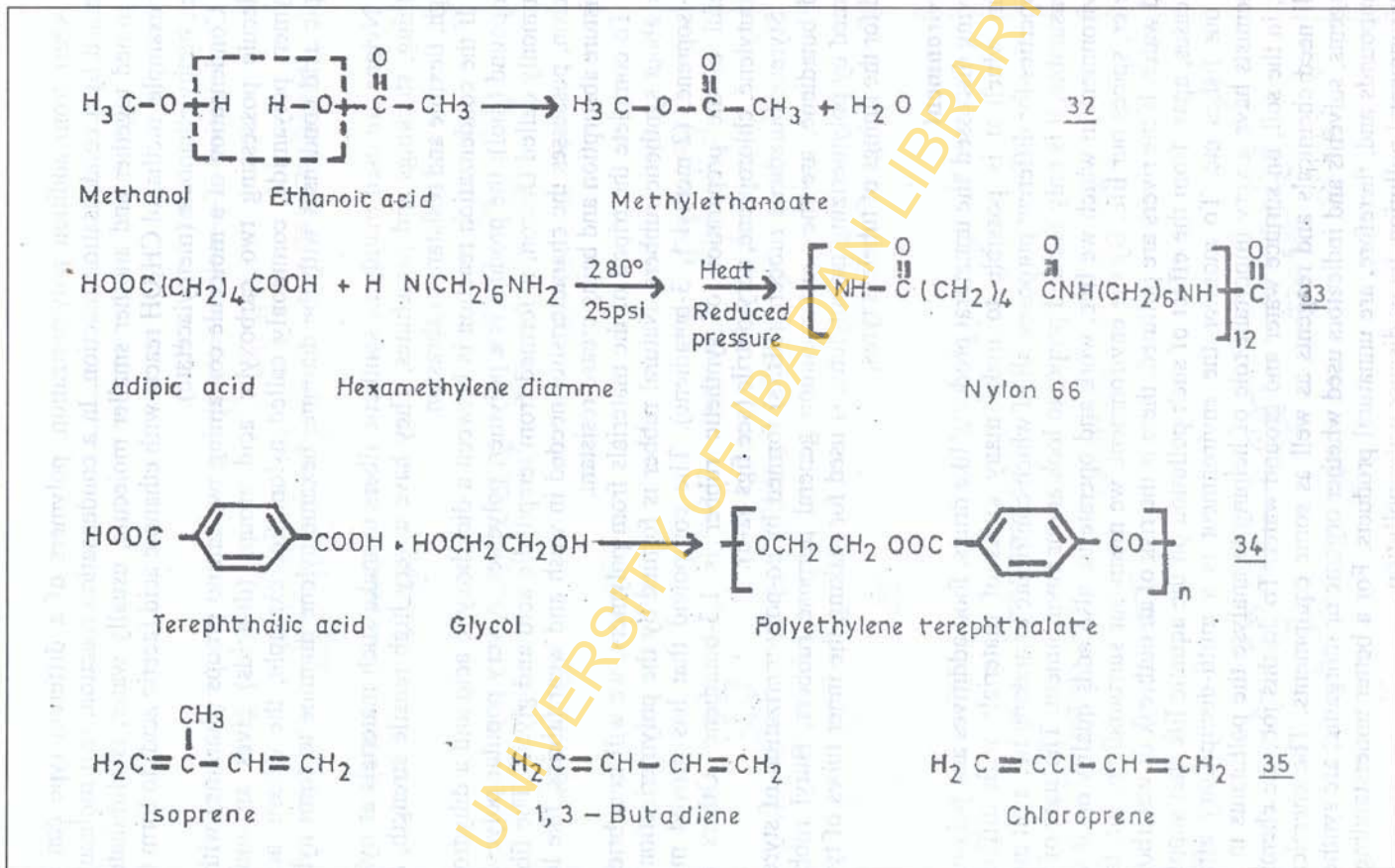


Fig. 8: Polymerization (by condensation) Reactions

Water pollution has been deliberately chosen for several reasons. Part of my state of origin belongs to the geographical Niger Delta while the whole state is in the political Niger Delta. The whole of the Niger Delta has many more waterways than highways. Most of the environmental work I have done, or I have been involved in, is in the Niger Delta area or on water. Water pollution is perhaps the most complex and difficult type of environmental pollution to understand and deal with (Dobbs 1976), because a very large number of different sources and pollutants exist. Moreover, water pollution is an international problem, since water has no boundaries. Water pollution may be described as the addition of some substances or materials or the alteration of some physical, chemical or biological properties of water which permanently or temporarily renders that water less suitable for the particular purpose for which it is intended viz: industrial, domestic, municipal, agricultural or recreational purposes. The water quality standards for these various activities differ.

Natural water has as dissolved impurities, mainly the cation salts of three metals - calcium, magnesium and sodium. There are also trace amounts of iron and manganese and at times a good quantity of potassium salts. The three anions present are bicarbonate, sulphate and chloride. Other natural contaminants of water include silica (sand, SO_2) and alumina, Al_2O_3 , which are constituents of clay and some amount of nitrates. There are also contaminants from industrial and municipal wastes, where there are waterways close to such establishments. Industries use water to dispose of waste products of processing. The indiscriminate use of waterways as dumping grounds has led to intolerable levels of pollution, thereby upsetting the delicate balance among insects, plants and fish and posing problems regarding quality of water for human consumption. While talking about surface water, let us not forget ground water on which many communities depend for their domestic water supply. Underground water can be very badly polluted by seepage of pollutants into the aquifer with time.

In monitoring water pollution, chemists and other relevant scientists measure some internationally accepted parameters such as pH, turbidity, total dissolved solids (TDS); total suspended solids (TSS), BOD, COD, dissolved oxygen (DO), Nitrates (NO_3^-), Phosphate (SO_4^{2-}), total organic carbon (TOC), oil and grease, heavy metals like Hg, Pb, total coliform, hydrocarbon utilizing bacteria (HUB) and fungi (HUF), total heterotrophs etc.). The results are compared with standards laid down by Ministry of Environment, Department of Petroleum Resources (DPR) and World Health Organization (WHO) for the particular use the water is to be put to.

In our laboratories, a few postgraduate students have looked at some of these water pollution parameters. Asuquo (1986) studied the levels of phosphates in Awba Dam river, which is still one of the main sources of water supply for domestic purposes in this University of Ibadan. The results of the analysis of Awba Dam water for inorganic and organic phosphates over a six-month period showed that the concentrations were comparatively low (Okorie and Asuquo 1987). There should really be little or no phosphates in natural water. Most of the phosphates in water come from household detergents, for detergent manufacturers use phosphates as builders. Other contributors to water pollution

due to phosphates are domestic wastes, agricultural and industrial effluents. Phosphorous and nitrates fertilize the growth of algae and aquatic weeds in freshwater rivers. These then develop in large quantities because of the surplus phosphates and nitrates. When these algae die and decay, they use up a lot of the dissolved oxygen in the water and the process of eutrophication sets in and aquatic life is endangered. However, it is known for now that phosphate toxicity to humans is low.

I believe that it is only proper for me, before I end this brief discourse on the environment, to alert all industrialists and would-be industrialists in our midst today, that there are laws and regulations enacted by the Federal Government, governing environmental issues. The regulatory agencies are the former Federal Environmental Protection Agency (FEPA), now Ministry of the Environment, and in matters of oil and gas, the Department of Petroleum Resources (DPR) in collaboration with the Ministry of Environment. One of the most important laws is FEPA, EIA Decree No. 86 of 1992, which makes it mandatory for any person or companies wishing to establish any type of business or embark on certain projects in Nigeria to carry out an Environmental Impact Assessment, (EIA), and obtain the go-ahead from the Ministry of Environment and/or DPR before starting the projects. The purpose of the EIA is primarily to identify, quantify and qualify, the potential impacts of the proposed activities. The environmental assessment is to cover the activities connected with or envisaged in the project, from the site preparation, through the construction stage, to the abandonment or de-commissioning stage. The EIA will therefore enable planning, modifying, designing and adoption of appropriate mitigation measures. The scope of a full EIA includes the following: Biodiversity assessment; Health risk assessment, Community and Socio-economic study, air quality assessment, water quality assessment (surface and underground), Soil assessment, Land use pattern, Vegetation study, Waste and Environmental management.

I have for many years now been involved in EIA, as a member or project leader of multi-disciplinary teams acting as consultants to Environmental Study Companies who won contracts from oil companies. In all the EIA projects undertaken, the environmental scoping and terms of reference were set out by the oil companies or others who owned the projects.

I had the privilege of looking at the EIA from the opposite side. This was for a period of nearly one and a half years as a member of staff of the Environmental Affairs Department of Shell Petroleum Development Company of Nigeria (SPDC-East) based in Port Harcourt. In this job, I had between seven and twelve EIA projects to supervise at any particular time. The projects ranged from road construction, through field development projects (FDP) involving either upgrading of existing facilities to brand new FDPs. About four of the projects were inherited while the others were new. For the new projects, you, as the supervisor have to prepare all the technical details, including the scoping, the Terms of Reference (TOR) and the environmental parameters to be covered. All these were packaged for the Contract Department to award the contract to an environmental study company. After the award of the contract, it became your responsibility to supervise the project, interact with the contractors and all their

consultants, the regulatory agencies, the Line Departments that owned the projects and your own head of department. The EIA remained your baby until the report was submitted and approved by the Ministry of Environment or DPR. I was able to successfully deliver some of the EIA reports by the time I had to return to the University.

Summary and Recommendations

In this short lecture, we have looked at how Natural Products Chemistry has revealed, and is continuing to reveal, that out there in our environment, there is a forest full of drugs which could be useful in improving the quality of life by fighting diseases ranging from malaria to cancer. The synthetic drugs, which I have termed 'unnatural' products, have helped to further prolong our life span. We have also looked at the ongoing race between increasing population and decreasing food supply. Since man must win this race, we saw how natural products, which are pesticides, antifeedants and allelochemicals, have all been put on deck. Their synthetic analogues, have played prominent roles in improving the quality of life through increased food production and nourishment. Furthermore, since a healthy environment is of utmost importance in spicing this life, we noted the important contributions of synthetic products in this regard. We also talked about polymers, another set of unnatural products, whose over-riding presence is in the things we use, wear, sit upon, ride in, eat from and otherwise find in our every day environment. All these things constitute spices to our lives in fascinating ways.

It is customary at inaugural lectures like this, to make some recommendations and call on the Government to do this or set up that. My observation, which is a sad one, is that the Government has not responded positively to any such calls or recommendations. I will therefore not waste your time by making such fruitless calls. All I can ask for is the proper funding of the Universities, so that, natural products chemists and other scientists can play their part in the struggle to uplift the economic fortunes of this country Nigeria. Let the Governments stop paying lip service to science and technology. It is a well known fact, all over the world, that science and technology have direct impacts on society which do not translate directly into economic growth.

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FROM WOMB TO TOMB: PROTECTING THE GATE FROM THE CRAB

I.F. Adewole

Department of Obstetrics and Gynaecology

Introduction

I felt highly honoured to stand before you today to deliver the 4th in the series of inaugural lectures for the 2000/2001 academic session from the Faculty of Clinical Sciences and Dentistry in the College of Medicine of our great University. This is the second inaugural lecture from the Department of Obstetrics and Gynaecology in twenty years. Professor O.A.Ladipo, a fine gentleman and an internationally acclaimed Reproductive Health specialist, delivered the last lecture in 1981. The title of his lecture was REPRODUCTIVE FAILURE. I give gratitude to God who made it possible for me to be an active participant at this 'celebration and swearing-in ceremony' as a Professor of Obstetrics and Gynaecology.

History of Obstetrics and Gynaecology

The speciality of Obstetrics and Gynaecology is an ancient one whose development possibly started in the Indus valley where civilization was flourishing about 5,000 years ago. Jacques von Siebold pointed out that the origin of Obstetrics differs from that of Medicine or Gynaecology. Gynaecology deals with abnormality. It is the scientific study and treatment of diseases of the female genital tract. In present day use, we have enlarged our speciality to embrace disorders of women. Obstetrics started as midwifery and is as old as humanity. It is derived from the Latin word *obstare*, which is translated to mean I stand by or *opstare*, meaning to render aid and *obstetrix*, meaning the woman who stands by. We do more than this. We not only stand beside our women, we also stand in front and behind them. Our women also stand around us.

My presentation today is an account of how well I have fulfilled my obligation of *STANDING BY, TO PROTECT WOMEN'S HEALTH*. While our counterparts in the developed world would like to bother themselves about *in-*

vitro fertilization, cloning, developing new generation contraceptives, intra-uterine monitors, perfecting laser techniques and pinhole surgery, we in the developing world have the real agenda of safeguarding the lives of our women. It is a privilege to be a male obstetrician and gynaecologist. I thank God for making me a recent creation, as in old texts there is no mention of male obstetricians although there were references to midwives. In ancient mythology, the goddesses were present at deliveries, but not the gods. In the ancient Middle East, older women were recruited from outside to help with deliveries in the harem as most of the women in them were young.

No matter how bad things were, no man was ever called. In the Bible, references were made to midwives and none to mid or full husbands! . "And it came to pass, when she was in hard labour, that the midwife said unto her, Fear not; thou shalt have this son also" (Genesis 35 verse 17). Even when there arose a new king in Egypt, who knew not Joseph: The king who wanted to enforce a population control policy for the Jews was still dealing with midwives. It was only at about AD325-403 that history recorded Oribasius as a male obstetrician in Byzantium.

The title of my Inaugural lecture is "FROM WOMB TO TOMB: PROTECTING THE GATE FROM THE CRAB". I wish to pay great tribute to Shirish S.Sheth, current President of the International Federation of Gynaecology and Obstetrics (FIGO). He said, "*From the Womb to the Tomb, women are made to pay dearly for their womanhood*". The title is partly coined from this caption. In the beginning, "God said, Let us make man in our image" and "so God created man in his own image". "And God saw every thing that he had made, and behold, it was very good (Genesis 1 verses 26,27 and 31). In performing the first surgical operation (Thoracoplasty) under general anaesthesia, God the Surgeon and Anaesthetist created a woman but He did not indicate that the woman was very good. The source of the imperfection, I believe, is the womb or the female genital tract.

Although primarily designed for procreation of the race, the womb can be a "source of woe particularly in many developing countries where about one million women die every year simply because they have wombs. For every minute that I spend on this podium, two fellow humans will be sentenced to their tombs. This will translate to about one million women annually or better described graphically, a jumbo jet carrying 250 passengers crashing every 2 hours!

Life is formed at fertilization and the sex is genetically determined at this stage. The judgment is earned at fertilization but execution takes place at variable times during life from Womb to Tomb. Their major offence is that they have WOMBS. Our women lack one of the most important freedoms we can have :the freedom from avoidable ill-health and mortality simply because they are women. *Our concern is : why should the womb send a woman to the tomb. Our mission is to stop this avoidable journey.*

Even in countries where the dead are honoured, the womb is religiously policed and very rarely causes death. Deaths from pregnancy and related events have attracted international attention since Allan Rosenfield and Deborah Maine

published their paper titled *Where is the 'M' in Maternal and Child Health?* in 1985. The Safe Motherhood Initiative (SMI) was launched two years later in Nairobi, Kenya in 1987. Then it was estimated that 500,000 women die every year from pregnancy and related events. The goal of the SMI was to reduce by 50% women's death attributable to pregnancy and related events by year 2000. In a recent review of estimates of women's death from pregnancy and related events by WHO/UNICEF at a technical consultation in Colombo, Sri Lanka, in 1997, the figures had gone up to 585,000. A modest increase of 20%! We know why they die. They die from Obstructed Labour/ Ruptured Uterus, Haemorrhage, Infection, Hypertension/ Eclampsia and Abortion. Outside pregnancy, Cancer of the Reproductive Tract and HIV-AIDS are major causes of death.

My colleagues and I have looked at causes of women's death in Nigeria. We have concentrated on three of the important causes in our environment. These are: Abortion, Eclampsia (the occurrence of non-epileptiform convulsion in a pregnant woman who has hypertension) and Genital Cancer.

In the early part of my career I was interested in induced abortion and studied the trend between 1980 and 1989. The findings were shocking. There was a sustained rise over the 10-year period despite increasing availability of family planning services and the vast amount of money infused into the services. Abortion was the commonest cause of death in the gynaecology service during the period of study and constituted 36.6% of the fatality (Adewole 1992). Majority (76.2%) of patients did not accept contraceptives and 29.8 % of terminations were performed by physicians. The rest were performed by non-trained providers (42.8%), Nurses (6.4%) and Chemists (21.0%) .The inherent contradiction in the results led us to probe further. We organized a Media Sensitization Campaign, Law Review Meeting and Abortion Methodology Workshop. My colleagues and I conducted a multi-layered prospective pilot study in South-Western Nigeria. The pilot study comprised of:

- Community based study of 3,743 respondents
- A survey of 140 health institutions
- A study of 1,947 abortion seekers
- Focus group discussion sessions with 17 groups of 10 participants each.

There was a need to answer the big question: *What is the size of the abortion problem in Nigeria?* We followed these with a nation-wide study conducted with the Alan Guttmacher Institute of New York. We were able to determine for the first time in the history of Nigeria the size of the abortion problem. Our studies revealed that 610,000 pregnancy terminations occur annually in Nigeria. (Henshaw S.K. *et al.* 1998). The cost to the nation is at least 2.6 billion Naira annually (Adewole *et al.* 1998). This is apart from the lives lost and numerous organs damaged. The cost of which we cannot accurately determine.

Other highlights of our findings are:

- 60 % of pregnancy terminations are performed by non-physicians

- 32.6% of abortion seekers are students
- 63.2% of abortion seekers were never married
- Abortion seekers have had about 2 previous terminations
- Dilatation and Curettage was the most common method used for pregnancy termination (59.7%)

The studies afforded us the opportunity to understand the problem of Induced Abortion and why our women fail to use family planning methods as only 28% of abortion seekers ever used a family planning method. We are currently addressing the training of providers, review of curriculum of medical schools and the obnoxious law on abortion that is unenforceable as it penalizes the offended as well as the offender.

We constituted a study group on eclampsia. We conducted an audit of all cases of eclampsia seen over a 10-year period. The information obtained was revealing. Eighty seven percent of our patients were pre-delivery cases. The incidence of eclampsia was high among primigravidae, young women under the age of 25 and unbooked patients. We introduced Magnesium Sulphate into the management of this condition in University College Hospital, Ibadan, Nigeria. We were able to document that Magnesium Sulphate is safe and effective in the management of eclampsia (Adewole *et al.* 2000). We facilitated its local production by the Pharmacy Department at the University College Hospital, Ibadan and from there supplied sister hospitals in Maiduguri, Sokoto and Adeoyo. We are currently participating in an international multi-centered study designed to evaluate the effect of Magnesium Sulphate on the health of the woman and her baby. We shall have the largest databank on pre-eclampsia in Nigeria at the end of the study. In the early part of my career, I fell in love with cancer of the female genital tract.

I was fortunate as a medical student to attend the 1977 International conference of the Society of Gynaecology and Obstetrics of Nigeria (SOGON) in Ibadan. In attendance was the one and only Professor K.D.Bagshawe. I became his disciple and was in his laboratory eight years later. I worked on Germ Cell Tumours (GCT) and Gestational Trophoblastic Diseases (GTD). GTD arises from error of fertilization and originate from early mesodermal cells to differentiate from the growing embryo in the womb. Hertig described GTD as God's first cancer. It became the first cancer to be successfully cured using drugs in 1956 and has been described as man's first cure. At the Cancer Campaign Research Laboratory, we worked on chemotherapy of gynaecological cancers. We were able to show that:

- Etoposide, called VP 1623 during phases 1 and 2 trials, did not affect fertility in treated patients (Adewole *et al.* 1986).
- Metastatic Germ cell tumour can be successfully cured (Adewole *et al.* 1987).
- A combined approach using fertility regulation and health education would reduce fatality in GTD by 62.8% (Adewole and Adeleye 1991).
- A sensitive ELISA for Human Chorionic Gonadotrophin (HCG) is

feasible and practicable in Nigeria (Adewole, 1991). It is cheaper and safer than radioimmunoassay.

- Oral Contraceptive Pill (OCP) and Intra Uterine Contraceptive Device (IUCD) are equally beneficial as a method of fertility regulation in women with Hydatidiform Mole (Adewole *et al.* 2000).

The Womb and the Gate

The womb has been a subject of fascination for thousands of years. Anatomically distinct, it is shaped like a pear with muscular structures beautifully arranged in three layers to allow for expansion in pregnancy to accommodate the growing fetus or fetuses. Functionally robust, it is the most efficient incubator available. The womb is spiritual and the ancient Greeks believed in the concept of a wondering uterus. The Womb consists of five distinct parts: The Fundus, Cornu, Body or Corpus, Isthmus and Cervix or Neck.

Cervix

The Cervix is the lowermost part of the womb in the human female. A beauty of architecture, the cervix is a fusiform canal that opens into the body of the womb superiorly at the internal Os, and the cavity of the vagina inferiorly at the external Os. Structurally, the cervix feels like the tip of the nose, but with a little dimple on it. The cervix varies considerably in length depending on age and parity. It measures about 3 cm long and 2.5 cm in diameter, and forms the inverted dome on top of the vagina. Of course, it is not visible in normal life. The woman is even unaware of its existence. The doctor can feel it easily during an internal examination and can visualize it by gently passing a visual aid [speculum] in to the vagina. Extremely accessible, no part of the human genital tract has been studied extensively as the cervix.

Layers of microscopic bodybuilding blocks called cells line practically all surfaces of structures and organs in the human body. Cell types vary from organ to organ, and even on the same surface of one organ. The two cell types which line the cervix are the squamous cells and the columnar cells. They exist in clearly demarcated areas and only meet at a hypothetical sector referred to as the Squamo-Columnar Junction [SCJ]. The Squamo-Columnar Junction is at the external os in a nulliparous woman. Cells are continuously produced and undergo constant shedding from the cervix throughout the human lifespan.

Although other mammals and viviparous creatures of God also have wombs with clearly defined cervix, that of the woman seems more remarkable. It is the super multipurpose GATE. It plays a major role in the reproductive career of the woman:

1. It is the narrow channel through which menses passes from the womb to the vagina.
2. It allows semen into the womb prior to fertilization.
3. It holds the pregnancy in place against pressure and gravity until it is generally safe for the baby to be born into the world.

4. It plays a dynamic role during labour and gently gives way, to allow the descent of the baby's head or buttocks.
5. It is claimed by many women, that the presence or absence of the cervix makes the difference between pleasurable and painful sexual intercourse.

I have been fascinated by the dynamic role of the cervix before and during labour. We recognized the value of the gate in facilitating smooth and problem-free labour. We evaluated at various times, inert substances, like silicon, hygroscopic dilators and gentle nipple stimulation. (Adewole *et al.* 1993; Obed and Adewole 1994; Adewole *et al.* 1994). We were able to show that gentle unilateral nipple stimulation is effective in initiating labour and opening this gate.

The Gate is also spiritual. It could be locked in an infertile woman. In the Bible, opening the gate leads to restoration of fertility. "And God remembered Rachel, and God hearkened to her, and opened her womb. And she conceived, and bare a son." (Genesis 30 verses 22-23). It is however a matter of great irony that the GATE commonly becomes afflicted by the CRAB during the course of its day to day activity. The Crab is synonymous with cancer, as the word Cancer is derived from the Greek terminology for Crab. Its first description was based on the similarity of the external surface of advanced Breast Cancer to the Crab's shell.

Cancer Burden in Women

Currently, the annual global cancer incidence is 10 million, with 6 million deaths. By the year 2020, there will be 20 million new cancer patients each year, and 12 million deaths: 70% of tomorrow's cancer patients will live in countries that between them will have less than 5% of global resources. (Karol Sikora, IARC 1999).

Cancer in Nigeria

Data from the National Headquarters of Cancer registries in Nigeria indicate that:

- 100,000 new cases of cancer are currently diagnosed annually.
- One out of every six Nigerians will develop cancer.
- It is estimated that by the year 2010, 500,000 new cases will be diagnosed annually.

Cervical Cancer in Nigeria

In the field of Oncology, Cervical cancer was the commonest cancer in women at the beginning of this century. Worldwide, cervical cancer comprises approximately 12% of all cancers in women. Today, cervical cancer is a non-issue in developed countries. Unfortunately in developing countries, it is the commonest cancer in women where it affects about half a million women annually translating to one case every minute. In Nigeria, the ranking changed in 1995 when Breast Cancer overtook it.

As of today, one out of every three cancers in women is a genital (gynaecological) cancer and cervical cancer constitutes about 63 % of our gynaecological cancers (Babarinsa, Akang and Adewole 1998).

The highest incidence of cervical cancer currently recorded worldwide is 67.2/100,000 in Zimbabwe. In Nigeria data from the Cancer registries report an incidence of 25/100,000. Cervical cancer has been one of the most studied of all human malignancies and the literature available on its epidemiology, aetiology, clinical presentation and management is vast.

Causes of Cervical Cancer

In the middle of the 19th Century, Italian scholar, Demenco Rigoni-Stern reported the extreme rarity of cervical cancer among nuns. Probably no epidemiologic parameter has been scrutinized as much as sexual activity. Data from our center and all over the world have demonstrated a clear association between a woman's risk of developing cervical cancer and the number of her sexual partners. Sexual activity was identified as a major risk factor. The incidence of cervical cancer is related to

- age at first intercourse
- number of sexual partners
- parity
- the male factor
- marital pattern.

We were able to show that the other wives in polygamous unions were at high risk of developing cervical cancer (Adewole, Babarinsa and Ayinde 1996). The only person who is immune from cervical cancer in this audience is that lady who has never had sexual intercourse.

The Viral Connection

That genital viral infection is the primary causative agent of cervical cancer has been a matter of intense study over the last 30 years. Several workers studied the role of infective agents, particularly viruses. Initially, the searchlight was on Cytomegalo Virus (CMV). Later in the 70's and early 80's, Herpes Simplex Virus (HSV) was suspected. Since the mid '80s there is accumulating evidence that genital infection with Human Papilloma Virus (HPV) is the primary aetiologic agent. Numerous reports implicate mainly the subtypes 16 and 18 which act on immature epithelial cells and transform them to potentially malignant cells. Cervical Cancer is now regarded as a sexually transmitted disease caused by a virus called Human Papilloma Virus (HPV).

The virus elaborates proteins E6 and E7 bind and inactivate the host's tumour suppressor proteins p53 and RB intracellularly and promote immortality of the dysplastic cells. Other concurrent factors like immuno-suppression, smoking, long term use of oral contraceptives, metabolites associated with chronic cervical infection have been implicated as co-factors in the development of invasive cancer.

Pathogenesis

I remember my childhood days in Ilesa when the then "Lagos been-to" came back with stories that fuelled our imagination. One of those stories was about how there was a deceptive, invisible turbulence at the point where the Atlantic ocean and the Lagos lagoon met. What can best be described as a similar turbulence occurs as well in the human cervix, particularly at the SCJ-where two different cell types meet! It is not clear exactly how the "invisible turbulence" comes about, but a number of risk factors are known to initiate, promote and accelerate it in addition to the infection by Human Papilloma Virus (HPV). They include:

- Smoking [active or passive]
- Race [Negroid race is 2X at risk above the White American]
- Human Immunodeficiency Virus
- Diet low in fruits and vegetables.

The effect of the above mentioned risk factors is not immediate: it could take from 1.5 years to 10 years before the first signs of "turbulence" are noticeable. Such signs are invisible to the naked eye-but visible (at microscopic examination) to the trained eye, looking at an appropriately stained slide of a smear or scrape of the cells of the cervix [Pap smear]. The "turbulence" results in the development of abnormal (pre-cancer) cells at the SQJ. As more and more of the cervix is taken over by these pre-cancer cells, the results of the Pap smear is progressively reported as mild (CIN 1), moderate (CIN 2), or severe dysplasia (CIN 3).

These conditions do not progress in a linear manner. But a CIN 3 condition is most likely to progress to frank [or invasive] cancer of the cervix. Most women with CIN 1 are likely to resolve even without treatment. Those with CIN 2 require careful follow-up, although some form of treatment is offered. All women with CIN 3 require prompt, if not aggressive treatment. Again, I must point out that, there is no way that we can know if a woman has CIN 1 or CIN 3, unless she has a Pap smear. It does not show on facial appearance, and it is no respecter of persons. Once you have had sexual intercourse, you are simply at risk.

I must also say that what I have described so simply in this section is a gross over-simplification of a complex subject that spans the disciplines of anatomy, biology, social medicine, physiology and pathology.

Clinical Presentation

While pre-cancerous and pre-clinical cervical cancer lesions are asymptomatic, the clinical presentation of invasive cervical cancer is uniformly predictable. The earliest symptom is contact (post-coital) bleeding. However, many of our women rather than report in the hospital abandon sexual intercourse and blame the husband for the bleeding. The symptom naturally 'disappears' but the disease progresses. The problem recurs as spontaneous vaginal bleeding and foul

smelling discharge follows within a year or two. Only 10.8% of our patients present early with contact bleeding, the vast majority present with advanced cancer (table 1).

Table 1: Cervical Cancer in Ibadan: Clinical Presentation

Symptoms	No.	%
Post-menopausal Bleeding	276	46.5
Vaginal Discharge	213	35.9
Weight Loss	195	32.9
Pelvic Pain	190	32.0
Inter-menstrual Bleeding	133	22.4
Constipation	89	11.5
Dysuria	68	11.5
Post-coital	64	10.8
Haematuria	45	7.6
Frequency of micturition	40	6.7
Urinary Incontinence	30	5.1
Peripheral Oedema	30	5.1
Diarrhoea	11	1.9
Faecal Incontinence	1	0.2

Trends in Nigeria

Fifty years of 'education' has done very little to change the outlook of this disease. Eighty percent of our patients presented with stages (IIB,III&IV) advanced disease in 1953-62. This remained 77.5% between 1962-72 and 74.5% between 1980-89 (Edoziem and Adewole 1993). In Zaria, 86.7% presented with advanced disease (Emembolu and Ekwempu 1988). In 1980, 83.8% of cases seen at the Mayo Clinic in USA presented with early stage diseases (Stages 1 and 11 A). The verdict even today, is that not much has changed in Nigeria. A sharp increase in frequency that began in 1981 has not shown any appreciable fall. Age specific incidences have recently showed a fall for the older age groups, but a rise in younger groups (Babarinsa, Akang and Adewole 1998).

Management

The management of cervical cancer is standard. This is surgery for early stage disease and radiotherapy for all stages. Chemotherapy is useful for selected cases. When I came back from the Cancer Campaign Research Laboratory, I started my patients on Platinum based multiple chemotherapy. I lost three of them in rapid succession. These were due to:

- Poor health status
- Poor response as they were either post radiotherapy or post hysterectomy.

The last patient was particularly disturbing. She was a business woman and the husband a top civil servant. The husband failed to provide the needed encouragement for follow-up on the initial histological diagnosis of carcinoma-*in-situ*. One of my teachers came and said sarcastically: "Mr. Oncologist, Is this worth it?" I took a break for a long, long time.

It was only this year that I was able to find my courage and introduced concomitant chemo-radiotherapy in carefully selected patients. We administered chemotherapy and radiotherapy at the same time up front and monitored using ultrasound to confirm complete response. This was confirmed at surgery. I was fortunate to attend a training course in radical surgery in Hungary in 1994 but since then, I have not seen a single case of stage I or IIA suitable for surgery. There is however a disturbing trend where doctors perform sub-optimal surgical treatment like sub total or total hysterectomies for patients.

Who is Next?

Many of you seated here probably believe that cervical cancer only affects "other" women: the women who are "immoral"; women who do not fast or go to church or to the mosque. Some will even reject it. Not even the young is immune. A clinico-pathologic study of invasive and *in-situ* carcinoma revealed that young Nigerian women are susceptible. Our youngest patient was 17 years old (Adewole *et al* 1997)

Let me tell you three short stories and I assure you that every sentence is true.

- The first story is about a 23 year old tall and well-nourished lady sent from Jos University teaching hospital because she was found with invasive cervical cancer. She arrived in Ibadan at about the time an American Professor of Gynaecologic Oncology was visiting. It was thought that, because of her age, and presumed early stage of her invasive cancer, she would benefit more from a surgical management [radical hysterectomy]. The American Professor accepted to perform the operation: think of the saved cost of a return air-ticket, hospital bill and insurance in USA/UK. The first problem that reared its head was that, at surgery, the cancer was found to be more advanced than was initially thought. This is our experience in practically all the cases we took to theatre (Adewole *et al* 1996). The operation went ahead anyway, seen as a challenge. The second problem was that she eventually developed ALL the known complications of surgery for cervical cancer. The final disaster was: the cancer returned within one year of this heroic surgery: I am not sure if I should be referring to her in the past or present tense.

- Mrs. X is a highly trained nurse who had the privilege of going abroad for international conferences, meetings and seminars. She never felt that she needed any cervical smear whilst in Nigeria. But on one of her journeys to the United Kingdom, she was encouraged to have one "just in case"...And lo and behold! She was found to have the early signs just preceding cervical cancer [CIN 2]. She rushed back to Nigeria had her womb and "trouble-promising cervix" surgically removed – and today lives happily ever after. This particular nurse will never tell you or her Pastor this story, because it was a close shave. I only was privileged to know because at some point, my opinion was sought. This story teaches us that it is good to look out for trouble before trouble looks out for you! But I dare say that, if she had developed cervical cancer, and any of you here got to know, you would have asked aloud: "Ah? Ah? Is she not a nurse...she MUST have known how to prevent it." But the gap between knowledge and practice, especially in health matters remains a mystery even in developed societies.

In a survey of knowledge and attitude to utilization of cervical cytology screening services by female workers in a Nigerian Teaching Hospital, 92.4% never had a Pap smear test done despite the fact that 81.4 % of them had heard of the test (Babarinsa and Adewole 1996). It appeared that the problem of utilization may be more psychosocial than financial. The nurse screening patients as well as the head of the nursing services division in one of the major teaching hospitals never availed themselves of the opportunity available to have a test done.

The situation was much worse among women in the lower socio-economic class. In another survey of 254 GOP attendants, while 90% of women have heard of cancer at one time or the other, only 15% of the women studied have heard of cervical cancer. Breast cancer was commonly heard of. Less than 4% have heard of pap smear test and only 1.2% had knowledge of a test to detect cervical cancer. Only 5% of 215 patients who expressed a willingness to do a pap smear actually did it (Ajayi and Adewole 1998).

- Finally, there was this young woman of 32 who was a middle-level executive in the financial sector. She was referred to me because the neck of her womb "looked suspicious", and she was bleeding from the private part for no clear reason. When I had a look, I did not like what I saw. The result of the biopsy confirmed our fears. I still recall the woman asking me: " Doctor, how can I have cancer? I have not lived a carefree life...Most of my friends have gone to bed with dozens of men, but I have had only two men in my life. The first one jilted me, and I am just preparing for my wedding to the second!" Of course, I had no answer. But the worse was yet to come. Despite prompt and efficient radiotherapy [money was no problem], the cancer simply got out of hand and killed the poor lady within six months of diagnosis. It was one of the clinical encounters in my professional life, which really upset me for a long, long time.

The lessons from these three stories are:

- once cervical cancer becomes invasive, treatment becomes difficult and
- death is invariably the outcome.

This is in agreement with what Tait said in 1889 that: "*Cancer of the Cervix is the most painful and terrible disease inflicted on humanity because there is no way to cure or even relieve it*". I am not trying to scare you, but I would want to believe that the prevention and pre-emptive measures are better than the treatment of invasive cervical cancer. If you still don't believe me, I invite you to come and speak to our patients, who are suffering from cervical cancer. We attempted to conduct a study on the quality of life of our patients after diagnosis and treatment with radiotherapy. It was easier to find water in the desert than to find a patient with cervical cancer alive after five years. The time interval between diagnosis and demise was less than three years.

Ray of Hope

Cervical cancer is both preventable and curable, especially if detected early. Widespread comprehensive cervical cancer control programmes have helped some developed countries to achieve up to 80% reduction in incidence and mortality from cervical cancer. In most developing countries where cervical cancer accounts for 80% of gynaecological cancers, 80% of the cancers are incurable at the time of diagnosis. In these countries, cytological screening is not currently available for population based screening programmes. Our salvation lies in PREVENTION which is cheaper, safer and more certain. The escape route is the PAP smear. The pap smear is of immeasurable value. Although not subjected to randomized controlled trial, it has resulted in a significant decrease in mortality in developed countries.

Prevention

Kesler stated that the prevention and control of a disease such as cervical cancer requires intervention at the level of one or more elements in its natural history:

- Aetiologic agent
- The host at risk
- The disease itself
- The environment

Primary and Secondary Prevention

Improvement in the status of women as well as a positive change in sexual behaviour have been recognized as viable strategy for reducing the burden of cervical cancer in any population. Factors such as socio-economic status and educational attainment of women act by altering known risk factors such as age at marriage and parity.

The objective of secondary prevention is to detect early, the pre-invasive and invasive stages and provide appropriate treatment. The effectiveness of organized screening services in preventing cervical cancer is well-established in developed countries. One of the cardinal principles of cancer management is that the earlier the detection the higher the chance of cure. The accessibility of the cervix and the abundance of exfoliated cells available for study made regular routine cervical smear of significant value in the study of the cervix and cervical abnormalities. It is estimated that some 40-50 % of women in developed countries have been screened for cervical dysplasia by 1988 compared with 5% of women in developing countries. Our main problem is the paucity of the services in addition to poor utilization even where it exists (Ayinde, Adewole and Babarinsa 1998). Though the incidence of abnormal cervical smears cases were on the increase, the size of the population screened declined.

We thereafter designed health education packages and commenced a pilot project in four local government areas of Oyo State. The outcome of our pilot work titled "*Impact of Health Education on Cervical Cancer control Programme*" won a fellowship at the 16th World Congress of the International Federation of Obstetrics and Gynaecology in Washington, 3-9, September, 2000. We demonstrated that SUSTAINED HEALTH EDUCATION IS REQUIRED TO PROMOTE CERVICAL CANCER SCREENING (Oladokun, Babarinsa and Adewole 2000).

Management of Abnormal Smears

Diagnosis of an abnormal smear requires a colposcopic procedure. The colposcope is an inverted binocular microscope designed to examine the cervix at a magnification of 6-40. It was introduced in our service in 1994. Prior to its introduction, we have utilized application of Lugol's iodine before taking cervical punch biopsies (Omigbodun *et al.* 1993). This was better than the four quadrant punch biopsy (64.7% Vs 38.9%).

The introduction of the colposcope revolutionized our practice. We abandoned the bloody Cold Knife cone biopsy and started cryotherapy which we documented to be cheaper, easier, and with little or no complication (Adewole, Babarinsa and Odeniyi 1998). We assessed the existing facility in the country and documented a need for capacity building if we are to successfully protect this gate from crab. In 1999, at the beautiful city of Tunis we fashioned out a document titled "*REPORT ON CONSENSUS CONFERENCE ON CERVICAL CANCER SCREENING AND MANAGEMENT*". It is the gold standard for comprehensive protection for the GATE.

We recommended:

- Rational National Screening with in-built education programmes and mechanism for capacity building.
- Screening for women between ages 30-60
- At least, once in a lifetime screening / 10 yearly with a target of 4 normal smears
- Later age at first marriage

- Men having fewer sexual partners
- Women having control over their sexual behaviour, particularly their ability to have sex when they want to and with whom they want to.
- Effective STD/HIV -AIDS control programme.
- Women empowerment.

In April 2000, we successfully organized the first African Regional/Technical Workshop on Cervical Cancer control in collaboration with WHO under the auspices of the International Network for the Control of Gynaecological Cancers (INCGC). Ten Nigerians were among the 40 participants (Gynaecologists, Radiotherapists and Pathologists) trained in the essentials of cervical cancer control activities. These include Pap smear taking, processing and treatment, especially the use of loop electrosurgical excision procedure (LEEP).

Programmatic Issues

The success of Cervical Cancer Screening will depend on the programme being acceptable to women themselves. Methods and activities have to respect the dignity, privacy and autonomy of women. This is more likely if women's rights and women's health advocates are involved in the development of the programme.

The greatest burden of disease occurs in poor countries with economies in transition. Thus, minimal requirements are proposed as a priority for reducing the number of women dying from cervical cancer internationally. The primary operational aim of the programme must focus on achieving the highest possible coverage rate. The aim should be to set up a nationally organized screening programme. It is more costly, less effective, to operate opportunistic screening than to choose a population based approach. A well run, comprehensive demonstration programme is advocated as a good method of starting. This will facilitate lobbying for national implementation and enable the organizers to learn from mistakes.

Conclusion

It appears that the journey from womb to tomb was not ordained by God but by man or woman. A woman may choose life or death. The choice is simple. Cervical Cytology is still the standard by which all other approaches are judged, as it is the only one that has been shown to reduce cervical cancer incidence and mortality. This is the surest way today to keep the crab away from the gate. Tomorrow we might have the vaccine against the human papilloma virus. However, all programmes will fail unless there is good patronage. We must create the facilities and it is possible to persuade women with abnormal smears to attend for diagnosis and treatment. A stitch in time saves ALL.

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BENEATH THE RIPPLES AND SUSTAINABLE FISH PRODUCTION

E. O. Faturoti

Department of Wildlife and Fisheries Management

Introduction

I feel highly esteemed and honoured to stand before this noble audience to present the fifth in the series of 2000/2001 inaugural lecture. It is also my pleasure that the Department of Wildlife and Fisheries Management of the Faculty of Agriculture and Forestry has the opportunity again to contribute to this academic discourse. The only opportunity so far came to the Department in 1986 when Professor S.S. Ajayi x-rayed the crisis permeating the wildlife sector. The Lecture then brought into focus the relevance of wildlife conservation. Indeed, that lecture established the need to conserve at all levels not only our wildlife resources but all other resources that are beneficial to mankind.

The science of wildlife management and also that of fisheries management are of relatively recent origin. In fact, fisheries study was initially perceived as the study of the biology of various fish species. Today, the story is quite different as fish is now seen as a commodity of trade. The practice of fisheries has grown from hunting to actual culturing fish in captivity. Relevant technologies have been developed to derive more benefit from the fisheries resources of the world and indeed that of Nigeria in particular.

I salute the courage of the founding fathers of the Department of Wildlife and Fisheries Management who in 1981 brought into focus the ideals of good visionary leaders and created the Department which today has grown across the various tertiary institutions in Nigeria and Africa.

About two and a half decades ago, I was posted to serve as an NYSC member in the Federal Department of Fisheries (FDF), Victoria Island, Lagos. The Research Unit of FDF absorbed me into a programme of post harvest Development of fish and fisheries resources. As part of my assignment, I had to undertake sea trips on research fishing vessel code-named KIAIA, invariably to

collect research biomaterials – Big Eye, *Brachydilerus auritus* a bony fish which was to be processed into more edible fish products.

My first sea trip in 1975 was quite thrilling and challenging in so many ways. The second trip provided other forms of challenges as the sea was quite rough and there were gastronomic disturbances and ripples that led to frequent vomiting. The first casualty on that sea trip was a colleague who was knocked off under 15 minutes of our take off.

At sea on that same trip, my thoughts reflected on the Biblical records of creation in Genesis Chapter 1 verses 2-21. "God's spirit was moving over the water" (as in Genesis 1:2) "Let the water be filled with living things large sea animals and every living things". Obviously the plankton, fishes and other aquatic animals are being referred to. In Genesis 1:21 "They produce more of their kind" was the command of God.

Finally, on the sixth day, "God created human beings in the image and likeness of God". From the foregoing it can be inferred that God empowered man to rule over the fish in the sea for the benefit of mankind. The empowerment given to man has led to increased intensity of procreation and the resultant population boom. There is, also the over bearing capability of man to over-crop fishes and aquatic life leading to inability of fishes i.e. those aquatic life to produce more of their kind and meet man's propensity to consume in a bid to satisfy his nutritional needs.

The interest of man to develop economically through the exploitation of various resources which God provided has set man on collision course with the perfect arrangement which God had put in place to sustain man and better his lot. The present day happenings in all facets of life are by no means causing ripples of various magnitudes. Simply perceived, ripple is a little wave on the surface of water. Wave in itself connotes an up and down movement or to and fro situation. It is also seen as a rising motion on the surface of water. In short, it can be perceived as a scenario, which portends a dangerous dimension. After creation, all man's various activities have created ripples.

For decades, the Nigerian political arena has remained highly unstable with ripples of various magnitudes. Presently, the *ethnic and religious clashes, vehement rhetorics on marginalization, conflicts between legislative and executive arms of government* are all pointers to unstable political environment. In the absence of a conducive political environment, it becomes difficult to develop all facets of our economy.

For those of us who believe in the powers of prayer, there is no gainsaying that Nigeria has come thus far because God as a perfect manager of all resources has continuously intervened. Our brothers in some African countries have not been so favoured and the consequences abound in the refugee status of most of the nationals of these countries. For the purpose of this discourse, my perception of ripple is in the realm of aquatic resource management. Today, I intend to enlighten on the causes and consequences of ripples in aquatic environment and proffer rational solution in the management of our endowed renewable natural aquatic resources as they relate to fisheries resources.

Causes of Ripples

The relevance of aquatic resources to man's livelihood is incontrovertible as J.W. Von Goethe, an environmentalist, stated that "Everything originated in water, everything is sustained by water". Air, water and food, strictly in that order are the basic essentials of life. Human beings can live for over sixty days without food. They can rarely survive for more than three days without water. They will die within a few minutes if deprived of air. About 70% of the human body, by weight, consists of water and many of the body functions depend on it. Thus regular intake of this precious gift of nature is essential for our survival.

It is also necessary to point out that whatever abuses that are passed on to water tend to manifest on contiguous resources such as land, atmosphere, vegetation, wildlife, fisheries and numerous other renewable natural resources which assist in the sustenance of man's livelihood. The quality of life can be greatly improved or disrupted depending on our interaction with aquatic environment.

Among all the natural renewable resources, fisheries present perhaps the greatest challenge for effective management. The problems are the most difficult under tropical conditions. There are many interacting factors: a greater variety of fish species, change in climatic and oceanographic conditions (including massive seasonal outflows or rainfall from land), the level of exploitation by fishermen, the impact of other industrial activities and the social, political and economic pressures on the market system. These factors all tend to create ripples of varying magnitude which need complex mechanism to manage for sustainability of man's livelihood.

What are the causes of ripples that affect the ability of water to sustain renewable aquatic resources? In answering this question, man stands out as a major cause of ripples. Man's activities have created untold hardship and ripples (Fig.1) and to settle these ripples, it will take the invention of perfect understanding of a balance between our demand for resources, unregulated or regulated entries and good rational and delicate exploration and exploitation and the need to monitor the biological effort occasioned by overbearing capacity of our population on the resources. It is after all these that the aquatic medium can be still. The perfect manager who brought calmness to the sea was Jesus Christ when he commanded the sea to be calm and it came to pass.

Basically, when a water body is loaded with waste materials or heat such that its natural ability can no longer cope with the situation we say that it is polluted. The water body is then seen to be suffering from the burden of unpleasant interference. Physically, ripples are generated when a serene water body is attacked by foreign bodies. The extent of ripples generated is usually related to the magnitude of attack by the foreign bodies, or better presented by the magnitude of abuse by various pollutants. I will now take time to look into some major causes of water pollution in general.

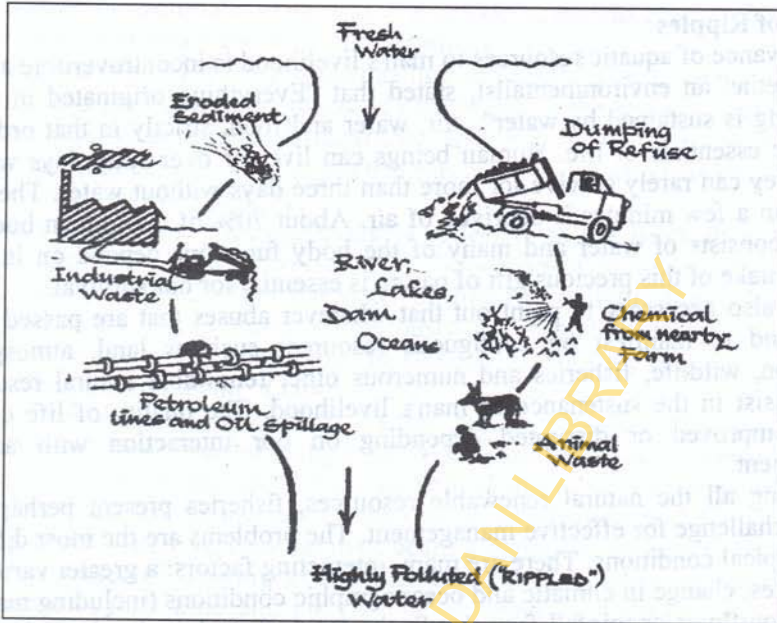


Fig. 1: Causes of Water Pollution

Major Groups of Water Pollutants

Oxygen-demanding wastes

These include domestic sewage, human and animal wastes, and biodegradable industrial wastes (such as canneries and wood pulp mills). The noticeable practice at present is for these wastes to be thrown, dumped or discharged directly into streams and rivers or into gutters, drains and waste dumps from where they may get washed by run-off water into water bodies.

Under normal conditions, these organic wastes are decomposed by microorganisms called decomposers. These decomposers require oxygen from the water and they compete with fish and other aquatic organisms, which need oxygen for respiration. Thus, in heavily polluted water bodies, the dissolved oxygen is used up leading to the death of aquatic organisms. Consequently, the water is turned into a putrid, turbid, decaying mess from which foul smelling bubbles of gases (methane, ammonia and hydrogen sulfide) rise to the surface.

Streams and rivers which flow through our towns and villages or into which these built-up areas drain are characteristically heavily polluted in this way. The Ogunpa river in Ibadan is a good example. Nevertheless, fishing activities still go on but invariably, the catches are relatively non-significant. The Lagos Lagoon which is adjacent to heavily populated areas tells the same story as orchestrated in the "Oku-Eko" fish production syndrome.

I wish to also share a documentation on urban streams and rivers being heavily polluted. The Samaru stream in Kaduna State drains much of the small university town of Samaru. It also drains some heavily fertilized agricultural as well as some uncultivated land. It receives effluent from an abattoir as well as

kitchen waste and septic tanks overflow from student hostels. In some places, it is used as a "natural lavatory" so that there are high concentrations of human excrement. Livestock are regularly watered in it. Therefore, animal faeces are a common feature. The stream is clearly heavily polluted from various sources. The ripples occasioned by the various pollutants are encapsulated in the submission of Vei. F. Smith that "there can be no doubt that Samaru stream presents a considerable health hazard to certain sections of the local community. Although the author has not observed people drinking the stream water, food is washed in the water and people washing in the stream must sometimes accidentally swallow some of the water. The water is contaminated with faecal material and there must therefore be a considerable risk of contacting water-borne diseases, such as 'schistosomiasis'. Unless my colleagues in Veterinary Sciences need to certify the scanty fish from the stream, the health status of such fish is suspect for human consumption.

Infectious Disease Agents

Domestic sewage, human and animal waste also pollute water by introducing into it viruses, bacteria and protozoa. Again the ripples of such occurrence are demonstrated in the major cholera epidemic which hit West Africa in 1970. Starting from the Gambia, Guinea Bissau, Guinea and Senegal in September of that year, it moved eastwards reaching Nigeria in December when the first three cases were recorded in the small fishing village of Ajegunle-Owode in Lagos State. The cases in northern Nigeria were recorded in Kano and Zaria. The dreaded typhoid fever is also common throughout the country. Typhoid outbreaks are a real danger in many of our cities, particularly at the onset of the dry season.

Plant Nutrients

Nitrates, phosphates and other plant nutrients which come from fertilized farmlands, from ashes, and from detergents, are an important group of water pollutants. When they are washed into water bodies, they encourage the growth of algae and phytoplankton. These aquatic plants may become so abundant that their decomposition drastically cuts down the amount of dissolved oxygen in the water. As a result, aquatic animals, including decay organisms, die off.

In 1976, the then Federal Military Government launched an accelerated food production programme tagged "Operation Feed the Nation". Successive governments have continued the drive under different names. The drives have created ripples and aggravated the problem of water pollution through its encouragement, all over the country, of the unregulated use of fertilizers, pesticides and herbicides. It is believed that the ripple created by the increased use of these agricultural inputs in the Lagoons of Ogun, Lagos and Ondo States and other various water bodies in the country have had their fair share of this ripple.

Pesticides

Organic chemicals in the form of many types of pesticides get washed into water bodies where they may kill aquatic life or be absorbed by them and passed up the

food chain until they become toxic to man. A good example of organic chemical toxicity to man is DDT, which was once widely used but its use has now been banned or severely restricted in many countries with Nigeria being a notable and unfortunate exception. As pollutants, these chemicals are particularly dangerous for two reasons. First, unlike sewage and animal wastes, they cannot be removed effectively with normal water treatment procedures. Second, scientists are still ignorant of the harm which some of them can do to humans and other animals especially in the long term.

A wide range of agro-chemicals have been introduced into Nigeria. Some of the best known being Gammalin 20 (for the spraying of cocoa trees), Aldrin dust (for seed preservation), and DDT (for tsetse fly control). In addition to normal use of the chemicals, some of our people have out of ignorance, developed the very dangerous habit of fishing and even hunting with them by applying them to water bodies and spraying them along animal tracts. The threat to our health which the legal and illegal use of organic chemicals represents is at present quite frightening.

Industrial Effluents

Perhaps the most serious risks from industrial production in Nigeria today come from water pollution. Almost all our industries discharge their effluents, without prior treatment, into rivers, estuaries, lagoons or the sea. Many of these effluents are toxic as they include DDT, dyes, mercury and cadmium, which pollute water and kill aquatic life. Some of the dyes which are in use in many of our textile factories are believed to be carcinogenic. Other industrial establishments such as distilleries, pulp and paper mills, fertilizer plants, and breweries, contribute their own types of effluent pollution to water bodies. A study of the effects of the thick black effluents from two breweries on Ikpoba River in Benin City, for example, shows an increase in chemical oxygen demand (COD) and an equally massive increase in total suspended solids, all of which had adverse effects on aquatic life.

In the 1960s, Rivers Iya Alaro and Shasha which drain the Ikeja Industrial Estate, were used as recreation spots and as sources of water for domestic use. Today, industrial effluent, especially from textile mills has turned their colour permanently bluish-green. The waters are also characterized by high pH, a high level of sodium compounds and a high lead content. These changes, together with substantial heat pollution (the temperature of the effluent is sometimes as high as 50°C) have made the water unsuitable for recreation and definitely unsafe for domestic use. As well, there is no trace of fish life for some 3km downstream from the effluent discharge point.

Thermal pollution of water has also been reported from around Aladja Steel Rolling Mill, where cooling waters are discharged into streams. A high rate of mortality of fish in these streams have been reported. Most of the fish have migrated downstream, far away from the steel mill.

Eroded Sediments

Sediment pollution of water bodies, as a result of accelerated soil erosion is a serious and wide spread problem in Nigeria. This situation is aggravated where

agricultural practices leave the soil bare at the rainy season. As well, the introduction of mechanized farming, especially in the middle belt without due regard to the nature of the environment, is aggravating the erosion and sediment problem.

High river water turbidity, well above permissible level, has been reported from many parts of the country. The FAO has estimated that almost 80% of the volume of a reservoir proposed at Zurmi, in Sokoto State, will be filled up with sediments in fifty years. Sediment pollution of water creates several problems; easily silting up of reservoirs; low transparency in rivers and reservoirs which adversely affect fish population; and high water treatment cost; reduced navigability, increased flooding; and blockage of irrigation canals.

In Oyo and Ondo States, several reservoirs which were created for water supply purposes, have been virtually silted up and eutrophicated. These include the ones near Ede, Owo, Iwo, Efon Alaye, Ilesha and Ado Ekiti. The Asejire Reservoir which supplies Ibadan with water has lost at least 25% of its capacity in the last 20 years or so.

Lake and reservoirs siltation often results in accelerated weed infestation. Thus in Lake Chad, the weeds *Aeschynomene elaphroxylon*, *Phragmites karka* and *Cyperos papyrus* have formed a great underwater ridge known as the Grand Barrier. The ridge is so thick and tight that it has effectively separated the lake into two parts with the waters on one side unable to mix with those on the other. These weeds waste water because of high transpiration. They also militate against algae productivity, thus reducing fish productivity.

Petroleum Products

Petroleum exploration, exploitation and refinery as well as transportation, storage, marketing and use of petroleum products have all created pollution problems in various parts of the country. Their seriousness varies from place to place. During exploration and exploitation, drill cuttings, drilling and (fluids used to stimulate the production processes), and accidental discharge of crude petroleum constitute serious water pollutants in the oil-producing areas of the Niger Delta. The refineries produce refinery effluents which include oil and grease, phenol, cyanide, sulphide, suspended solids, chromium and biological oxygen-demanding organic matter which may pollute water bodies.

During transportation, storage, marketing, and use of petroleum products, accidental spills of petrol, lubricating oil as well as sludges and bitumen slops from tank-cleaning operations are commonly discharged onto the landscape. These wastes which have a high BOD and COD, often find their way through run-off and erosion of contaminated soil into water bodies, thus polluting them.

In the Niger Delta area, where oil pollution of water is most serious, the effects have often been catastrophic. The formation of a film of oil on water bodies effectively prevents natural aeration, leading to the death of organisms trapped below. Fish may also ingest spilled oil directly or indirectly, becoming unpalatable or even poisonous.

I have taken time to transverse the ripples as occasioned by man's lack of concern for aquatic environment. This trend is likely going to be aggravated for several reasons. There is the rapid rate of urbanization as a result of the

movement into towns by the rural populace along with lack of enforcement of land use control. The growth of industrial empires is bound to create more ripples.

The reflection of my mind on the sea and the ripples of 1975 propelled my interest in knowing more about what goes on beneath the ripples. The deep thoughts of what kind of life exists under the sea and how can the available aquatic resources support man's existence. If at all, there are potentials for a life support system from the aquatic life, of what magnitude? What are the rational means of exploiting the aquatic resources? Are the aquatic resources sustainable? All these questions are monumental in charting my course of developing fisheries through education of mind and purposeful research agenda.

An opportunity knocked at my door when I applied for a scholarship to enable me pursue postgraduate studies in Wildlife Fisheries Management. Though I succeeded in bagging the scholarship, fate had it that I had to truncate my focus for a period of five years when I took the period to work on the nutrient requirements of the African Giant rat for a Ph.D. programme. My appointment in the Department of Animal Science as a lecturer II in 1980 refocused my attention in fisheries research. The then Head of Department Professor A. U. Mba of blessed memory provided me with the opportunity to re-focus my interest in fisheries by procuring my first six sets of aquaria. Coincidentally, my interaction with Professor S.S. Ajayi and Professor O.O. Tewe during my Ph.D. programme had created a bridge between Animal Science programmes and Wildlife and Fisheries programmes. These eminent scholars have pioneered highly resourceful, aggressive and impactful multidisciplinary research agenda. Their vision, which I shared, propelled me further to draw on the inspiration of a broad-based research agenda within renewable resources terrain.

My research plain in Fisheries within Animal Science Department was barely incubated for twelve months when I had to join the then newly created Department of Wildlife and Fisheries Management. The inceptional Head of Department, Professor S.S. Ajayi gave me the mandate to develop the Fisheries programme of Wildlife and Fisheries Management Department. I must say that in a bid to fashion out a realistic fisheries programme, there was the need to look into the nature of fisheries activities and education pervading the terrain of the Nigerian economy. The development activities and overview of Nigeria's fisheries industry will be relevant at this juncture.

Overview of Fisheries Development in Nigeria

Fisheries development dates back to 1914 when a fisheries branch headed by a Senior Agricultural Officer, was established in Agricultural Department of the Colonial Office. The present development oriented Federal Department of Fisheries took-off in 1976 as an offshoot of the research-oriented, Federal Fisheries Service established in the early 40s by the colonial officers. The mandate then was solely Fisheries research for which it had two centres at Victoria Island in Lagos and Malam Factori in present Borno State. The Department was split into two in 1976 to form the Nigerian Institute for Oceanography and Marine Research (NIOMR) and the current Federal

Department of Fisheries. At that time, I was a serving youth corper who moved with NIOMR because of my interest to concentrate on research, the mandate of NIOMR, to unravel part of the ripples of aquatic ecosystem. The Federal Department of Fisheries is charged with the responsibility of developing Nigerian fisheries for the achievement of sustainable self-sufficiency in fish production, utilization and fisheries resource conservation.

Nigeria is a Coastal State with 850km coastline and 200 nautical miles Exclusive Economic Zone (EEZ) of marine waters with an area of 210,900km². Nigeria has numerous inland water bodies estimated at 12 million hectares, which are fairly rich in fresh water fishes. The marine waters, though poor in fin fish resources, have been found to be rich in shrimp and tuna resources.

There are two main sub-sectors that contribute to the Nigeria's fish production. They are capture and culture fisheries. Despite high fisheries potential occasioned by large aquatic resources, at the exit of the colonial masters in 1960, the Nigerian Fisheries Economy was still at its infancy with practically undeveloped public and private sectors. The other sectors of agriculture responsible for cash crops (cocoa, groundnut etc) and forest products were more focused in view of the fact that they satisfied the interest of the industrial sector of the colonial masters. In the public sector, Fisheries was seen as an unimportant appendage of Agriculture. The poor concept of the importance of Fisheries by Government led to the confusion as to whether Fisheries should be placed under the Ministry of Commerce and Industry while some State Governments believed it should be part of the Department of Forestry.

This state of confusion permeated educational organs particularly at the tertiary level, taking over 20 years after independence before Fisheries was properly realigned within University's Faculties and Colleges of Agriculture. This present arrangement cannot be said to be perfect in view of the large scope of the fisheries activities and need for its development. This scenario set a weak foundation for the development of Fisheries in Nigeria.

Fisheries activities were initially capture-oriented and were purely artisanal, exploiting the rivers, lakes, the estuaries and a few nautical kilometers off-shore. The industrial fisheries sector was yet to develop, as very little was known of the fish resources of the marine environment. Fisheries research was done by rickety fishing vessels, while research activities were badly implemented.

Fish Demand and Supply

Sources of fish to the world are the natural waters comprising the oceans, lagoons, lakes and rivers. Aquaculture (Freshwater and Mariculture) is presently making significant contribution as well. World food fish production is around 72 million metric tonnes in the early nineties. Based on a current world *per caput* fish consumption of about 13.0kg per year; approximately 91 million metric tonnes would be required by the year 2010 (FAO 1995). The *per caput* demand is a function of increase in income, population and relative substitution of fish for meat and by-products. Nigeria based on 1991 population census of 88.5 million and projected population of 107.10m in year 2001 would require 1392300 mt of fish (Table 1).

Table 1: Domestic fish production/supply and annual deficit in supply

Year	Projected Population (million)	Per caput Consumption (kg)	Projected Fish demand (mt)	Total domestic fish production	Deficit (mt)
1985	77.34	11.0	850740	304229	546511
1986	79.20	11.0	871200	372301	498899
1987	81.06	11.0	891660	498150	393510
1988	82.92	11.0	912120	463540	448580
1989	84.78	11.0	932580	676739	255841
1990	86.64	11.0	953040	434579	518461
1991	88.50	11.0	973500	596630	376870
1992	90.36	11.0	993960	721492	272468
1993	92.22	11.0	1014420	619211	395209
1994	94.08	11.0	1034880	515135	519745
1995	95.94	11.0	1055340	-	-
1996	97.80	11.0	1075800	-	-
1997	99.66	11.0	1096260	-	-
1998	101.52	11.0	1116720	-	-
1999	103.38	11.0	1137180	-	-
2000	105.24	13.0	1368120	-	-
2001	107.10	13.0	1392300	-	-
2002*	108.96	13.0	1416480	-	-
2003	110.82	13.0	1440660	-	-
2004	112.68	13.0	1464840	-	-
2005	114.54	13.0	1489020	(500000)*	(989020)*

*estimated average over ten-year period (1985-1994).

Sources: Faturoti (1999) Population based on 1991 census, FDF (1994 Statistics).

With the FDF (1994) statistics for the period 1985-1994, the average yearly total fish supply including those from distant waters is about 500,000 tonnes. The deficit of about one million tonnes by year 2005 would have to be met by increased production through management of our resources at all segments of fish production activities.

This scenario and the magnitude of envisaged deficit can be seen as a first pointer to what challenges await all fisheries stakeholders. It also points to the fact that would be investors are guaranteed good and stable market judging by the continued deficit in fish supply over the years if fisheries is made to have business cardinals.

Refocusing Fisheries Development – A Pioneer Approach

A new mandate was given in 1981 at the inception of the Department of Wildlife and Fisheries Management by the then Head of Department, Professor S.S. Ajayi, after reviewing the past and the then present situation of fisheries

development activities. My assignment could be seen as one fashioning routes in the forest terrain or wild aquatic and oceanic landscape to map out the future of fisheries developmental activities. I also have a conviction, that the success of a fisheries development programme particularly on a sustainable level should be pivoted on a very strong academic beacon, ushering an articulated knowledge of the fisheries resources.

Coincidentally, I was lucky to have a Head of Department who himself believes in the strong empowerment of man's knowledge before maximizing through effective management the gains occasioned by endowed fisheries resources. In the inaugural lecture delivered by Professor S.S. Ajayi in 1986, he traced the evolution of non-cellulose renewable resources education at the University of Ibadan to the involvement of Food and Agriculture Organization (FAO) which initiated in 1968/69 academic sessions by commissioning a biologist, Dr. W.N. Holsworth, to introduce wildlife conservation course into the curriculum of the Part I students in the then Faculty of Agriculture, Forestry and Veterinary Science. By 1974/75 academic session, the restructuring of the curriculum of Department of Forestry gave more prominence to Wildlife and Fisheries. Eventually, the name of the Department was also changed to the Department of Forest Resources Management giving credence to the fact that the Department was engaged in activities other than tree planting.

It is also of note that the onset of the four-year degree programme in the Faculty of Agriculture and Forestry in the 1977/78 academic session provided additional opportunity to give Wildlife and Fisheries Management the prominence they deserve in the curriculum of the Department of Forest Management. As a result of this programme, undergraduate degree training was extended over four years with the opportunity of specializing in any of the following three areas in the final year:

- Inland Fisheries Management
- Wildlife and Range Management
- Forestry

With the creation of the Department of Wildlife and Fisheries Management in 1981, my perception of what fisheries education should be got an inspiration from my thoughts of ripples during the sea trip about two and half decades ago on the Atlantic ocean. I also reflected on some linkages during my sojourn at both FDF and NIOMR. All these resulted in drawing a list of renowned individuals who shared the ideals of fisheries development of my vision. Consequently, the fisheries curricula were drawn and indeed these curricula re-orientated the fisheries landscape in manpower development.

All fisheries stakeholders in the country have benefitted from the graduates of these curricula. Our programme has also permeated the development of fisheries programme for many tertiary institutions across the country. It is important to mention that the curricula focused on trained manpower that should be able to create jobs and produce fish for all and sundry.

The crusade of bringing Fisheries to the forefront engaged my thoughts in

1986 when I was in the University College of North Wales, UK, on a British Council award. Another sea trip embarked upon as part of my research activities presented me with an opportunity to witness the enormity of aquatic fauna as dolphin and other aquatic animals were in abundance and demonstrated an aquatic ecosystem in a state of equilibrium. This time, the ripples were created more by the somersaulting of fish and other aquatic animals. A scene of abundant and stable aquatic resources was presented. This is a product of rational management for sustainable development of fisheries resources of British waters.

Sustainability and Capture Fisheries

As late as the early 19th century, fisheries resources were viewed as the gift of nature and therefore considered the heritage of mankind. Consequently, people engaged in various fishing activities without any caution or restriction. Towards the end of the Second World War in 1945, attention was drawn to the rate of depletion of fisheries resources in the high seas when warfare vessels were converted into fishing fleets. This invariably led to the convening of the United Nations Conference on Law of the Sea (UNCLOS) in 1970.

However, it was reported that there were obvious signs of over fishing showed by the depleting fish stocks, damages caused to ecosystems, economic losses as well as problems affecting international trade. All these threaten in the long run fisheries sustainability and consequently, their contribution to food supply. This worrisome situation led fisheries authorities to express their concern, at various international fora, for a new framework, focused at a better management of fisheries resources. The concerted efforts in this regard, led to the evolution of national fisheries edicts and conversation measure such as the Sea Fisheries Decree of 1971 updated in 1992 and Inland Fisheries Decree of 1992. The United Nations Organization (UNO) through its FAO Fisheries Department also came up with conservation measures including Code of Conduct for Responsible Fisheries and Fisheries Monitoring, Control and Surveillance (MCS) programmes.

The implications of all these programmes and efforts were to put in place sustainable fisheries management cardinals with the perceived aim of following a systematic procedure of rational exploitation of fisheries resources in such a way that the sustainable economic and social benefits accruing to man are conserved and maintained.

In 1986, during my visit as a British Council Scholar to University College of North Wales, UK, my study on the management of global fisheries resources revealed that a lot of work had been done on management of the fisheries resources of most lakes in Africa particularly those in West Africa, Nigeria's Kanji Lake though popular was not seriously considered for assessment of its fisheries potentials.

My focus shifted to how I can put Nigeria's Lake fisheries into global reckoning. I invariably proposed a research work to focus on the assessment of Asejire and Eleiyele man-made lake fisheries in Ibadan, Oyo State, Nigeria. I stimulated the interest of Dr. T.J. Pitcher and A. Maguran who have both acquired tremendous information on mainly the management of African Lakes in

Southern Africa (Malawi, Kariba, etc.) as collaborators in my singular effort. Consequently, the study was supported with the funds provided by the British Council.

The Study Area and Fishery of Asejire and Eleiyele Lakes

Asejire and Eleiyele are man-made lakes which were constructed in 1970 and 1942 respectively. They were both to supply water for domestic uses but they became relevant in fisheries activities as fishermen settled around these lakes to earn their living.

The morphometry of Asejire and Eleiyele lakes is presented in Table 2.

Table 2: Morphometry of Asejire and Eleiyele lakes

	Lakes	
	Eleiyele	Asejire
Location (Latitude and Longitude)	07°25'N	07°21'N
	03°55'E	04°05'E
Altitude (above sea level)	125m	135m
Main source of water	River Ona	River Oshun
Catchment area	323.7km ²	7175km ²
Length across dam	240m	840m
Total storage capacity (reservoir)	5.46km ³	32.9km ³
Maximum water elevation (at dam)	9.0m	153.9m
Length of lake	2.4km	11.2km
Water surface area	162ha	526ha
Average depth	6.0m	11.0m
Total dissolved solid (TDS)	174.7mg/l	154.2mg/l
Morpho Edaphic Index (MEI)	29.1	14.0
Flooded area	0.5km ²	6km ²

The Asejire and Eleiyele lakes were formed by damming the Oshun and Ona rivers which are part of the dense network of inland water courses that flow southwards into the Lagos creeks (Figures 2,3,4).

From its source of the dam, the river covers a distance of about 62 kilometres across thickly forested zones. The Eleiyele lake lies northwest of the city of Ibadan at an altitude of 125m above sea level. It has an area of 5.46 sq. km with a storage capacity of 1550 million gallons (70,460 x 10⁶ litres). The basin is long and narrow and divided into two main arms (Figure 3). At its widest, it is over 250m and at its narrowest just over 20m. The bottom profile is rather irregular and non-uniform in character being hard with gravel in some parts as well as soft with mud and decaying organic matters in others.

On the other hand, the Asejire lake was constructed in 1970 to supply additional water to the city of Ibadan after the realization that the requirement for water was fast exceeding the supply by the Eleiyele lake. The Asejire lake is located along latitude 07° 21'N and longitude 04° 05'E. It has a water surface area of 526 hectares and an average depth of 110m. The total dissolved solids is lower than that of Eleiyele, while the total flooded areas is larger (Figure 4). The Oshun River was dammed to create Asejire lake. The fishery activities of the lakes are under the jurisdiction of Fisheries Division of the Ministry of Agriculture and Natural Resources.

On the fisheries of both lakes, (Table 3) shows the list of resident fish species specifying the commercially important families. The nature of the fishery is multispecies and it is typical for tropical fisheries. Gill nets of varying sizes ranging from 2.5" to 4.6" were predominantly used for the Asejire and Eleiyele lakes.

Table 3: List of resident fish species in Asejire and Eleiyele lakes

1.	CICHLIDAE	*	(**)
	<i>Saothemon galilaeus</i>	*	
	<i>Tilapia zilli</i>	*	
	<i>Tilapia mariae</i>	*	
	<i>Hemichromis fasciatus</i>	*	
	<i>Pelmatochromis guentheri</i>	*	
2.	CHARACIDAE		(*)
3.	BAGRIDAE	*	(**)
	<i>Bargrus docmac</i>	*	
	<i>Achenoglanis occidentalis</i>	*	
4.	CLARIIDAE	*	(**)
	<i>Clarias lazera</i>	*	
5.	MOMYRIDAE		
6.	SCHILBEIDAE		
7.	HEPSETIDAE	*	(**)
	<i>Hepsetus odoe</i>	*	
8.	ICHTHYBORIDAE		
9.	CENTROPOMIDAE	*	
	<i>Lates niloticus</i>	*	
10.	MOCIIOKIDAE		
11.	CHANNIDAE	*	
	<i>Chana obscura</i>	*	
12.	ANABANTIDAE	*	
	<i>Ctenopoma kingslaviae</i>	*	
13.	CITHARINIDAE		
14.	CYPRINIDAE	*	
	<i>Barbus occiditalis</i>	*	
15.	SHRIMP		

In our study on the assessment of these lakes, catch and effort data were used. The data were obtained from the annual statistical reports compiled from

the monthly catch and boat-days statistics on man-made lakes of Fisheries Division of the Ministry of Agriculture and Natural Resources (1977-1986). The methods used to assess the lakes are variations in the Surplus Yield Model. This model is one of the two major types of fishery management models used to predict maximum sustainable yield (MSY) (This model fundamentally holds biomass regeneration as a single process and does not consider other effects that occur within the population. It also adopts the principle that modelling is basically concerned only with inputs and outputs to the biomass of the population, despite the fact that biomass regeneration subsumes a great many real population processes such as tissue growth, mortality and increase in number through reproduction).

Our study predicted MSY for Asejire and Eleiyele lake fisheries using the variation in Surplus Yield Mode (see figures 5, 6, 7 and 8).

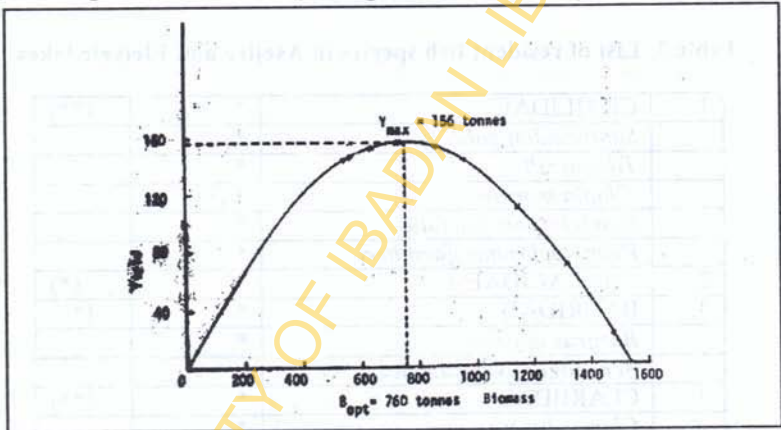


Fig. 5: Yield/biomass curve for Asejire Lake Fisheries using the Catchability (q) = 0.00198 obtained from Schnute's method. MSY was 156 tonnes with optimal biomass of 760 tonnes.

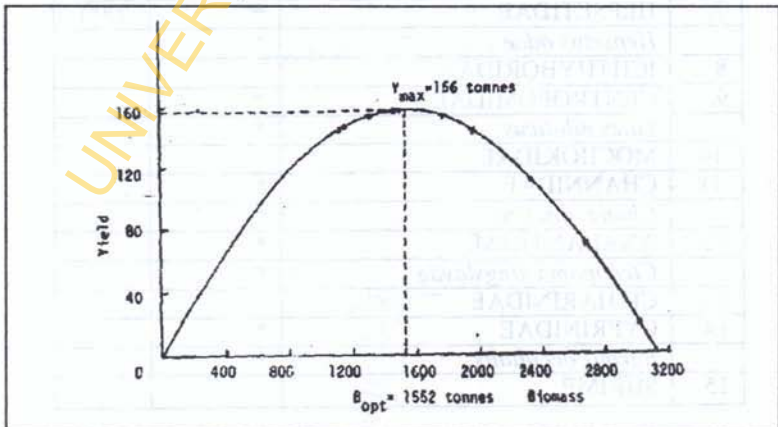


Fig. 6: Yield/biomass curve for Asejire Lake Fishery using the Catchability (q) = 0.00097 from Multiple Regression (Standard) method. MSY was 156 tonnes with optimal biomass of 1552 tonnes.

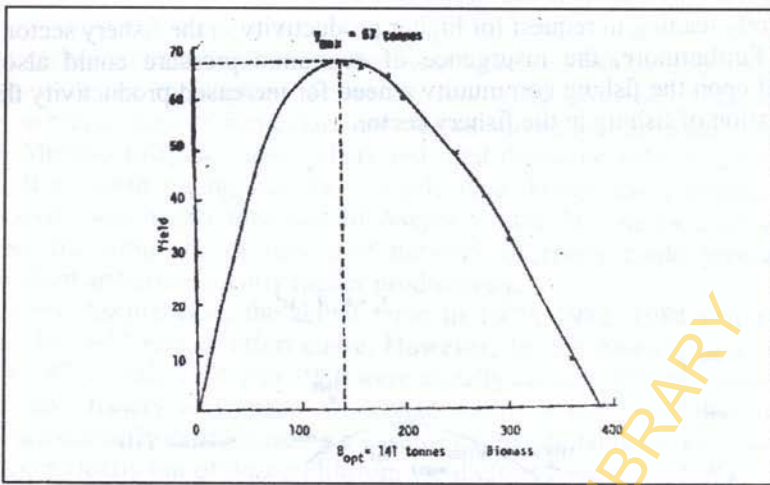


Fig. 7: Yield/biomass curve for Asejire Lake Fishery using the Catchability (q) = 0.00407 from Schnute's method. MSY was 67 tonnes with optimal biomass of 141 tonnes.

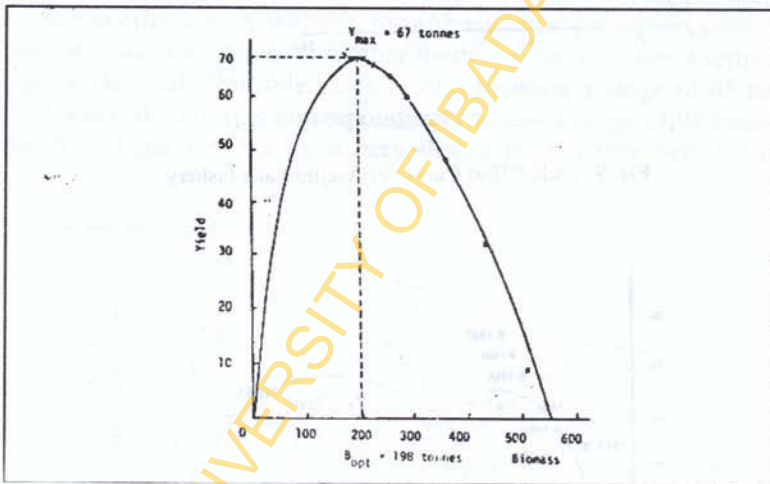


Fig. 8: Yield/biomass curve for Asejire Lake Fishery using the Catchability (q) = 0.00289 from Multiple Regression (Standard) method. MSY was 67 tonnes with optimal biomass of 198 tonnes.

To further elucidate on the state of the two lake fisheries Figures 9 and 10 reported the superimposition of actual yield data points on the equilibrium yield/effort curve. The highest fishing efforts were in 1982. Though there was increased fishing effort in 1982, our study revealed that the catches were not the highest for the ten-year period studied. This increase in fishing effort was traced to the introduction of Green Revolution programme of the then Federal and State Governments of Nigeria which made available more fishing boats and nets,

consequently leading to request for higher productivity in the fishery sector of the country. Furthermore, the insurgence of economic pressure could also have impressed upon the fishing community a need for increased productivity through intensification of fishing in the fishery sector.

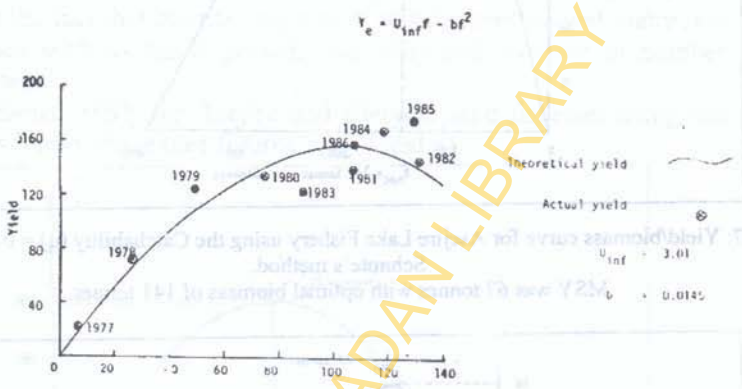


Fig. 9: Yield/Effort Curve for Asejire Lake Fishery

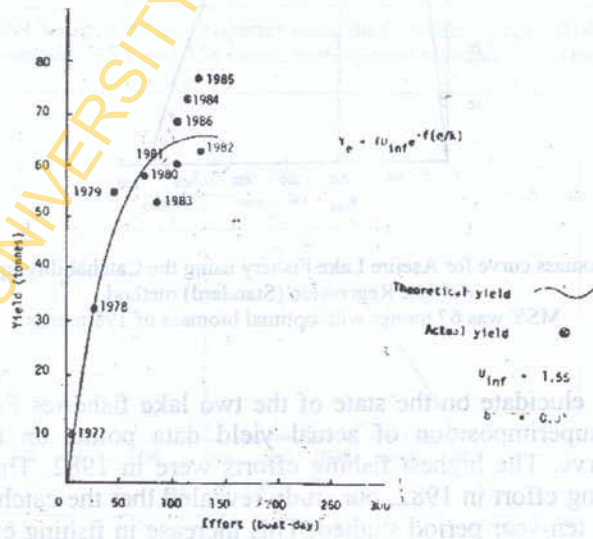


Fig. 10: Yield/Effort Curve for Eleiyele Lake Fishery

As earlier pointed out, though there was increased fishing effort in 1982s the catches were not the highest. However, biological processes such as random pulses in recruitment of particular year classes and natural productivity as shown by the Morpho-Edaphic Index (MEI) and total dissolved solid could have great effect. It is worth noting that the Eleiyele lake though has a smaller area, its productivity was higher than that of Asejire (Table 2). The location within the city and the influence of runoff of network of rivers could provide higher nitrification and consequently higher productivity.

For the Asejire case, the actual yield in 1979, 1982, 1984 and 1985 were outside the yield against effort curve. However, for the Eleiyele case, the actual yield in 1979, 1982, 1985 and 1986 were equally outside. While it seems that the Asejire lake fishery was operating in 1986 within a safe zone, that of Eleiyele seems to be clearly demonstrating a case of overexploitation as most of the later years were clearly out of the equilibrium yield effort zone.

Lastly, our study employed the use of Walter (1986) graphical method to assess the changing state of the Asejire and Eleiyele lake fisheries (Figures 11 and 12). Basically, Walter (1986) attempted to reduce the noise amplification where catch per unit effort against effort have been used, recommended the use of catch against effort. With Walter's recommendation and observation, the range of estimate is lower compared with other method estimates. For Asejire, Walter's method gave the total allowable catch (TAC) between a range of 65 tonnes and 147 tonnes while the effort is correspondingly within a range of 97 boat-days and 196 boat days. Thus, the Asejire fishery should be managed between the stated figures.

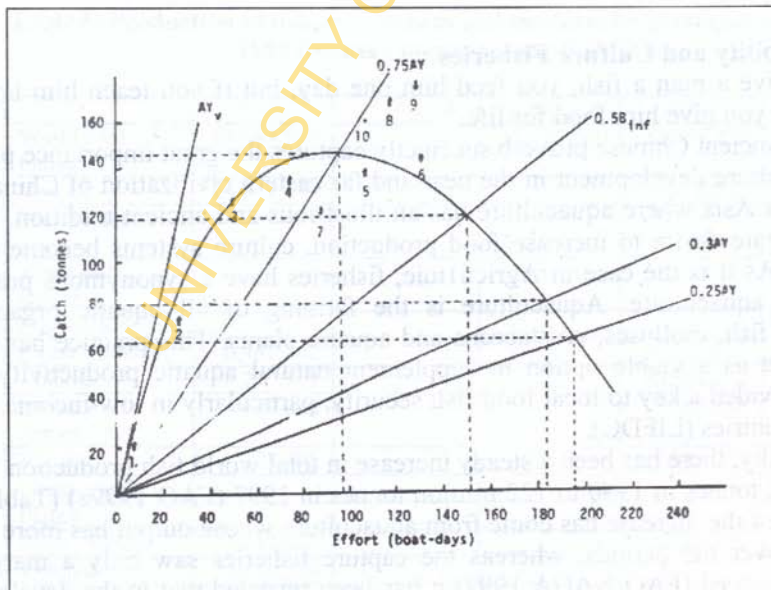


Fig. 11: Catch Versus Effort Data for Eleiyele Lake Fishery (Water graphical method)

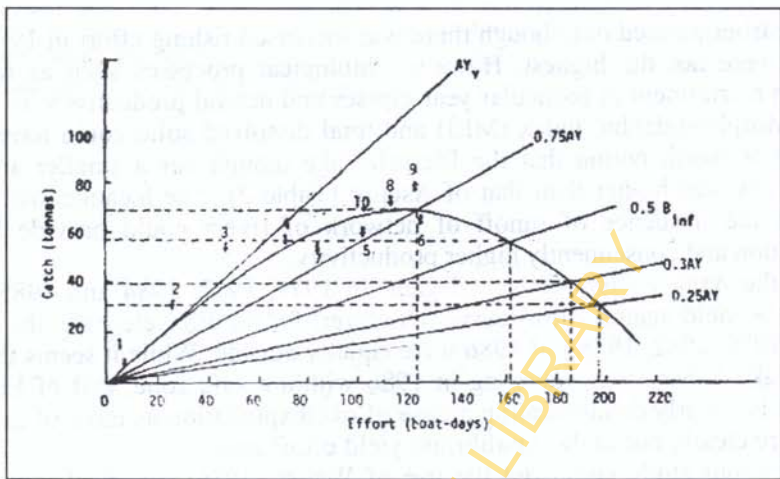


Fig. 12: Catch Versus Effort Data for Eleyeile Lake Fishery (Water graphical method)

The Eleyeile fishery, using the Walter's method gave between 30 and 70 tonnes of catch from a recommended effort*of 126 to 198 boat days. The lesson learnt is that capture fisheries has been traumatized by ripples of various dimensions. Its predictability has been a matter of concern worldwide. It is therefore not surprising that what has been a major source of fish supply to the teeming population who relish fish is fast declining. Consequently, the trend in increased productivity of fisheries resources has shifted to culture fisheries. This is discussed hereunder.

Sustainability and Culture Fisheries

"If you give a man a fish, you feed him one day, but if you teach him how to farm fish, you give him food for life."

This ancient Chinese proverb succinctly captures the great importance placed on aquaculture development in the near and far eastern civilization of China and South-east Asia where aquaculture has an illustrious and ancient tradition. With the desperate desire to increase food production, culture systems become quite relevant. As it is the case in Agriculture, fisheries have a synonymous practice which is aquaculture. Aquaculture is the farming of all aquatic organisms including fish, molluscs, crustaceans and aquatic plants. This practice has been recognized as a viable option to supplement natural aquatic productivity and hence provided a key to local food fish security, particularly in low-income food deficit countries (LIFDC).

Globally, there has been a steady increase in total world fish production from 99 million tonnes in 1990 to 122 million tonnes in 1997 (FAO 1999a) (Table 4). The bulk of the increase has come from aquaculture whose output has more than doubled over the periods, whereas the capture fisheries saw only a marginal increase. Indeed (FAO-NAGA 1997) it has been revealed that in the developing countries output volume from aquaculture grew at a rate of approximately 11% a

year during the period 1985-1995, this compared with a rate of only 2% in the developed countries.

Table 4: Global Increase of Aquaculture Production

World fish production		Nigeria
1997 → 122 tonnes		25,000 tonnes
1990 → 99 tonnes		18,000 tonnes
Growth rate of Aquaculture (1985-1995)	Developing countries	Developed countries
	11%	2%

Source: FAO 1984 Africa Aquaculture Situation

Nigeria's aquaculture production at 15,000 tonnes is second in Africa after Egypt. 84% of total aquaculture production in Africa from Nigeria and Egypt. 16% from other countries in Africa.

World aquaculture production of fish and shell fish (Table 5) totalled 30.8 million tonnes in 1998 and had an estimated value of US \$47 billion with China topping the league tables by producing 20.8m tonnes. With the 1998 estimated production of seaweed and other aquatic plants, the total world aquaculture harvest amounted to nearly 39.4m tonnes.

Table 5: Production of fish, crustaceans and molluscs by principal producers in 1998 (tonnes - metric value - US\$ '000)

	1990	1991	1992	1997	1998
World total - tonnes	13,084,267		15,470,000	28,824,238	30,863,067
Volume	24,652,574	25,000,000		45,812,563	47,081,126
World total + sea					
Weed and aquatic					
Plants - tonnes					39,400,000
China - tonnes	6,482,402			19,315,623	20,795,367
Volume	8,217,342			20,509,594	21,715,957
Norway - tonnes	150,028			367,298	408,862
Volume	773,205			1,081,823	1,133,580
China + aquatic					26,000,000
Plants					
India - tonnes	1,012,121			1,862,250	2,029,619
Volume	1,600,285			2,141,902	2,222,789
India + aquatic					
Plants					2,290,000

<i>Volume</i>				2,200,000
Japan – tonnes	804,293		806,534	766,812
Volume	2,885,463		3,525,432	3,061,798
Indonesia – tonnes	499,824		662,547	696,880
Volume	1,477,269		2,051,972	2,137,787
NIGERIA – tonnes				28,000

ASIAN COUNTRIES	= 27m tonnes	VALUE = \$38 billion
EUROPEAN COUNTRIES	2m tonnes	
NORTH AMERICA	656,288 tonnes	
SOUTH AMERICA	601,027 tonnes	
AFRICA	185,817 tonnes	

Comparing figures since 1990, there has been a year by year rise in farmed fish and shell fish production. Between 1990 and 1991 the volume rise was almost the same but from 1992 the harvest soared from 15.47m tonnes to 30.86m in 1998.

World farm production is much less evenly spread than the world catch. The latest figures show that it continues to be dominated by the Asian countries – 27m tonnes valued at US \$38 billion. European farms follow far behind producing a total of almost 2m tonnes with Norway topping the scale at 408,862 tonnes. North America comes third with 656,288 tonnes followed by South America at 601,027 tonnes. Africa produced a total of 185,817 tonnes.

If China's 6m tonnes of aquatic plants are included, China produced 26m tonnes, well over 50% of world production. India came in second place with 2.29m tonnes, but its estimated \$2.2 billion value was less than the \$3 billion from Japan's 766,000 tonnes and was about the same as Indonesian farmers earned from their 696,000 tonnes.

In 1981, I met the state of aquaculture in Nigeria quite appalling. In my submission on Nigerian aquaculture during the International Seminar on Aquaculture organized by Department of Aquaculture and Allied Fisheries of Auburn University, Alabama, USA to the international participants of the Aquaculture Training Programme held in 1982. I observed the following features of Nigerian aquaculture.

- Expansion of warm water fish culture on the African Continent involving the use of techniques of fertilization and feeding began rather late by early 1950s when compared with Asiatic aquaculture.
- In Nigeria, the art of fish culture was just over 25 years old then; now, about fifty years old.
- Noticeable achievement and documentation had practically been mostly a government affair.
- Early private initiatives for the adoption of: unworkable government

model fish farm were defeated inspire of the fact that the natural conditions for rapid aquaculture development in Nigeria are favourable.

- No single law and regulation for aquaculture in Nigeria
- Lack of adequately trained manpower in aquaculture.
- Public sector initiatives were demonstrated in building of six model fish farms in a country as big as Nigeria.
- Standardized inputs (feeds, fingerlings, fertilizer and lime etc) and usage practices were undeveloped.
- Fish being cultured were fed with table waste and roughages that do not meet the nutrient requirement of such species.
- Statistics on aquaculture were practically unavailable.

I also observed that the major constraint to Fisheries development in Nigeria and aquaculture in particular derived from Nigeria's wrong concept of the status of Fisheries at independence. Fisheries was believed to be synonymous with Zoology of aquatic species. Whereas, Fisheries is an economic terminology encompassing the state of commercially important aquatic resources, their exploitation and their utilization. Therefore the emphasis in fisheries is quantitative with qualitative undertone. By this definition, investors are not interested in the anatomy and physiology of fish species, neither are they interested in the biomaterial properties of fish. Investors would like to know of the quantities of fish harvestable, how to harvest them and how lucrative the fish market is. As far as they are concerned, fish is a commodity of trade like cement, yam, rice etc. and their major interest is the magnitude of return on their investment relative to other competing products therefore, the pre-occupation of the fisheries workers should have been to encourage capital formation and increase fish production in a bid to enhance fish consumption by Nigerians for proper growth (physically and economically) and good health.

As in agriculture, aquaculture also recognizes the interplay of all relevant experts in all fields of human endeavour. In trying to chart the course of aquaculture programme within our Department of Wildlife and Fisheries Management, I recognize the need to have animal fish nutritionist, aquaculture engineers, economist, fish diseases expert, fish breeders/geneticists, limnologist extentionists, soil scientists, among others all working in consonance to develop aquaculture sector of our economy.

For the aquaculture industry to thrive, apart from development of adequate manpower, there is also the need to research and develop various inputs of production such as feed, fish seeds (fingerlings), inorganic and organic fertilizer and economics of production. Consequently, in the last two decades, I have focused my research activities on some of these areas. In my research pursuit, I observed that the nature of Nigerian multispecies fisheries provides a diversity of species that have potential for aquaculture in the nation's natural waters. Table 6 shows culturable finfish and shellfish in Nigeria.

Table 6: Culturable Finfish and Shellfish in Nigeria

Local Species	Availability of seed for stocking	Known feeding habit
<i>Tilapia melanopleura</i>	Year round and adequate	Algae, Phytoplankton, Detritus various supplementary feed
<i>Orocharomis niloticus</i>	"	"
<i>Sarotherodon gahlae</i>		
<i>Tilapia zilli</i>		
<i>Chrisichthys nigrodigitatus</i> (cat fish)		Bivalves-supplementary feed-groundnut cake and palm kernel cake essential
<i>Liza falcipinis</i>	Year round and adequate	Detritus, phytoplankton, algae, supplementary feed
<i>Mugil bananensi</i>	"	"
<i>Liza gradisquamis</i>	"	"
<i>L. dumerili</i>	"	"
<i>Mugil curema</i>	"	"
<i>Clarias lazera/Clarias gariepinus</i>	"	Omnivorous, supplementary feed
<i>Heterotis niloticus</i>	Seasonal and inadequate	Phyto and zoo plankton
<i>Ethmalosa fimbriata</i> (Bonga)	Seasonal (?)	Phytoplankton
<i>Panaeus duorarum</i> (pink shrimp)	Seasonal	Detritus of both animal and plant origin
<i>Machrobrachium spp.</i>	Seasonal	Detritus of both animal and vegetable origin
<i>Lates niloticus</i> (Nile Perch)	Scarce	Predatory
<i>Hemichromis fasciatus</i>	Adequate	Predatory
<i>Latjanus apodus</i> (Snapper)	Inadequate	Predatory
<i>Lutjanus agenes</i>	Inadequate	Predatory
<i>Gymnarchus niloticus</i>	Inadequate	Predatory
<i>Elops lacerta</i>	Inadequate	Predatory
<i>Crassostere gasor</i> (Oysters)	Almost through the year and adequate	Phytoplankton
<i>H. bidrsalis</i>	Seasonal	Omnivorous
<i>D. engycephalus</i>	Seasonal	Herbivorous
<i>Distichodus rostratus</i>	Seasonal	Herbivorous
<i>Malapterurus electricus</i>	Seasonal	Predatory
<i>Megalops atlanticus</i> (Tarpon)	Seasonal	Predatory
<i>Pomadasys jubelini</i> (Grunter)	Seasonal	Predatory
Exotic		
Species already introduced		
<i>C. carpio</i> (Common carp)	Year round and adequate	Omnivorous
<i>M. salmoides</i> (Large mouth bass)	"	Predatory
<i>L. macrochirus</i> (Blue gills)	"	Omnivorous
<i>C. catla</i>	Inadequate	Herbivorous
<i>C. mrigala</i>	Inadequate	Herbivorous
<i>L. rohita</i>	Inadequate	Herbivorous
Exotic species worth introducing		
<i>C. idella</i> (Grass carp)	Nil	Feeds on grass and weeds
<i>H. molitrix</i> (Silver carp)	Nil	Phytoplankton

Source: Faturoti, 2000

As in other forms of agricultural and livestock production, there is the need to understand the environmental requirement as well as feeding regime before any meaningful aquaculture practice could be undertaken. Furthermore a fish species should be able to breed in captivity. There is therefore the need to stimulate all natural factors for fish to grow and reproduce under confined artificial facilities such as ponds, raceways, and aquaria.

Fish Feed Development

In 1983, I approached Pfizer Livestock Feeds requesting the organization through a proposal to support the development of fish feeds for some culturable fish species in Nigeria. The company is reputed for producing feeds for all categories of domestic livestock such as poultry, pigs, rabbits etc. All these livestock had well-developed feeds that meet their requirement for production. As of that time, Nigerian aquaculture had no reliable fish feeds formulation.

Consequently, my proposal was to work out the nutrient requirement of some culturable fish species using the requirements to develop practical fish feed formulations for various species. I worked with other scientists to lay a foundation for what is now seen as a dependable fish feed industry in Nigeria. In the last two decades, in over forty publications, our team of scientists comprising Faturoti, Balogun and Ugwu (1986); Ayinla (1988); Bamimore (1990, 1993); Aransiola (1991); Lawal (1991); Omitoyin (1995); Ipinjolu (1998); Obasa (1998) and Akande (2000) have contributed progressively and severally to the development of fish feed, seeds and other various inputs in aquaculture development and practices. Fish feeds were developed for popularly cultured fish species in Nigeria such as *Clarias gariepinus* - aro; *Heterobranchus spp* - aro else; *Chrysiochthys nigrodigitatus* - eja obokun; *Tilapia spp* - epiya and *Heterotis niloticus* - alapa. From our results on feed and protein utilization (Tables 7a, 7b and 7c) a range of 37% and 40% was optimum protein content of diets for juvenile *Clarias ganepinus*.

Table 7a: Gross composition of experimental diets

Percent Protein	DIETS				(M) +
	31%	34%	37%	40%	
Yellow maize	36.70	30.30	29.92	17.54	
Groundnut cake	32.97	37.23	41.49	45.74	
Fishmeal	9.89	11.17	12.45	13.72	
Blood meal	6.59	7.47	8.30	9.12	
Oil	5.00	5.00	5.00	5.00	
Brewer's waste	5.00	5.00	5.00	5.00	
Bone meal	2.50	2.50	2.50	2.50	
Oyster shell	0.50	0.50	0.50	0.50	
Ad-Vit	0.60	0.60	0.60	0.60	
Salt	0.25	0.25	0.25	0.25	
Total	100.00	100.00	100.00	100.00	

+ Microencapsulated egg diet (48.8% crude protein).

Table 7b: Proximate composition of experiment diet

Percent Protein	DIETS				
	31%	34%	37%	40%	(M)+
Determined					
Dry matter (%)	87.54	89.70	88.30	88.39	
Crude protein (%)	30.96	34.03	36.79	39.72	48.8
Ether extract (%)	10.22	10.43	10.61	10.80	43.2
Crude fibre (%)	3.54	3.66	3.75	3.86	
Ash (%)	13.12	15.53	10.56	10.65	
Calculated					
Calcium (%)	1.53	1.58	1.62	1.67	
Available					
Phosphorus (%)	0.78	0.82	0.86	0.90	
Lysine (%)	1.49	1.65	1.65	1.97	
Methionine (%)	0.57	0.63	0.68	1.73	
Methionine + Cystie (%)	1.10	1.20	1.30	1.40	
Metabolizable energy (ME)					
Kcal/kg)	3106.01	3081.45	3040.7	3008.45	4810.00
Total digestible nutrient(TDN)	80.33	80.72	4	80.84	
Starch equivalent (SE)	75.55	75.69	80.67	75.36	
Me: Protein ratio	10.03	9.06	75.42	7.57	9.86
			8.27		

+Microencapsulated egg diet (48.8% crude protein)

Table 7c: Growth and nutrient utilization of young *Clarias lazera* fed different dietary protein levels

Percent Protein	DIETS					
	31%	34%	37%	40%	(M)	(SE+)
Initial weight (g)	1.04	1.06	1.03	1.07	1.01	0.02 ^{NS}
Final weight (g)	1.82c	1.81c	1.67b	2.93b	1.40a	0.59++
Weight gain (%)	77.23c	70.75c	52.03b	89.85d	32.23a	12.59+
FCR ¹	20.17c	12.08b	15.91b	7.22a	26.80d	3.51++
PER ²	0.16b	0.32c	0.17b	0.35c	0.08a	0.02+
SGR ³ (W/D)	1.13a	1.73b	1.66b	2.29c	1.01a	0.51+
PPV ⁴	10.55b	21.44c	11.22b	49.73d	5.02a	1.86+
Nm ⁵	5.99b	5.77b	4.92b	14.30c	3.00a	1.36+
NPU ⁶	1.23c	1.08c	0.85b	2.29d	0.39a	0.12++

In a more detailed work on feed development for *Clarias gariepinus*, six experimental diets with varying protein contents between 25% and 40% were studied. Furthermore, their interplay of feeding on heteroplastic and homoplastic hypohysed products of *Clarias ganepinus* were also studied. A range of 31 % to 40% was responsible for the various performances of fingerlings, juvenile and adult Clarias. (Tables 8a, 8b, 9, and 10). Survival was best for the products of broodstock raised on 40% for both heteroplastic and homoplastic hypohysed Clarias.

Table 8a: The Gross Composition of Experimental Diets

Ingredients	1	2	3	4	5	6
Yellow Maize	49.45%	43.08%	36.70%	30.30%	23.92%	17.54%
Groundnut Cake	24.47%	28.72%	32.97%	37.23%	41.49%	45.74%
Fish Meal	7.34%	8.62%	9.89%	11.17%	12.45%	13.72%
Blood Meal	4.89%	5.74%	6.59%	7.47%	8.30%	9.15%
Oil	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Brewer's Waste	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Bone Meal	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Oyster Shell	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Vitamin Premix	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%
Sodium Chloride	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Calculated Crude Protein	25%	28%	31%	34%	37%	40%

Table 8b: Proximate composition of the Experimental Diets

Diet	Crude Protein	Fibre	Moisture	Ash	NF	Me	Calorie
	%	%	%	%	%	Kcal/kg	Protein ratio
1	25.26	3.33	13.53	10.64	37.39	3169.74	125.48
2	28.19	3.45	13.45	8.93	35.93	3137.45	111.29
3	30.96	3.54	13.42	9.71	32.39	3106.00	100.32
4	34.03	3.66	13.34	12.27	26.27	3081.45	90.55
5	36.79	3.75	12.39	14.47	21.00	3040.74	82.65
6.	39.72	3.86	14.06	14.4	17.16	3008.45	75.74
NIC OMR	31.73	2.62	9.8	5.18	46.98	2990.00	94.24

Table 9: Heteroplastic Hypophyisation of *C. gariepinus* using Cyprinus Carpio Pituitary and response of the Hatchings

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	NIOMR Feed
Average Broad stock	F1.0kg 46cm	F0.9kg 44cm	F1.0kg	F0.85kg 40cm	F0.90kg 43cm	F0.75kg 41cm	F0.8kg 41cm
Weight	M500g 30cm	M550g 11cm	M520g 32cm	M600g 35cm	M450g 29cm	M48g 32cm	M460g 32cm
Standard length	M500g 31cm	M500g 31cm	M5330 g 32cm	M500g 30cm	M500g 30cm	M450g 30cm	M500g 31cm
Average No of eggs	4,500	4,100	4,300	3,850	4,200	3,700	3,800
Average No. of Hatching	4,100	3,600	3,400	3,100	3,700	3,100	3,000
Average % Hatching	91	87.8	79	81	88	83	79
Average No. of Surviving fry	800	750	1,200	900	3,200	2,800	550
Average % Survival	19.5	20.83	38.71	29.03	86.46	90.32	18.33

M= Male
F= Female

Table 10: Homoplastic Hypophysation of *C. gariepinus* and response of the Hatching Experimental Diets

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	NIOMR Feed
Average Broad stock	F1.5kg 44cm	F0.9kg 46cm	F1.0kg 47cm	F0.80kg 36cm	F1.0kg 46cm	F0.80kg m	F0.8kg 41cm
Weight	M1.0kg 53cm	M1.0kg 46cm	M1.3kg 53cm	M0.8g 40cm	M0.7kg 36cm	M0.5kg 35cm	M0.6kg 37cm
Standard length	M1.0kg 53cm	M1.0kg 47cm	M1.0kg 48cm	M0.8kg 38cm	M0.8kg 38cm	M0.6kg 36cm	M0.6kg 36cm
Average No of eggs	6,500	4,500	4,600	4,000	4,200	4,360	3,900
Average No. of Hatching	5,200	3,300	3,200	3,000	3,600	3,700	3,100
Average % Hatching	80.00	73.3	69.57	75.0	85.7	86.05	79.49
Average No. of Surviving fry	1,100	60	850	1,600	3,000	3,200	840
Average % Survival	21.10	26.06	26.56	53.3	83.3	86.49	27.10

M= Male

F= Female

In a bid to improve on survival of early life forms of *Clarias gariepinus* under culture conditions through in depth study of nutrient requirements within the first 28 days of egg to hatchlings (unfertilized eggs to advanced fry), series of experiments were undertaken. Our findings revealed that the chemical composition of the early life forms were widely varied within the first 28 days (Table 11). Furthermore, the early feeding stages (fry) were subjected to varying experimental diets (30%, 40% and 50% protein content) (Table 12), varying stocking densities (50fry/m², and 80fry/m²) and varying feeding levels (10%, 20% and 30% body weight).

At 50fry/m² (Table 13) the highest survival rates were recorded. Mean weight of the fry also varied with the stocking density and feeding regime. The weekly mean weight distribution is presented in Figure 13. As the fry ages, the weight variation within the population varies. This situation is crucial to the performance of hatchery operation in Catfish farming.

Table 11: Proximate Composition of the Early Life Forms of the Experimental *Clarias gariepinus*

S/No.	Early life form	%CP	%EE	%Moisture	%Ash	%NFE
1.	Unfertilized eggs	34.290 ^a ±0.014	1.769 ^b ±0.001	62.574 ^b ±0.103	1.175 ^b ±0.001	0.147 ^a ±0.000
2.	Fertilized water hardened eggs	27.240 ^{ab} ±0.063	1.086 ^{ab} ±0.003	70.614 ^{ab} ±0.055	0.954 ^b 0.013	0.106 ^a 0.000
3.	Swim-up fry	16.081 ^b ±0.001	0.406 ^b ±0.007	82.945 ^a ±0.005	0.56 ^b ±0.004	0.005 ^b ±0.000
4.	Advanced fry	16.907 ^b ±2.143	0.816 ^b ±0.739	79.947 ^a ±2.061	2.259 ^a ±0.812	0.071 ^a ±0.000
	Significance	**	*	*	**	*

a,ab,b means without superscripts in vertical columns are significantly different (*P<0.05, or **P<0.01).

Key: CP-Crude protein; EE – Ether extract; NFE – Nitrogen free extract.

Table 12: Proximate Composition of the Experimental Diets

	Diet C ¹	Diet C ²	Diet C ³
% Crude protein	31.167	39.785	49.176
% Ether extract	6.199	5.875	6.189
% Moisture	8.019	7.896	7.413
% Ash	13.448	12.848	12.498
% Crude fibre	4.914	4.403	4.294
% Nitrogen free extract	36.253	29.193	20.430
Estimated Energy Content (Kcal/kg)			
(i) Gross (GE)	3764.667	3919.713	4105.509
(ii) Digestible (DE)	3078.049	3210.923	3343.795
(iii) Metabolizable (ME)	2436.494	2605.475	2821.584
DE/protein ratio	9.880	8.071	6.700
ME/protein ratio	7.820	6.550	5.740

Table 13: Final Survival Rates (%SR), Population Mean Weight (MWP), and Total Biomass (TBM) of First Feeding Larval *Clarias gariepinus*

	C _k (%CP)									0% (Critical)
	C ₁ -30%			C ₂ -40%			C ₃ -50%			
	B ₁ (FL)			B ₁ (FL)			B ₁ (FI)			
	B ₁ 10%	B ₂ 20%	B ₃ 30%	B ₁ 10%	B ₂ 20%	B ₃ 30%	B ₁ 10%	B ₂ 20%	B ₃ 30%	(Ctrl 0%)
(50)	Trt 1	Trt 4	Trt 7	Trt 2	Trt 5	Trt 8	Trt 3	Trt 6	Trt 9	Trt 28
%SR	98	100	100	100	100	98	93	62	91	74
MWP	0.46	0.47	0.65	0.60	1.00	1.07	0.52	0.82	1.12	0.23
TBM	38.43	40.31	54.80	50.91	85.37	89.12	40.93	43.30	86.35	14.43
(65)	Trt 10	Trt 13	Trt 16	Trt 11	Trt 14	Trt 17	Trt 12	Trt 15	Trt 18	Trt 29
%SR	93	95	96	93	91	95	95	75	60	49
MWP	0.56	0.72	0.82	0.64	1.29	1.51	0.57	1.24	1.20	0.37
TBM	57.21	75.31	88.14	66.24	128.80	159.70	59.67	102.80	80.66	20.11
(80)	Trt 19	Trt 22	Trt 25	Trt 20	Trt 23	Trt 26	Trt 21	Trt 24	Trt 27	Trt 30
%SR	54	54	77	54	33	71	77	74	71	28
MWP	0.86	0.98	0.79	0.78	1.30	1.00	0.80	0.80	1.04	0.53
TBM	63.53	71.25	82.73	57.41	58.51	95.84	83.33	80.30	99.70	20.04

Key:

A_i(SD) Stocking density (Number of fry/m²);

B_j - (FL) Feeding level (% body weight per day);

C_k - (%CP) Crude protein level of supplementary feed (%).

Trt - Treatment;

Ctrl- Control Treatment

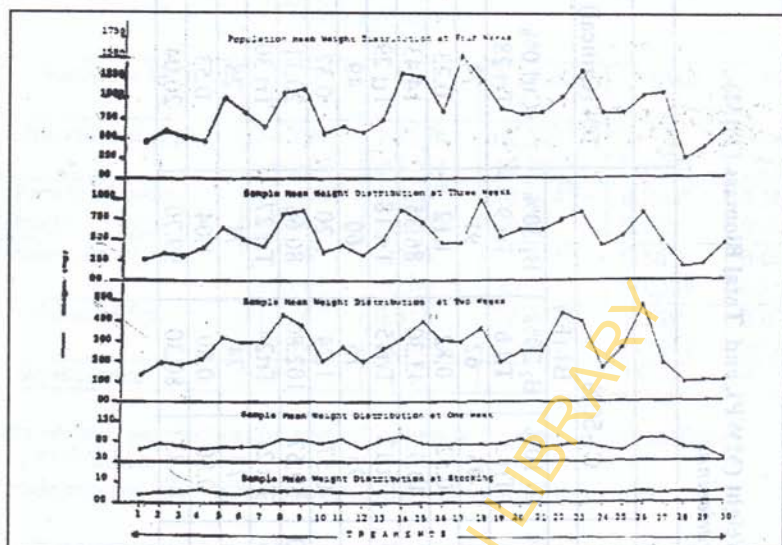


Fig. 13: Larval *Clarias gariepinus* Weekly Mean Weight Distribution at First.

In the course of promoting aquaculture in Nigeria through development of fish feeds that meet the requirement of *Clarias gariepinus* and other culturable fish species, it was observed that lack of cheap nutritive feed due to the rising cost of fish meal is a major constraint to intensification and expansion of aquaculture. Our research effort focused on development of alternative and unconventional feed stuffs to alleviate this problem.

With the emergence of large-scale poultry industries in Nigeria, there is the availability of enormous poultry waste that can be recycled to reduce cost of fish feed. Among the wastes identified were chicken feather and offals. Our major objective was to study the performance and utilization of these wastes in the diets of catfish. Feather with its natural keratinous structure is resistant to digestive enzymes. It is therefore imperative that some of these wastes may need further treatment to transform them to valuable protein. Consequently, in our studies feathers were treated by autoclaving, cooking with potash and the use of reducing agent such as sodium sulphide. All the treated feather products were incorporated into experimental diets with a range of 0% to 100% replacement levels.

Valuable deductions from the study are as follows: Yield of feather meal (fig. 14) from different processing methods are for autoclaved feather 55.8%, potash treated feather 52.8% and sodium sulphide treated feather 53.07%. Growth responses of *Clarias gariepinus* for autoclaved, potash and sodium sulphide treated diets are shown in figs. 15, 16, and 17.

Another study also evaluated the usefulness of chicken offal as direct food both in the raw and cooked form for *Clarias gariepinus*. A comparative analysis of fishmeal, raw offal and cooked offal is presented in table 14. The protein contents of fishmeal was 72.16%, raw offal 47.48%, while cooked offal was 61.58%. Growth responses of *Clarias gariepinus* fed differently processed chicken offal are presented in fig. 18. Cooked chicken offal gave the best growth

over and above the raw offal and control diet for *Clarias gariepinus*. In economic terms, Table 15 gave indices of return on investment in a catfish production based on the use of offals. The cooked offal still gave the best result.

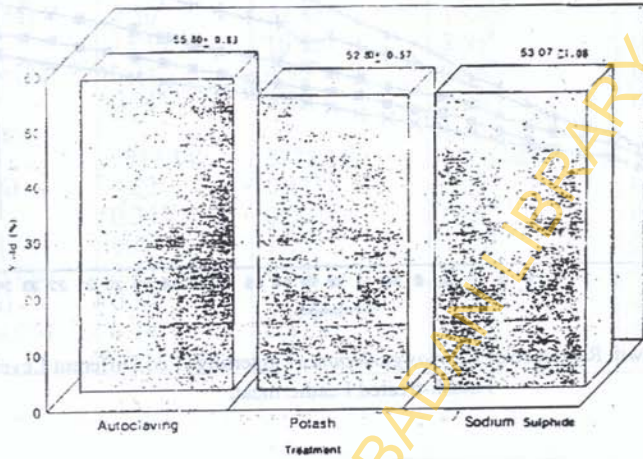


Fig. 14: Yield of Feathermeal from Different Processing Methods

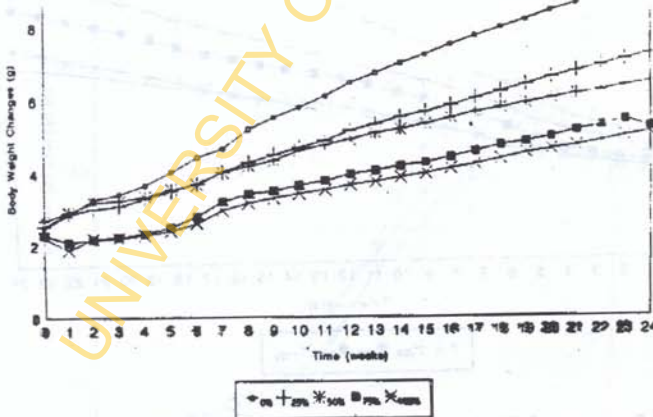


Fig. 15: Growth Response of *Claria gariepinus* Fingerlings Fed Differently Levels of Autoclaved Feathermeal.

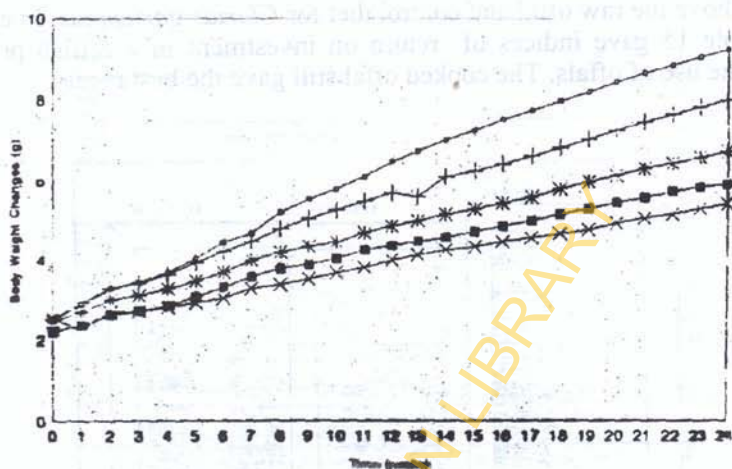


Fig. 16: Growth Response of *Clarias gariepinus* Fingerlings Fed Different Levels of Potash-treated Feathermeal.

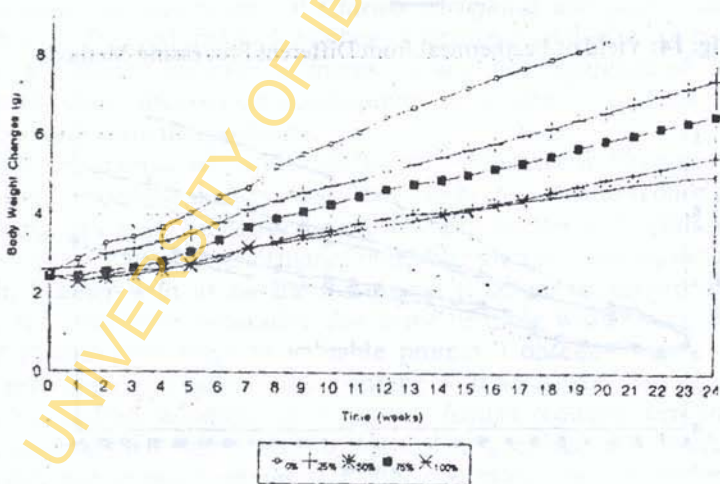


Fig. 17: Growth Response of *Clarias gariepinus* Fingerlings Fed Different Levels of Sodium Sulfide-treated Feathermeal.

Table 14: Proximate, Gross Energy and Mineral Composition

Parameters	Fish Meal	Raw Offal	Cooked Offal	SEM	ANOVA SIG.
Moisture (%)	6.37 ^b	8.58 ^a	8.27 ^a	0.37	***
Crude Protein (%)	72.16 ^a	47.48 ^c	61.58 ^b	3.58	***
Crude Fat (%)	7.50 ^c	22.82 ^a	16.45 ^b	2.23	***
Ash (%)	13.19 ^a	10.85 ^b	8.96 ^c	0.63	***
Crude Fibre (%)	0.34 ^c	4.95 ^a	3.46 ^b	0.68	***
NFE (%)	0.34 ^b	6.09 ^a	2.20 ^b	0.91	***
Gross Energy					
Kcal/kg	3012.14 ^c	5278.14 ^c	5060.38 ^b	361.02	***
Calcium (%)	4.82 ^a	0.42 ^b	0.23 ^b	0.75	***
Iron	0.347 ^a	0.00 ^b	0.00 ^b	0.01	***
Potassium (%)	0.38 ^b	1.13 ^a	1.10 ^a	0.12	***
Magnesium (%)	0.37 ^a	0.35 ^a	0.27 ^b	0.02	***
Sodium (%)	0.18 ^c	3.11 ^a	2.57 ^b	0.46	***
Phosphorus (%)	3.14 ^a	0.71 ^b	0.38 ^c	0.44	***

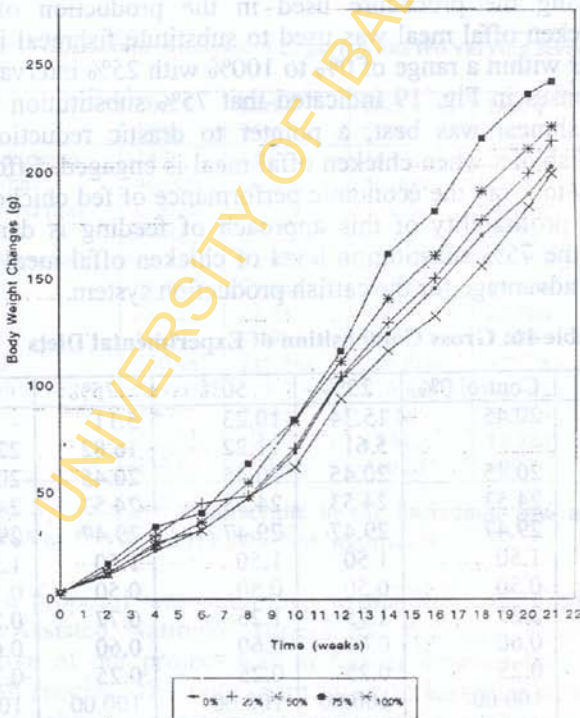
Fig. 18: Growth Response of *Clarias gariepinus* Fed Different Level of Chicken Offal Meal.

Table 15: Economic Analysis of *C gariepinus* fed differently processed offal

Parameters	Control Diet	Raw Offal	Cooked offal	SIG
Production period (days)	147	147	147	
Stocking density/ha	40,000	40,000	40,000	
Surface area of pond	0.002 ^b	0.002 ^a	0.002 ^b	
Pond Depth (cm)	0.78 ^{ab}	0.74 ^b	0.82 ^a	***
Net production (kg/pond)	11.38 ^b	21.02 ^a	22.83 ^a	*
Survival rate (%)	91.80 ^b	94.12 ^{ab}	98.36 ^a	***
Feed input	22.22 ^c	85.31 ^a	76.65 ^b	*
Cost of feed/kg(3)	10.37 ^a	2.50 ^c	2.85 ^b	***
Total cost of feed (3)	230.46 ^a	213.28 ^a	218.45 ^a	*
Total value of fish	569.09 ^b	1050.80 ^a	1141.71 ^a	NS
Profit Index	2.47 ^c	4.93 ^a	5.23 ^a	***
Incidence of cost	20.25 ^a	10.15 ^b	9.57 ^c	***
Gross profit (3)	338.63 ^c	837.52 ^b	923.26 ^a	***

Means followed by the superscript on the same horizontal row are not significantly different (* $p > 0.05$ or *** $P > 0.001$). NS = Not significant

In pursuit of better utilization of chicken offal, chicken offal was processed into meal following the procedure used in the production of commercial fishmeal. The chicken offal meal was used to substitute fishmeal in the diets of *Clarias gariepinus* within a range of 0% to 100% with 25% intervals (Table 16). The growth responses in Fig. 19 indicated that 75% substitution level chicken offal meal for fishmeal was best, a pointer to drastic reduction in cost of production of catfish diet when chicken offal meal is engaged. Efforts were also made in this study to x-ray the economic performance of fed chicken offal meal. Indicators on the profitability of this approach of feeding is demonstrated in Table 17. Again, the 75% substitution level of chicken offal meal for fishmeal, conferred the best advantage for the catfish production system.

Table 16: Gross Composition of Experimental Diets

Ingredient	Control 0%	25%	50%	75%	100%
Fish meal	20.45	15.34	10.23	5.11	-
Chicken offal meal	-	5.61	11.22	16.82	22.43
Soyabean meal	20.45	20.45	20.45	20.45	20.45
Groundnut cake	24.53	24.53	24.53	24.53	24.53
Yellow maize	29.47	29.47	29.47	29.47	29.47
Bone meal	1.50	1.50	1.50	1.50	1.50
Oyster shell	0.50	0.50	0.50	0.50	0.50
Palm oil	2.25	1.75	1.25	0.77	0.27
Ut/Premix	0.60	0.60	0.60	0.60	0.60
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
% of crude protein	40.00	40.00	40.00	40.00	40.00

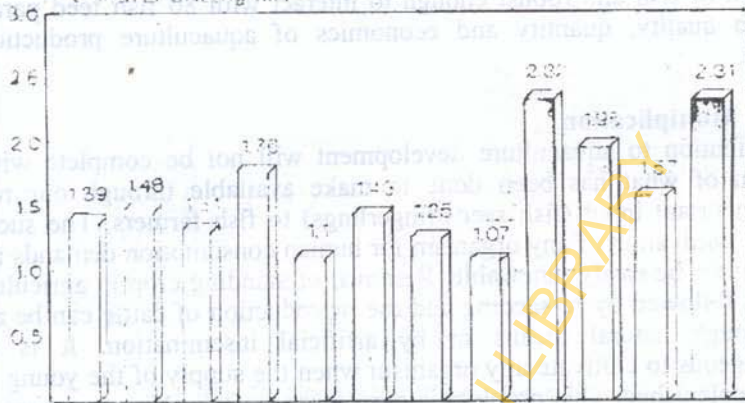


Fig. 19: Monthly Variations in Progesterone (ng/ml)

Table 17: Economic Analysis of *C. gariepinus* fed varying levels of COM

Parameters	Diet 1 10%	Diet 2 25%	Diet 3 50%	Diet 4 75%	SIG 100%	
Production period (days)	147	147	147	147	147	
Stocking density/ha	40.000	40.000	40.000	40.000	40.000	
Surface area of pond (ha)	0.002a	0.002a	0.002a	0.002a	0.002a	NS
Pond depth (cm)	0.78a	0.78a	0.78a	0.78a	0.78a	NS
Net production (kg/pond)	11.38 ^a	12.47ab	12.22ab	13.35a	11.406ab	*
Survival rate (%)	91.80 ^a	95.08a	90.16a	90.16a	93.44a	NS
Feed input (kg)	22.22 ^a	22.7a	22.14a	22.98a	20.75a	NS
Cost of feed (kg)	10.37	9.49b	8.61c	7.72d	6.8c	***
Total cost of feed	230.46 ^a	215.88a	190.60b	177.28b	141.75c	***
Total value of fish	569.09 ^b	623.70ab	610.8ab	667.53	570.34b	*
Profit index	2.47 ^c	2.89d	3.21c	3.77b	4.03a	***
Incidence of cost	20.25 ^a	17.30b	15.9c	13.28d	12.42c	***
Gross profit	338.63	407.82	420.24	490.24	428.60	

Means followed by the same superscripts in the horizontal row are not significantly different (* $P > 0.05$ or *** $P > 0.001$); NS: Not Significant

In 1996, a proposal was submitted to the Research Grant Scheme of the World Bank Assisted National Agricultural Research Project (NARP). The overall objective of our project was to further develop fish feeds suitable for indigenous fish species. The only grant given to Fisheries nationwide under the Research Grant Scheme was to our team of scientists under my leadership.

Arising from this grant, we were able to develop over 60 fish feed formulations that considered the interplay of least cost feedstuffs for more effective and economical production of fish feeds through aquaculture. In addition a FAT-NARP computer software programme ammenable to rapid formulation of fish and robust enough to interact with 80 fish feed parameters relating to quality, quantity and economics of aquaculture production was developed.

Fish Seed Multiplication

Our contribution to aquaculture development will not be complete without a submission of what has been done to make available through our research another important input (fish seeds/fingerlings) to fish farmers. The successful large scale cultivation of any organism for human consumption demands that the living resource be easily renewable. Removal of standing crop in agriculture for instance is followed by re-seeding and the reproduction of cattle can be assured either through natural means or by artificial insemination. It is clearly disadvantageous to cultivate any organism when the supply of the young cannot easily be replenished. This problem is even more acute in Nigeria where only a few species of fish are cultured. There are two solutions to this problem which are either collecting fish from natural sources or breeding fish in captivity. The latter option has received more attention in our research agenda in view of the rapid growth which aquaculture is experiencing in the country.

Reproductive processes are by no means fully impaired in captivity. The progressive development of gonads remains in general inhibited up till the final stages of gamete maturation, and it is only at the point of gamete release that the sequence is arrested. Both gonadal maturation and spawning behaviour have long been known to start in responses to environmental stimuli such as temperature, photo period and the amount of rainfall etc. In aquaculture, it has proved possible to intervene successfully at the stage where the needed environmental cues are lacking and to push the process to an artificial completion. This has been accomplished through the technique of induced breeding through hormonal manipulation. However, a knowledge of the gonadal hormones associated with reproduction is necessary for a successful manipulation externally. It is noteworthy that our earlier work on *Clarias gariepinus* succeeded in the more rapid dissemination of methods of artificial propagation which presently has made it possible for most hatchery operators and fish farmers to produce in massive quantity fingerlings/seeds for grow out ponds.

Effort was also initiated on another aquaculture fish species which is highly relished. The species is *Chrysichthys nigrodigitatus*, also a catfish but with the local name *Obokun*. This fish commands high consumer's acceptability that it is implicated in its ability to hook lovers by its occultic potency. It has been reported that estranged wives have resulted to this "*Obokun*" fish to win back the hearts of their husbands. Our baseline study was to determine the gonadal steroids of *Chrysichthys nigrodigitatus* (progesteron, testoteron, and oestradiol) and also determine the seasonal and environmental influences on these hormonal parameters (figs. 20, and 21). Radioimmunoassay (RIA) procedure was employed to determine the effects of season on the three steroids.

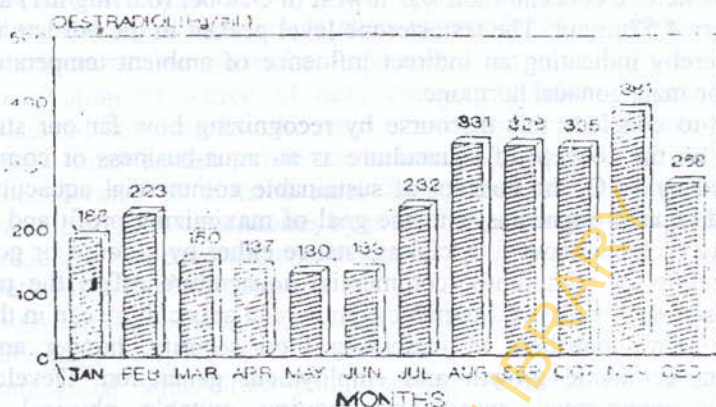


Fig. 20: Monthly Variations in Oestradiol (ng/ml)

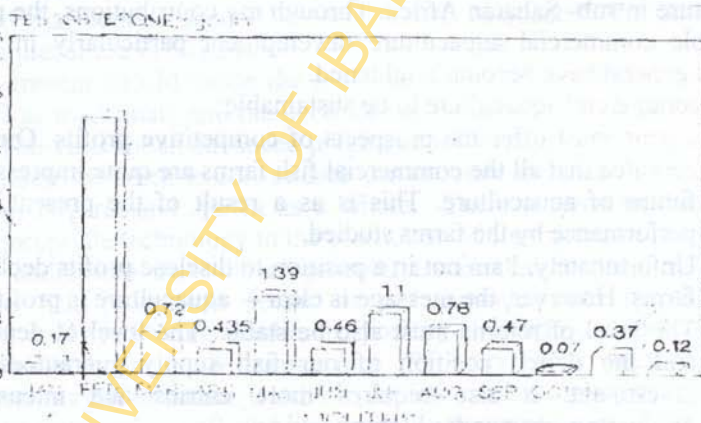


Fig. 21: Monthly Variations in Testosterone

Progesterone

Mean progesterone concentration was 1.76mg/ml in April, dropped to the lowest concentration in August and rose to a maximum concentration of 2.32mg/ml in September.

Oestradiol

The plasma concentration of 17 β oestradiol was lowest in May 129.62pg/ml and highest in November, 318.77pg/ml. The progesterone and oestradiol peaked during the spawning period.

Testosterone

Mean testosterone concentration was lowest in October (0.07mg/ml) and highest in February 4.52mg/ml. The testosterone level peaked in the hot late dry season month thereby indicating an indirect influence of ambient temperature on the level of the male gonadal hormone.

I like to conclude this discourse by recognizing how far our studies have impacted on the concept of aquaculture as an aqua-business or commerce. As recognized by FAO, the concept of sustainable commercial aquaculture is the rearing of aquatic organisms with the goal of maximizing profit and mainly by the private sector without financial assistance either by a donor or government. By generating its own funds, commercial aquaculture offers the prospect of financial self-sufficiency. Sustainable commercial aquaculture can in the medium and long term contribute to increasing food security, hunger and poverty alleviation, economic growth and employment generation. Development of sustainable commercial aquaculture requires suitable physical, technical, economic, market conditions, legal and policy environment.

I have been able to capture the concept of aquaculture and its potential in Nigeria and Africa. For the past one year, I have been involved through Food and Agriculture Organization of United Nations (FAO) in a survey of Commercial Aquaculture in sub-Saharan Africa. Through my contributions, the prospects for sustainable commercial aquaculture development particularly in Nigeria and Africa in general have become brightened.

For commercial aquaculture to be sustainable:

- Farms must offer the prospects of competitive profits. Our survey has revealed that all the commercial fish farms are quite impressed about the future of aquaculture. This is as a result of the present encouraging performance by the farms studied.
- Unfortunately, I am not in a position to disclose profits declared by such farms. However, the message is clear – aquaculture is profitable.
- The level of returns must also be stable. The level of demand for fish and the deficit position of our fish supply guarantees returns on investment. It also requires more entries and intensification of production systems for higher yield.
- The fish farmed and the farming processes must be acceptable and meet general, cultural, gender and social norms, especially when the output is intended for domestic consumption. The fish from aquaculture are quite acceptable. The demand at present cannot be met.
- Aquaculture operations must also be environmentally friendly, in part because sustainable development requires intergenerational equity. Therefore aquaculture's contribution to the potential well-being of future generations should be expected to be at least as high as the present, which implies that both natural and man-made assets be at least maintained over time.

Our studies further revealed the advantages of commercial aquaculture to include the following:

- Contribution to food security, directly by producing fish for food, and indirectly by generating employment income for the purchase of food.
- Contribution to the government revenues.
- Contribution to source of hard currency through exports; even if consumed domestically, the output from commercial aquaculture may replace imported fish and this saves foreign exchange.
- When located in isolated rural areas, commercial aquaculture can generate positive externalities by pressuring for improved infrastructure, promoting the development of small communities and discouraging youths from migrating to cities.
- Commercial aquaculture can generate jobs in secondary (processing, marketing, transportation...) industries.
- Commercial aquaculture can stimulate research and technological development and some of it can be funded by the industry itself.

The situation as presented is one that brightens hope for sustainable aquaculture and fish self-sufficiency in Nigeria and Africa. However, it is not time for our team of aquaculturists to rest on our oars. It is however, recommended that actions should be identified to re-quantify the potential of commercial aquaculture in Nigeria and Africa as a whole.

The government should tackle the problem of low private investment in the sector as well as inadequate and the need for increased feed and seed in quantity and quality. This calls for an advanced pragmatic research agenda.

Action should be taken to consolidate and promote the gains of commercial aquaculture in Nigeria and Africa as a whole. There is need to enhance the transfer of appropriate technology in the promotion of commercial aquaculture.

It is by addressing these developmental issues that the ripples that still permeate the fish production sector of our economy can be settled for sustainability, improved living conditions, poverty alleviation, food security and indeed the well-being of entire human race. "Nobody fights water and wins", water is a precious gift of nature, a vehicle for fish production to better the lot of mankind. I like to call on all and sundry to support in every little way the sustenance of our fish production and settle the ripples of our life.

Ripples and Development of the University System

The management of ripples in the fish industry gives some useful insight into ways of handling the ripples in our educational system and the socio-political system of our country. It is my personal observation over the years as a researcher, teacher and administrator in the University system that the lack of sustainability of many potentially viable projects has been largely due to the culture of personalizing and narrowing the frontiers of knowledge by limiting such projects to the ability and absolute control of the Chief executor. I am referring to the carving and grabbing of empires by individual scientists.

There is a need to start seeing the University as a corporate body where interdisciplinary research can be nurtured to have bearing on the development of our society. Any viable organization exists because of a felt need in the society. This need might be obvious, unexpressed or unappreciated. It is therefore the responsibility of the University to make its impact felt through development of such research projects that bear direct relevance to solving the needs of different facets of our society. As the sustainability of the fish industry can only be guaranteed through the recognition of the need to develop all facets of that industry. So, it is that the talents of all must be recognized within the system and these should be judiciously harnessed for the improvement of our community and the larger society.

The nation is presently nurturing a nascent democracy. The concern is that kleptocracy, sycophancy, and hypocrisy keep dominating our polity. The way out of this, is to build the culture of self reliance particularly in our youths. It is only as we recognize and develop the talents of each individual rather than encouraging them through our examples of reaping where we do not sow and channelling their energies to be job creators rather than job seekers, that we can redress these issues and move towards a new social order. The Faculty of Agriculture and Forestry has over the years tried to inculcate this into its students; it is our intention in the immediate future to bring our impact to bear more on our society through increased production of food, meat, fish and other agricultural produce through staff and students whose talents would be harnessed for this purpose.

We also have our research agenda which in essence will be market-oriented, farm-gate targeted, and private-sector driven to ensure the sustainability of our training and research programmes. It is our conviction that by harnessing the talents of all in executing this agenda, we will be contributing our quota not only in meeting the nutritional needs of our society but also building a group of virile, energetic, curious and responsible youths in our graduates who will be fired by seed of self-reliance to find fulfilment in selfless and responsible service to the community. It is my humble submission that all stakeholders should be allowed to find their usefulness in our community and the larger society. Through this, we will be better positioned to manage the ripples in different facets of our community and thereby restore Ibadan to its place of leadership and excellence nationally and in the global academic community.

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17

ELEMENTS, METALS, CATIONS AND HUMAN DISEASES: A COMING OF AGE

F.A.A. Adeniyi

Department of Chemical Pathology

Introduction

I feel extremely honoured this evening standing before this august assemblage of eminent scholars, committed academics, selfless patriots and thoughtful friends in order to render an account of what, I have, along with others, been able to structure together over a period of about two and a half decades or more concerning my speciality area within the discipline of Chemical Pathology. This lecture is the third in the series for the 2000/01 academic session and indeed the fourth from our Department of Chemical Pathology. The first was delivered by Professor David Olatunbosun, someone I referred to a short while ago as my mentor and I am repeating it for emphasis. He was a previous Head of Department and he is currently the Provost, College of Health Sciences, Ladoke Akintola University of Technology. The second was by Professor Babatunde Osoimehin, also a previous Head of Department and more importantly a former Provost of our dear College and the third was by Professor Oluyemi Agbedana, the present Head of our Department. Our Department is constituted into nine speciality areas under six units. The first lecture came from the Trace Elements Unit, the second from the Endocrinology Unit, the third from the Lipid Unit and this present one is again coming from the Trace Elements Unit.

Over the years until today, society has been sending the same message to us, professional scientists; what they say to us is this: tell us about the end points of science and technology, and not the basic science underlying them! Such a call from the lay public, to my mind is unfair and unjustifiable to science itself. It is in response to this kind of request from basically unscientific minds that I have decided, in this humble presentation, to review the interactive roles of some basic entities of science in the pathogenesis of certain human diseases.

An inspection of the Periodic Table of Elements will reveal that as of today 106 elements have been allotted slots in the table (fig. 1). In order to maintain the

structural and functional integrity of its cells, the human body needs only 21 of these elements. The human body needs C, H and O to make up water, simple lipids and carbohydrates; water constitutes about 70% of the total body weight in an adult male and about 60% in the adult female. Lipids serve many important structural and biochemical roles in the human body in addition to providing a concentrated source of energy. Carbohydrates provide about 50% of our energy needs. The human body also needs N and S to make proteins and other nitrogenous substances; proteins serve to maintain body structure, to regulate body functions and to allow for body growth.

The human body also requires Ca and P for various vital physiologic and biochemical processes. For example, the ionized calcium fraction i.e. the divalent cations of Ca has six principal functions in the human body. It is required for skeletal mineralization, for blood coagulation, for neuromuscular conduction, for the maintenance of normal tone and excitability of skeletal and cardiac muscle, for stimulus secretion coupling in various exocrine glands and for the preservation of cell membrane integrity particularly in terms of Na^+ and K^+ exchange. It is also mandatory for the human body to have adequate supplies of K, Na and Cl. These three elements maintain in part, the electrolyte composition of tissue cells and circulating fluids. Electrolytes are of extreme importance to the human body. All metabolic events in man are effected to some reasonable degree by the relative and absolute concentrations of the electrolytes. Electrolytes are important determinants of osmolality, state of hydration of the body and pH (i.e. H^+ concn) of both the intracellular (ICF) fluid and the extracellular fluid (ECF). In addition, membrane potentials and normal functioning of nervous and muscle tissue are closely regulated by the concentration differences between ICF and ECF electrolytes.

These 10 elements that I have mentioned are among the group we commonly refer to as bulk or macronutrient elements. Chemists refer to them simply as macroelements (fig. 2). There are 13 other elements which are either concerned with the activation of many enzymes systems or are integral parts of some of the enzymes themselves. They are referred to as trace or micronutrient elements. Again, chemists refer to them simply as microelements. Most of these microelements function in the body as metalloenzymes, as co-enzymes, as enzyme activators or as component atoms in other biologically active macromolecules such as I in thyroid hormones, Fe in hemoglobin and Cr in glucose tolerance factor. These elements (fig. 3) are further sub-classified as essential trace elements to distinguish them from nineteen other elements which also satisfy the criteria for classification as trace elements but which unfortunately are either toxic or inert to the human body. Those nineteen elements are referred to as non-essential toxic elements (fig. 4).

In man, a trace element is defined as one that makes up $<0.01\%$ of the total body mass. Of the 13 essential trace elements, 11 of them are vital for the life and health of humans. These are Cu, Fe, Mg, Mn, Zn, Mo, Co, Cr, I, F and Se. Bo and V are required essentially by plants and animals. A summary of these essential trace elements of man indicating their sources, RDAs, RNIs, ESSADIs, major functions, deficiency, groups at risk and toxicity is shown (fig. 5).

During these past twenty-five years or more, I have, in collaboration with some of my teachers, some of my colleagues and with all my PG students looked more closely into various aspects of these essential trace elements of man. We have carried out some comprehensive relevant investigations on all of them. We have also studied two of the non-essential toxic elements viz: Pb and Cd. We have done this because the toxic elements are adventitious as far as the human body is concerned. They all can gain entrance into the human body via food, water, external environment and by physical contact.

However, because of the limitation of time for an inaugural lecture, a limitation which must again not be a reason for compromising or sacrificing quality, I have decided in this humble presentation to discuss some of our major findings for three essential trace elements (Copper, Zinc and Magnesium) and one non-essential toxic element (Lead).

Copper

Copper is an excellent catalyst for many oxidation — reduction reaction systems. The element shows great versatility for an impressive variety of oxidation — reduction reactions including the formation of water from H and O at body temperatures. Such a reaction will be highly explosive without the catalytic cover of copper. A good number of important diagnostic and investigative enzymes have been shown to be copper metalloenzymes. These include cytochrome-c-oxidase, superoxide dismutase, ceruloplasmin, tyrosinase, uricase, dopamine- β -hydroxylase, lysyl oxidase, spermine oxidase, benzylamine oxidase, diamine oxidase and histaminase to mention a few. The element functions in the synthesis of Fe and protoporphyrin to form heme. Among the most significant clinical features of a copper deficiency state is a microcytic hypochromic anaemia.

While working in the Department of Biological Sciences at the University of Lancaster, Lancashire in England between 1976-78, we were particularly inquisitive about the form of anaemia that results from a Cu-deficiency state. This is the same form of anemia that is associated with Fe-deficiency. Our experimental efforts using the Wistar albino rats as an animal model were quite rewarding. We conclusively established that for ionic Fe, the divalent cation of the metal i.e. the Fe^{2+} ions to be transported out of the intestinal mucosal cells, there must be adequate amounts of the copper transport protein, an α_2 globulin, ceruloplasmin. So, as it is, even when Fe was sufficient in the diets of our Cu-deficient animals, a microcytic hypochromic anemia characteristic of Fe deficiency still resulted. These early observations by Heaton, Loveless, Alfaro, Nehlawi and Adeniyi^{1,2} have since been confirmed in human by many others^{3,5}. The most current consensus of opinion on this subject today can be summarised thus (fig. 6). Certainly, this kind of information must be important and valuable to the clinician who is confronted with a patient who may not be responding to the direct conventional treatment for iron deficiency anaemia.

Still treading in the terrain of the hematologist; in one of our earliest investigations published in the "*Lancet*" in 1973, we established a direct correlation between hypocupremia and the degree of irreversible sickling that might have taken place in a sickle cell anemia patient. This observation was

made by Olatunbosun, Isaac-Sodeye, Adeniyi and Adadevoh⁶. The observation emphasizes the cooperative role of divalent cations of Cu^{++} with other monovalent and divalent cations of other essential micronutrients in the maintenance of the structural integrity of the red cell membrane.

On the other side of the coin are situations associated with hypercupremia and problems associated with excessive accumulation of copper in the human body. In two separate studies we established hypercupremia in pregnancy and in women using oral contraceptives. We suggested that the hypercupremia was being determined by estrogen levels. This is particularly so as plasma Cu rose with increasing age of normal uncomplicated pregnancy and levels did not change with increasing age of abnormal complicated pregnancies. Additionally, plasma Cu levels rose in women using oral contraceptives that contain high levels of derivatives of estradiol, while levels did not change in women fitted with intra-uterine contraceptive devices (IUCDs). The sum total of these various observations made by Olatunbosun, Adeniyi and Adadevoh^{7,8} emphasize the fact that Cu is necessary for the healthy development and maintenance of all products of conception.

All essential trace elements of man are toxic if taken in sufficient excess. However, Cu toxicity is rare from dietary sources. Nevertheless, severe Cu-toxicity may result from an inborn error of Cu metabolism. This is Wilson's disease (hepato-lenticular degeneration). The disease is characterized by compensatory physiologic and biochemical processes in the liver and brain. The disorder is inherited as an autosomal recessive trait usually in the second or third decade of life. The inheritance of the disorder requires consanguinity of parents. The abnormality is coded on chromosome 13. It may be present at any age, even in the seventh decade. The fundamental defect in this disease appears to be an inadequate synthesis of the copper binding protein ceruloplasmin. Consequently, plasma ceruloplasmin is significantly decreased while loosely albumin-bound copper is significantly increased and so copper is easily dislodged from these weak complexes and deposited in many structures of the body. The most vulnerable sites are the liver, basal ganglia, cornea, kidney and cerebral cortex, causing damages in those locations. The true incidence of the disease is still largely unknown probably because the diagnosis is often overlooked.

Estimated incidences in the developed world vary between 1 in 200,000 to 1 in 20,000. Because of these problems associated with an accurate diagnosis of the disease in its early stages, we tried a pilot study.

While on a prolonged intermittent attachment as visiting Lecturer in the Department of Chemical Pathology at the Usmanu Danfodiyo University, Sokoto between 1983-90, we selected at random, 48 apparently healthy young men who were most likely, from a well-guided oral interview, to be offsprings or products of consanguinous marriages. In one of these individuals, we established a significant hypocupremia, significant hypoceruloplasminemia and significant hyper-cupriuria (fig. 7). From available evidence in the literature, this is indeed the classic biochemical picture in Wilson's disease. One year later, we were lucky to be able to bring back to Ibadan a needle biopsy of the liver of the same subject who was then undergoing a hepato-portal enterostomy. The histologic features of

the liver that were later confirmed to us include a nonspecific hepatocellular degeneration with glycogen deposition, pleomorphic mitochondria, ballooning nuclei, steatosis, piece-meal necrosis, diffuse fibrosis and micronodular cirrhosis.

Our suggestion, Adeniyi, Bot and Johnson,⁹ from this study was that since the clinical features of Wilson's disease are so non-specific, laboratory measurements and investigations may offer the best means of establishing an early diagnosis.

We commend this to clinicians as one of the avenues to explore when confronted with liver disorders which appear insidious in onset and in characteristic behaviour.

Zinc

Zinc is needed for growth and repair of tissues. Its essentiality in the human diet was first recognized in 1963 when a syndrome of growth depression and delayed sexual development seen in a group of Iranian and Egyptian men consuming diets based on vegetable protein was alleviated by supplements of zinc. Although the diets were not low in zinc *per se*, they were high in grains containing phytates which interfered with zinc absorption thereby causing a deficiency.

Because of the diverse roles that zinc plays in cellular metabolism, the symptoms of zinc deficiency are non-specific and can resemble the symptoms of deficiencies of other essential nutrients. However, some of the most important features of severe zinc deficiency are dwarfism (impaired growth), anaemia, hypogonadism, hepatosplenomegaly, idiopathic hypogeusia (loss of taste), dysgeusia (abnormal taste), hyposmia (loss of smell), dysosmia (abnormal smell), malabsorption, depressed immunity, cirrhosis, and acrodermatitis enteropathica. Zinc is involved in the proper functioning of at least seventy enzymes. These include alkaline phosphatase, aldolase, carboxypeptidases A, B and C, carbonic anhydrase, glutamic dehydrogenase, lactate dehydrogenase, leucine aminopeptidase, pyruvate carboxylase and reverse transcriptase.

Since pregnancy can also be considered as a form of disease (after all, in some people, it is often accompanied by nausea and vomiting) and since it is associated with cellular growth, we examined the implications of hypozincemia in human pregnancy. We also found it worthwhile and useful to study the suitability of assessment of zinc status in the differential diagnosis of hepatic disorders.

In the first set of preliminary experiments, we confirmed the previous observations of others, firstly that in human pregnancy, estrogens are strongly bound to plasma proteins¹⁰ and secondly that zinc exists in two forms in the human plasma¹¹, some firmly bound to the globulins and a greater percentage loosely bound to albumin. From our various observations and those of others, we deduced that there is active competition between estrogens and most of the loosely bound zinc for binding sites on the plasma proteins. Overall, our various data led to the suggestion that during pregnancy when zinc is lost from the plasma, an increased population of unbound zinc results leading to substantial zinc influx into the leucocytes and into the products of conception. Such an hypothesis is in agreement with previous reports of *in vitro* and *in vivo* studies

which suggested that zinc influx into the leucocytes was directly dependent on extracellular zinc concentration¹²⁻¹³. Consequently, we went further from the position of properly corroborated data that our observation of significantly lower concentration of zinc in cord plasma of infants with reduced birthweights and reduced plasma estrogens in their mothers indicated the positive roles of zinc and estrogens in the course and eventual outcome of human pregnancy¹⁴. These various observations were made by Adeniyi in 1987.

In the second set of experiments, we looked more closely at the blood levels of zinc in liver disorders since hypozincemia has been shown by us (Adeniyi and Meludu)¹⁵ and by others¹⁶ as a consistent finding in hepatic diseases. For a proper and an accurate evaluation of our data, we limited our investigations to four types of hepatic pathology viz: hepatitis, extrahepatic cholestasis, cirrhosis and primary liver cell carcinoma. Plasma zinc levels in hepatitis and in extrahepatic cholestasis were significantly lower than in cirrhosis and PLCC. Differential diagnosis of liver disorders can therefore be made using the plasma zinc in patients with hepatitis and extrahepatic cholestasis on the one hand and patients with cirrhosis and PLCC on the other.

Hepatitis can be differently separated from extra hepatic cholestasis by a negative correlation that we found present in hepatitis between plasma zinc and plasma albumin. PLCC can also be differential separated from cirrhosis by a negative correlation which we also established between plasma zinc and total bilirubin in PLCC.

Our suggestion from this study is that this diagnostic approach if used in conjunction with:

- (a) standard liver function tests based on the excretory, clearance, conjugating and synthetic capabilities of the liver.
- (b) standard measurements of enzyme activities such as those of ALT, OCT, LD₅, ICD, 5'N the patient may be spared from the rigors of extensive invasive clinical exploratory procedures.

Magnesium

By our criteria for classification, Mg does not strictly belong to the group we commonly refer to as trace elements, nevertheless, it performs so many functions in intermediary metabolism that it sometimes can stand in for divalent trace metals like Mn and Zn.

In the *Kreb's cycle* for example, Mn^{++} activates the enzyme ICD in the oxidative decarboxylation of isocitric acid to α -ketoglutaric acid. That reaction cannot proceed without the metal activator Mn^{++} . Mg^{++} stands in for Mn^{++} in that reaction.

Also, the enzyme ALP has four zinc atoms in its molecular structure. Two of the atoms are necessary for the maintenance of the quaternary structure of the enzyme protein while the other two are required for enzymatic activity. It has been shown that the two zinc atoms necessary for enzymatic activity can be replaced by magnesium without change in the overall activity of the enzyme. For these two reasons, we conventionally and conveniently group Mg with the essential trace elements.

Magnesium deficiency is rare in the normal population. However, in clinical medicine, causes for hypomagnesemia may be viewed under seven categories viz: Gastro-intestinal, nutritional, renal, endocrine, metabolic, neo-natal and childhood. Between 30-40% of Mg in the diet is absorbed. $1,25(\text{OH})_2\text{D}_3$, one of the ten hormones involved in Ca and P metabolism, is also a major factor in Mg absorption and as Ca in the diet increases Mg absorption decreases. Mg is necessary for the utilization of ATP and it is therefore an important activator of enzymatic reactions involving ATP. Such reactions are extremely important in the metabolism of CHO, lipid and proteins and in the synthesis of DNA. It is against this background that hypomagnesemia has been vaguely cited in the pathogenesis of Diabetes Mellitus.

Early in 1991, I assembled a group of medical scientists, physicians and two of my postgraduate students so that we could look into the prospects of magnesium supplementation in Diabetes Mellitus. I explained to the members of this group how we (my PG students and I) arrived at the decision to initiate that kind of study. I laid out the aims and objectives before the members and solicited for their cooperation in terms of laboratory space, laboratory reagents, accessibility of my PG students and other ancillary staff to clinics, petty funds and consumables for use in the clinic and most importantly a completely free hand in the selection of patients and control subjects. The cooperation that I received from the members of this group was wonderful and encouraging. We started on the selection of subjects and collection of biological samples and we embarked on the preliminary investigations and measurements. As luck would have it, two years into the project, one of my PG students who was involved in it (in actual fact the study encompasses his Ph.D work) secured a World Bank study fellowship through his home university, the University of Maiduguri. I quickly made arrangements for him with the Division of Diabetes, Nutrition and Metabolic Disorders, Department of Medicine at the University of Liege in Belgium, a suitable place for the tenure of the fellowship. Professor P J Lefebvre, the Director of the Center kindly and thoughtfully approved our request. The arrival of Mr. Meludu (now Dr. Meludu) at Liege, coincided with the arrival of Dr. Castillo from the University of Granada, Spain. Dr. Castillo's interest was along the same line as ours and the study became more interesting.

At Liege and at Granada, our preliminary experiments at Ibadan were repeated for confirmation of results. New experiments were designed and successfully executed and what finally came out of all these efforts was the manufacture of ampoules of magnesium salt supplements. Successful clinical trials were conducted both at Liege and at Granada. It is clear that such clinical trials on patients cannot and must not be the last. Trials will have to continue in many parts of the world including Nigeria and appropriate approval from government regulating bodies has to be given before such approach for treatment can be considered conventional.

At the risk of complete oversight, let me quickly highlight the summary of the results of some of the investigations that we made which led to the clinical trials with magnesium supplements:

- (a) We established that magnesium depletion is a consistent feature of DM and that magnesium administration enhances glucose oxidation by increasing insulin sensitivity.
- (b) We showed a remarkable difference between Africans and Caucasians in the handling of extracellular and intracellular magnesium following an oral glucose load. The findings further re-emphasize the significance of magnesium in the adequate utilization of glucose.
- (c) We observed that glucose infusion increases plasma magnesium concentration while it decreases erythrocyte magnesium concentration. In the diabetic state therefore, hyperglycemia will probably aggravate these effects thereby leading to intracellular magnesium depletion and magnesuria.
- (d) We provided evidence that insulin administration consistently decreases plasma magnesium concentration while it has a tendency to increase erythrocyte magnesium concentration. We therefore suggested that depletion of intracellular magnesium in the diabetic state may be a consequence of insulin resistance.

All these represent some of the observations of Meludu, Akinlade, Castillo, Scheen, Adeniyi, Taylor, Lefebvre and us on this subject matter which were reported in six different publications between 1995-97. Let me now round up the body of this story by reviewing some of the major findings that we made in our study of a classic non-essential toxic element, lead.

Lead

Lead (Pb) is a toxic trace element that has no useful function in the human body and technically, its ideal blood level should be considered as zero. However, because of its excellent physico-chemical properties, the element has been found to be useful in a wide variety of occupations that are extremely beneficial to man. The largest single use of lead is for the manufacture of storage batteries. Lead salts also form the basis of many paints and pigments. In its arsenate compound, it enjoys wide applicability in the insecticide industry. The sulphate and acetate compounds have important uses in rubber compounding while lead naphthenate is used extensively as a dryer. Tetra-ethyl lead, one of the most important compounds of lead, is used as an anti-knock additive in gasoline.

In view of the diverse roles of lead in the industries, painstaking attention should always be paid to those precautionary measures that are capable of protecting against undue exposure of workmen, artisans and the general populace to lead. This is because lead is a poison in all its forms. Excessive exposure of humans to lead in the air, food, and water has been known to have significant adverse effects on the renal, nervous, hemopoietic, immune and endocrine systems.

In the light of these evidences, we designed and successfully executed two studies on lead between 1994-98. In the first, we explored the magnitude of lead poisoning in two distant states of Nigeria and in the second, we examined ways whereby individuals in lead-based occupations who may develop lead poisoning can quickly be identified and appropriate intervention made.

For the interpretation of our results, in both cases, we categorized two levels of lead poisoning. Metabolic poisoning, we defined as existing when it is possible to detect alterations in metabolism that result from the lead absorption and clinical poisoning as a stage when the absorbed lead starts to produce signs and symptoms which are obvious to the patient or to the attending physician. Consequently, metabolic poisoning may exist without clinical poisoning but not the converse.

In the first study, we established that blood lead levels are significantly higher in individuals occupationally exposed than in normal control unexposed subjects and in such individuals, one or more deleterious signs or symptoms may be evident. These include anemia, anorexia, nausea and vomiting, dizziness, dulling sensation, insomnia, irritability, gout, weight loss, memory loss and metallic taste. An even more worrisome discovery was that among our supposedly control subjects, over 80% of them had values falling outside the commonly acceptable blood levels. This implicitly indicates the severity of the problem in the states where the study was conducted and by extension, in the whole country as a whole. This is more so as contributory factors for exposure that we discovered included excessive use of alcohol and tobacco, undue exposure to exhaust from vehicles using lead gasoline, exclusive use of wells as sources of drinking water and increasing consumption of the Nigerian table salt. It has been well established that the Nigerian table salt contains higher concentrations of lead than salt from many other parts of the world. Also, lead in gasoline is commonly considered to be one of the most important contributors to environmental lead which determines lead levels in occupationally unexposed subjects. Petroleum products that contain high lead levels are major factors in atmospheric lead pollution in countries using such energy sources.

Overall, our data in this phase of the study suggest that lead poisoning arising from occupational and environmental factors is of a high magnitude. Precautionary measures appear sensible and desirable by all who are occupationally and/or environmentally exposed.

In the second study, we investigated a wide range of biochemical indices including blood lead, total and ionized calcium, inorganic phosphate, total protein and albumin, uric acid and $1,25(\text{OH})_2\text{D}_3$. Serum total and ionized Ca levels and $1,25(\text{OD})_2\text{D}_3$ levels were significantly lower in lead workers than in control population. Uric acid was also positively correlated with blood lead. The biochemical abnormalities that were established in our report clearly reflect metabolic poisoning and we suggest that they may be helpful in its early detection before the onset of clinical poisoning particularly in nutritionally disadvantaged communities like ours.

Conclusion

This is an overview or a summary of some of our observations on three of the essential trace elements and one toxic element. The approach to our studies on these four elements is representative of the approach we took in viewing all the others.

Let me quickly observe that scientists carry out experiments for a number of

reasons, amongst which is a desire to promote some particular application of science either by advancing basic understanding or by developing an appropriate technology. Technology is the application of Science to solve the various problems of the human being. It is used to accelerate development and to improve the health, economic and social well-being of the populace. Needless to say that scientific research is a cultural activity, a means of training and refining the mind, tastes and manners and a means of training in the discipline of objective enquiry just as the study of history for example. It follows from this that much of fundamental basic research has no apparent application at the time it is done. Indeed, basic researches may be done with no application in mind. It is very often only with hindsight that we can see their importance.

It is this point that non-scientists and science – related professionals who do not have the benefit of relevant research – oriented training often find difficult to grasp. So, as it is, experiments at the time they are done may appear to have no relevance to the conquest of disease because that cannot be foreseen. They do, however contribute to the body of knowledge in a subject out of which knowledge application may come. Every serious and committed scientist or a practitioner of science – related vocation depends on this body of knowledge, a point aptly exemplified by Sir Isaac Newton in 1675 when he wrote to Robert Hooke: “If I have seen further, it is by standing on the shoulders of giants”.

During the past two and a half decades or more, we have carefully identified the giants in our area of speciality and from their shoulders, we have been usefully and meaningfully interacting with the consumers of our research findings. We have been telling them many things and they have been happy listening to us. Among these are:

- (i) that when chelators are being administered to a patient with Wilson's disease, due attention must be paid to the copper status in such a patient;
- (ii) that although a patient with hemochromatosis may come to clinical attention with one of four symptom complexes, only a knowledge of the iron status in such a patient can bring out the correct diagnosis clearly and unequivocally;
- (iii) that because magnesium is extremely necessary for the utilization of ATP, it is an important activator of all enzymatic reactions involving ATP and it will play significant roles in carbohydrate, lipid and protein metabolism. It is therefore necessary to assess its status in many metabolic disorders;
- (iv) that because zinc is needed for growth and repair of tissues, it is necessary to assess its status in pregnancy, liver disorders, leg ulcers, abnormalities of taste and smell and in sterility among others;
- (v) that in handling complications that may arise as a result of oxidative cellular damage, the interactive roles of manganese and selenium should be well appreciated;

- (vi) that treatment of a patient with gout may not be effective if the patient is from a region with high environmental molybdenum and if nothing is done about the probable high content of molybdenum in the patient's diet;
- (vii) that presenting complaints such as weakness, numbness, tingling in the extremities, difficulty in walking, loss of vibratory sense, incoordination of movements and disturbed mentation by a patient may ultimately require the assessment of cobalt status;
- (viii) that excessive consumption of excessively refined foods will rid the body of chromium and chromium is extremely important for the utilization of insulin in glucose metabolism;
- (ix) that in managing a patient with hypothyroidism, it must always be remembered that Iodine has only one role in the human body. It is required to complete the formation of the hormone, thyroxine;
- (x) that the relationship of Fluorine with dental caries and with mottled enamel should be well understood.

When through our contributions in research we continue to disseminate such information, and our consumers are paying desired and deserved attention to them, the situation can only be summed up just in one direction and one direction alone, it is indeed a coming of age for the essential trace elements of man.

Recommendations

Included in this presentation, are some of the contributions that we have made over the years and as humble as they may be, they are not without their frustrations and lamentations. On some occasions, we had to throw away expensive materials for experiments mid-way owing to inexplicable and embarrassing prolonged power outages. On other occasions, we had to delay the investigations for weeks because of erratic supply of pipe-borne water. At other times we had to wait helplessly and watch labour union leaders prosecuting what, in some cases, we regard as unnecessary and thoughtless strike actions. On many occasions in the past, some of those actions appeared to have political undertones. They were probably being arranged, financed and fuelled by an irresponsible and an unelected government that could only rule by dividing the people. As soon as there were periods of respite from such ungodly acts, we usually rushed into our laboratories to re-assemble our thoughts and ideas. Indeed, our golden rule in those days and even today, the dictum that has enabled me today to pronounce my "Ebenezer" in my career this evening, is the dictum that you also know too well, and which every member of this community can attest to its efficacy today, it is "try, try and try again".

In our University today, there are a few issues the corrections of which require urgent attention:

- (a) Our research efforts are being greatly detracted from because of lack of facilities; facilities, which in other societies are freely provided simple facilities such as basic amenities of life
- (b) Our interest in meaningful scientific research is being dampened by extreme shortage of funds; a single law maker of the Federal Republic of Nigeria today wants to continue breaking the law by insisting on basic allowances which are many times the amount of funds required by a serious and committed scientist researcher to develop projects that will eventually promote the health, economic and social well-being of the populace
- (c) Lawlessness in our various campuses pervades the air; there are union leaders who periodically call out their members on total strike over the flimsiest excuse and irrespective of the essentiality of their jobs; they go further in encouraging their henchmen to even disrupt, disorganize and disturb services that they know nothing about and which they are not capable to provide; they then sit back and roll out demands to their employers; some of those demands on close analysis are similar to demands usually being made to psychiatrists by their patients!

It is my hope that your new administration, which is evidently clear that it has the input of God in its positioning, will competently address all these issues and will be able to put a seal of finality on their solution.

One of the surest ways to eradicate this kind of irresponsibility among members of staff is good and exemplary leadership and working out of schemes and measures that are capable of fostering unity and genuine friendship among members of different unions within the University. We have to develop an attitude of being our brothers' keepers and we have to show our mutual respect. A professor who has no such expressions as "Thank you", "I am sorry", "Well done" for even a cleaner in his office cannot be a dependable leader. For those of us that have interacted with you for a long period of time, we know that such expressions are very close to your lips.

In the body of this presentation I described a joint study between Ibadan, Liege and Granada. Among the factors that facilitated the success of that study was a direct telephone line which I personally installed in my office since 1986. There are many of us here today who have no telephone culture. We have to be on the road most of the time carrying out assignments which can simply be accomplished over the telephone. It is not enough for principal officers of the University and members of council to have unhindered access to telephone in their homes and offices while professors will have to queue in front of telephone kiosks in the Maintenance Department to make calls. It is my advice that you should see it as a matter of extreme urgency that every Department in this University has at least one direct telephone line within the next one year. In like manner, every member of the academic staff should have an unlimited access to a computer in the nearest future.

The question of regularity of payments of salaries and adequacy of

remunerations also have to be addressed. Whatever factors that are responsible for delay in the payment of salaries should be looked into urgently and appropriate actions should be taken. It is also important that members of staff should not be exposed to unfair temptations. A research team leader who is administering fat grants but whose salary cannot take him home will probably develop funny ways of balancing his research account.

At this point let me quickly acknowledge the tremendous efforts of the present Federal Government in promoting and enhancing the welfare of workers in our country today. In whatever direction and angle that we may look at it, this is a government that is most unlike any other that we have had in this country before — a humane and listening government indeed.

On Thursday October 05, 2000, on page 6 of the "Punch" newspaper I read and I proudly quote "for the first time after many years, we have a leader and a government whose mind is in the right direction". This was said by Professor Jerry Gana, a minister of the Federal Republic of Nigeria, one who is evidently competent to spot the difference between a good government and a bad one, having previously served in two or three other governments that were widely accepted to be bad ones.

Finally the administration of an academic community must be carried on in a way so as to motivate all members of staff. A chief executive of a University who vacates his seat regularly and willingly allows himself to be conscripted into attending meetings similar to those of the notorious Vision 2010 (a poor and blurred vision) and those of apparently thieving foundations will surely lose focus and will surely end up destroying all that a University should stand for.

I want to observe that this community by accepting you without question as its leader for the next five years has given to you its highest accolade and it hopes to receive from you in turn the lustre of your achievements. For those of us who had interacted with you in the past we know that the lustre is truly brilliant and we hope you will bear us out in the years ahead.

FROM VIBRATIONS TO FRACTALS: EXCITEMENT AT THE FRONTIERS OF KNOWLEDGE

Babatunde Alabi

Department of Mechanical Engineering

Without any iota of exaggeration, one can say there is hardly any branch of science, in which vibration does not play an important role. For the engineers, vibration is essentially a practical matter which they have to contend with routinely. The study and understanding of the nature and features of vibrations have received considerable attention over a number of centuries. One can not but take a bow when confronted with the landmark contributions of many great mathematicians, physicists and engineers to the excitement at this frontier of knowledge. These giant contributors include:

- Sir Isaac NEWTON (1642-1727)
- Compte de Joseph Louis LAGRANGE (1736-1813)
- Marquis de Pierre Simon LAPLACE (1749-1827)
- Sir William Rowan HAMILTON (1805-1865)
- Lord John William RAYLEIGH (1842-1919)
- Emeritus Professor S. TIMOSHENKO (1879-1972)

In the world of vibrations, they are still revered as superstars. All of them have foiled relentlessly at the frontiers. They doggedly explored for the best ways and the most appropriate probing tools, to unravel the deepest secrets of the nature of vibrations, and the effects of vibrations on matter and structures. Each one of them, has several laws and theories accredited to him. They cumulatively and progressively amassed sure knowledge, in the subject matter and.

have helped in their own ways, to push further the frontiers of knowledge significantly.

The most obvious reason why a body should vibrate is simply that it is shaken by some external agent. However, the two basic properties required by a body to vibrate freely are:

- (1) mass or inertia, which is an indication of its capability of possessing kinetic energy by virtue of its motion; and
- (2) the ability to store potential energy by virtue of its distortion from its position of rest.

A very common example of the second property is the restoring forces induced by elasticity. Incidentally, all the materials used by engineers, ranging from steel to concrete, as well as the human body, possess both mass and elasticity. Therefore, for the engineers there is no place to hide and there is no running away from vibrations. Understandably, engineers devote a lot of interest and energy to vibration control problems and solutions.

In the past few decades, economic and design trends favouring progressive increase in power and velocity in modern machines, have constrained the emergence of vibration analysis, as the pre-eminent focal point in mechanical engineering design problems. It is seemingly self-evident that problems of great practical significance, such as the vibrations of turbine blades, the vibrations of railway tracks, the vibration of foundations, the vibrations of electricity power transmission lines and the behaviour of ships in waves, can be thoroughly understood only on the basis of the fundamental concepts and theories of vibration. It is no secret that increase in the power and speed of machines implies that there will be correspondingly more energy to cause vibrations, which in turn implies that there will be a corresponding increment in the dynamic response of mechanical systems and structures. **Some of this undesirable features) there from, include malfunctioning of equipment loss in reliability of machines, fatigue of materials, wear fretting of machine components, noise nuisance and human discomfort.**

Vibrations control is no stranger to excitement or innovation, primarily due to the combination of the numerous advantageous applications of vibrations, and the attendant severity of some of the unwanted side-effects of vibrations. *This is why there is never a dull moment at this particular frontier of knowledge.*

Noise Control

Sound may be described simply as a physical phenomenon that stimulates the sense of hearing, whenever vibrations of certain frequency range reach the inner ear. Sound is vital for communicating, but when it becomes noise, it is, a nuisance, capable of killing communication altogether. **Noise is basically a subjective term, referring to an unwanted blend of sounds.** Noise is also widely recognized as the de-facto running-mate of vibration. Its frequency, which is the number of vibrations per second, is calibrated in hertz (Hz). The human ear perceives sounds in the frequency range, 20Hz to 20,000Hz, while elephants are

sensitive to low-frequency sounds, known as infrasounds (below 20Hz), whereas dolphins and bats though virtually blind, move about thanks to ultrasounds which they emit at greater than 20,000Hz. The ear is a marvellous instrument with a tremendous sensitivity, which is usually expressed in **decibels (dB) - a logarithmic scale**. The audible threshold is set at zero dB, 85dB is the risk level, 90dB the danger level and 130dB the pain threshold, i.e. *a range of sensitivity which is 10^{13} times more than the audible threshold*. Beyond this point the eardrum may rupture. This extremely wide sensitivity range and the stereophonic ability of the human ear to distinguish sounds from a general background, makes effective noise control rather difficult and complicated. Interestingly, researchers are not used to hoisting a white flag of surrender. Any wonder then that the noise control frontiers continue to attract the attention of many talented researchers and investigators, who are contributing immensely to the excitement at this sector of the frontiers of knowledge.

The noise of public-work machinery, such as pneumatic drills and concrete mixers, is highly irritating and unpleasant for both the operatives and anyone else who happens to be nearby. Similarly, traffic and low flying aircraft are major causes of noise pollution in cities, and as such, noise pollution ranks among the foremost environmental problems in the industrially developed countries. In the case of **Nigeria, a typical developing country**, major sources of noise pollution include the religious worship-centres, the open markets, road traffic and the countless internal-combustion electricity generators, in both the industrial and residential areas. However, Nigerians don't really talk much about noise pollution, *largely because it is completely overshadowed by the demands of the struggle for day-to-day survival, or it has become part of the day-to-day experiences that it has been relegated to the sub-conscious.*

Most people don't need much persuasion to agree that too much noise can damage the ears. An explosion of 140dB can cause permanent deafness, for it destroys certain cells in the inner ear that are not capable of regeneration. On the other hand, permanent deafness can also occur gradually due to long duration exposure to sound-level of about 85dB. However, what they don't know is that the human body is also affected in other ways too. There are immediate effects, such as, cardio-vascular problems with an accelerated heartbeat and high blood pressure, gastric-intestinal problems, a decrease in alertness and ability to memorize, nervousness, pupil dilation and a decrease in the visual Field. *These effects may be temporary; others are long lasting, such as insomnia, bulimia, anxiety, depression and even sexual malfunctions!*

The persistent trend to higher speeds of machines and means of transportation by road, rail and air, coupled with an increased reliance on automation and miniaturization, have resulted in vibrations at higher Frequencies. Incidentally, the level of sound power produced by a vibrating machine component is approximately proportional to the square of the velocity of vibration. By the time the vibration control engineer would have succeeded in reducing the vibration level to a half, the effective reduction in sound power level is a mere 6dB; and when there are many machines contributing to a noisy environment, then treating only one will have a minimal reduction effect.

Vibration Induced Discomfort

The human body has many suspended organs, such as the brain, heart, eyes and the lungs, as shown in Fig. 1. Moreover, the body shivers when it is cold, heart beats, lungs oscillate, larynges vibrate, etc. ***Any wonder then that exposure of the human body to vibration can cause a change of comfort-level, a change in performance or a reduction in health and safety-level (1).*** The sensitivity of human beings to vibration is remarkably high. The range of sensitivity depends largely on the vibration level, vibration frequency, vibration axis or direction, and vibration duration. However, there are often many additional extrinsic variables including physical factors such as the sitting and task dynamics, age, sex, height, weight and miscellaneous psychological variables.

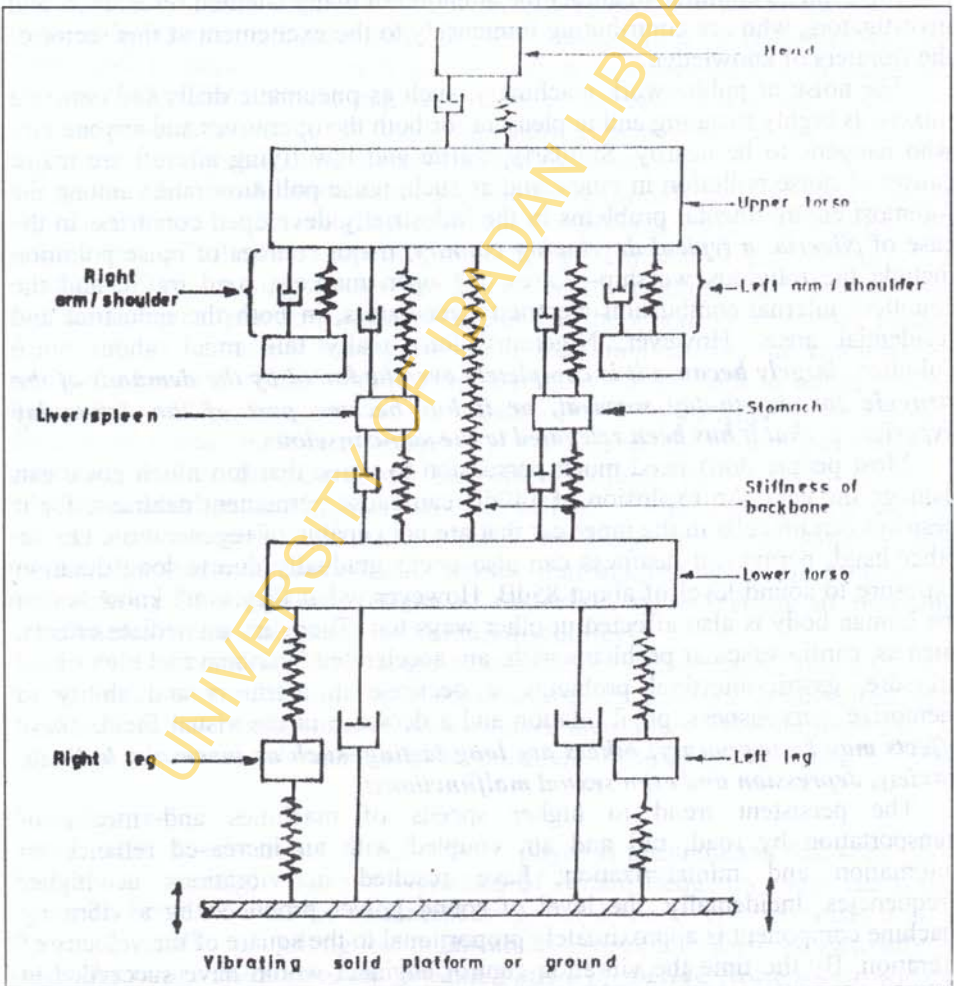


Fig. 1: Mass-spring-dashpot model of a human body exposed to whole-body vibration in the standing position

The problem is further complicated by the inherent ability of the human body to sense vibrations even at very low levels. Thus making it rather difficult for the engineers to guarantee a certain level of comfort. A case in point is the sudden ground-borne vibration from an unseen source, such as a high-speed train, which can be very annoying and destabilizing. In dealing with this problem, engineers have introduced a distinction between "**whole-body vibrations**", which is generally considered to be that due to vibration from a platform which is the main supporting surface for the body (e.g. a tractor-seat) and "**local vibrations**" due to, for example, hand-held tools. It is, therefore, understandable why a lot of attention is focused by aircraft manufacturers, railway/train designers and automobile companies on finding cost-effective solutions to vibration isolation and vibration transmission problems; especially in the areas of suspension and seat designs. Expectedly, this frontier continues to arrest the attention of great minds and brilliant researchers worldwide. **The sheer magnitude of innovative solutions being introduced regularly, constitute a monumental testament to the great excitement at this frontier.**

Vibration Induced Loss of Reliability

Reliability may be described simply as a measure of the ability or capability of an item (e.g. a product, an equipment, etc.) to perform a required function consistently, under stated conditions and designated environment, for a specified minimum period of time or minimum number of cycles or events. Reliability is, therefore, of great concern to the engineers. The functional "availability" of any equipment depends critically both on reliability and on maintainability.

The overall system reliability, **R**, depends on the total number of components, **n**, and the individual component reliability, **r**, such that

$$R = r^n$$

The power law governing **R**, effectively constrains the design engineers to go for a high degree of individual component reliability, in order to ensure a reasonable value for the system reliability. For instance, with $r = 99.9\%$, *Table I* shows that system reliability decreases sharply with doubling the number of components:

Table 1 : System reliability sensitivity to number of components

S/N	Number of Components (n)	System Reliability (R) %
1	25	97.5
2	50	95.1
3	100	90.5
4	200	81.9
5	400	67.1
6	800	44.9
7	1600	20.2
8	3200	4.1

Therefore, in designing machines, it seems advantageous to keep the number of components very low, which incidentally is contrary to the demands of full automatic control and self-adjusting systems. These conflicting demands have constrained the need for very high standard of engineering and quality control.

Effective and efficient performance of many machines depends on the accurate geometric profile of their working parts (2); for example, the accuracy of gear tooth profiles is critical to the correct performance of gear wheels. If vibration occurs between machine parts, it may degrade the quality of the surface finish through substantial increment in the rate at which parts become worn, eventually causing a deterioration in the performance of the machine concerned. Ironically, small errors in the geometry of rotating parts and gear wheels, may also on its own cause vibration. In the case of scanning photocopiers, the scanned image of a stationary original is formed onto a moving photoconductor. Imperfections on the moving parts, their assembly or interconnections, introduce vibrations which inevitably degrade the quality of the copy.

Vibration is also associated with alternating stresses, hence the ever present danger of failure of systems and components by fatigue. In the case of lathes and other machine tools, the possible onset of fatigue is a more important reason than the reduction of machining accuracy, for making strenuous effort to prevent vibration of such machines. Modern cutters and precision tools are capable of removing metal rapidly, but their hardness and wear resistance have been achieved only at the expense of resistance to fatigue.

When a machine component is exposed to shock and vibration, a condition of resonance can greatly magnify the imposed motion, by a factor of 50 to 100, especially when the environmental conditions in service are such that the damping is reduced. In which case, there is an obvious need for vibration endurance testing under extreme conditions expected to occur during service. For

example, resonant vibration is one of the causes of blade failure in turbomachinery, because during steady motion, any given blade passes any given point at accurately fixed intervals. If, for instance, a water turbine blade receives a splash, then it will do so at regular intervals and may break as a result of resonance. *Nevertheless, just like most other things in life, there are also many ways in which resonance may be put to good use.* For instance, to shake a sieve mechanically, it is natural to mount it on springs, and to obtain the assistance of a resonant condition. Other examples include the pneumatic drill and the concrete-mixer.

Sophisticated electronic equipment and on-board computers which are installed in helicopters, aircrafts and guided-missiles are normally supported on resilient "anti-vibration" mountings to ensure that the vibration of their environment do not affect them adversely, or impair their accuracy, or cause the malfunction of a control system whilst in service, after passing a quality control test in a stationary position. *Similarly, many sensitive equipment used in optics and metrology require input vibration to be limited to less than 0.01m/s^2 acceleration, and displacement amplitudes to be limited to less than 25nm.* Typical machinery and building vibration occurs at 10 to 100Hz with displacement amplitude of less than 100 μm . Consequently, effective isolation of sensitive equipment from vibrations, requires an isolation system with a transmissibility of about 0.001 or below, and a fundamental frequency of the order of 2 Hz or less.

Modern engineering relies heavily on exploring the boundaries of ideas and expertise. This prompted the adventure into *Fractals* and *Chaos* to be discussed next.

Fractals

Many of my colleagues often ask me, "*What is this fractal stuff that you are now working on*", some have jokingly inquired whether *fractal* is a new fancy word for *fracas* or *fraction*. Well, the term "fractal" is relatively new. The Polish-born French mathematician, **Benoit Mandelbrot**, coined the word and introduced it to the English speaking scientific community in 1977, in his famous landmark book entitled "*Fractals: Form, Chance and Dimensions*", (3).

He had observed that many important spatial patterns of nature, are either irregular or fragmented to such an extreme degree, that the well-known classical geometry (comprising of regular shapes, curves and surfaces such as circles, cones, spheres, etc.) is hardly of any help in describing their form. ***For instance, mountains are not cones, and the coastline of a typical oceanic island is neither straight, nor circular, nor any of the familiar classical curves.*** Similarly, no surface in the traditional classical geometry can adequately represent the boundaries of clouds. In general, many patterns of nature, which are of interest to mankind, involve a higher level of complexity, well beyond the scope of classical geometry (4,5). Fractals may be described simply as a family of shapes or fractal sets, which can be used advantageously to facilitate adequate representation of many seemingly complex forms and patterns encountered daily in nature, science and art. Some sets are curves, others are surfaces, still others are clouds of

disconnected points, while others are so oddly shaped that there are no good terms for them in either the sciences or the arts. The most useful among them involve chance, and their irregularities are statistical in nature. The term "*fractal*" emanated from the Latin adjective "*fractus*", which has the same root as "*fraction*" and "*fragment*" and means "irregular or fragmented". It is related to "frangere" which means "to break".

Fractal is indeed the ultimate multi-disciplinary tool. If there was a medal to be awarded for excitement at the frontiers, it must go to fractals. *Things that fractals can model include:*

• Weather	• Human body rhythms
• Stock market and other economic Systems	• Machine breakdown pattern in a Factory
• Fluid flow	• Plants
• Geologic activities	• Planetary orbits
• Animal group behaviour	• Socio-economic patterns
• Cancer cells growth pattern	• Celestial mechanics

The elegance and visual beauty of fractal art is one of the reasons for the excitement amongst the general public over the invention of fractal geometry. Fractal designs are now common feature on greeting cards, posters, calendars and T-shirts

Fractal Geometry

Fractal geometry is often referred to as the language of nature. Its structures are what gave orders to chaos. Elements of this new language are very simple algorithms (i.e. mathematical rules or recipes), which can be readily transformed into intricate geometric shapes and forms through iteration. A well-known iterative process in nature is the process of cell division, which is 1 into 2, 2 into 4, 4 into 8, etc. The development and supply of algorithms is infinitely large. But once this new language is mastered, one can easily and precisely describe the forms of clouds, or any natural object or any pattern for that matter, just as easily as an architect describes a building, using the language of traditional classical geometry with lines, circles, ellipses, spheres, etc.

The power of fractal geometry lies in its simplicity, which pivots on the idea that instead of a complex shape, just think of the simple rule that generates it. fig. 2, illustrates the simple rule that generates the famous *Koch snowflake curve*. The rule states that anytime that a simple line is encountered, divide it into three equal parts and replace the middle segment by two equal segments forming part of an equilateral triangle. Thereafter, iterate by repeating the line replacement procedure over and over. At each stage of the iteration, each of the four line

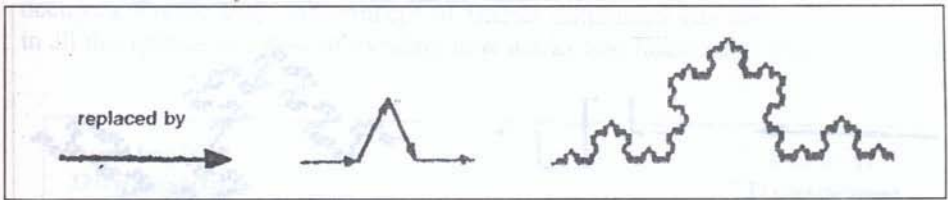


Fig. 2: The replacement procedure for generating Koch snowflake curve

segments (i.e. the generator) is replaced by four new line segments with length one-third of their parent line (i.e. the initiator) fig. 3 shows the first five stages in the construction of the Koch snowflake curve. Similarly, fig. 4 shows the iterative procedure for generating a variation of the Koch snowflake curve.

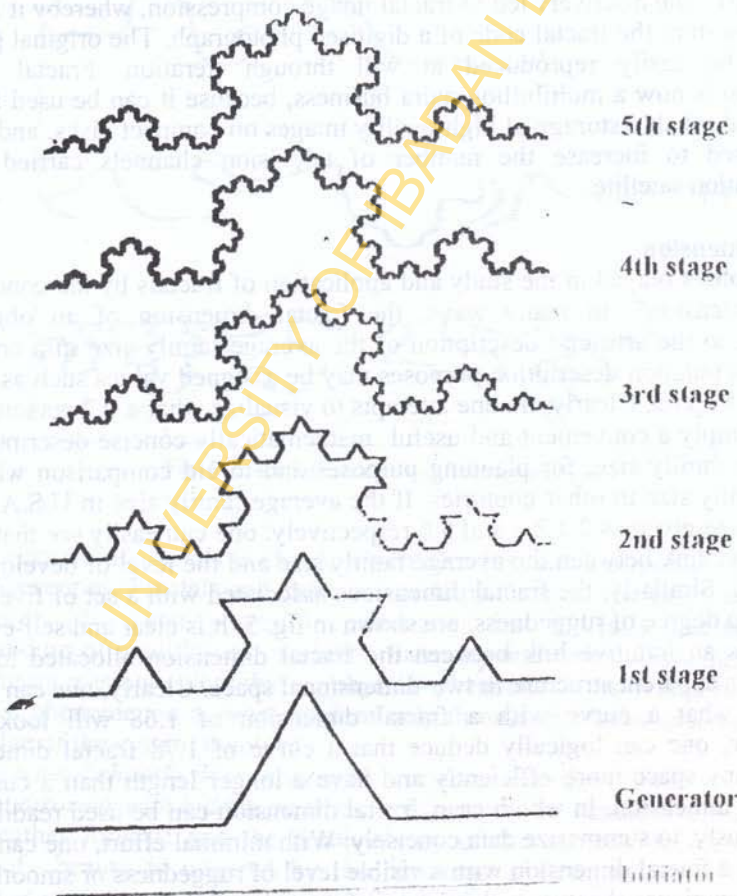


Fig. 3: First five stages in the iterative procedure for generating the Koch snowflakes

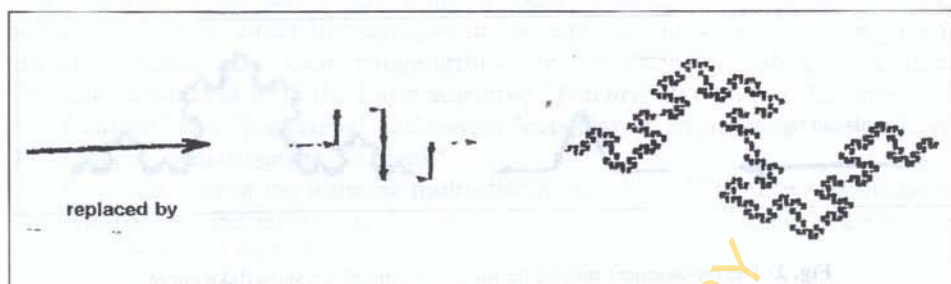


Fig. 4: The replacement procedures for generating a variation of Koch snowflake curve

Michael Barnsley, an English-born mathematician invented the *Fractal Transform*, which automatically detects fractal codes in real-world images (i.e. pictures) 161. The discovery led to fractal image compression, whereby it is only necessary to store the fractal code of a digitised photograph. The original picture can then be easily reproduced at will through iteration. Fractal image compression is now a multibillion naira business, because it can be used for the efficient and reliable storage of high-quality images on compact disks, and it can also be used to increase the number of television channels carried by a communication satellite.

Fractal Dimension

A central role is played in the study and application of fractals by the concept of "fractal dimension". In many ways, the fractal dimension of an object is comparable to the artificial description of the average family size in a country, which for population description purposes may be assigned values such as 4.7 in the case of Nigeria. Clearly, no one attempts to visualize what a 0.7 person looks like. It is simply a convenient and useful mathematically concise description of the average family size, for planning purposes and to aid comparison with the average family size in other countries. If the average family size in U.S.A, U.K, and Ghana are given as 2.1, 2.3 and 5.6 respectively, one can easily see that there is an intuitive link between the average family size and the level of development of a country. Similarly, the fractal dimensions associated with a set of five lines, with varying degree of ruggedness, are shown in fig. 5. It is clear and self-evident that there is an intuitive link between the fractal dimension allocated to each curve and its apparent structure in two-dimensional space. Clearly, one can easily figure out what a curve with a fractal dimension of 1.68 will look like. Furthermore, one can logically deduce that a curve of 1.78 fractal dimension would occupy space more efficiently and have a longer length than a curve of 1.69 fractal dimension. In which case, fractal dimension can be used readily and advantageously, to summarize data concisely. With minimal effort, one can learn to associate a fractal dimension with a visible level of ruggedness or smoothness, and that experience becomes the basis of intuitive interpretation of fractal dimension for various natural systems. Similarly, a rugged surface can be given a

number between two and three which indicates how the structure fills the space it occupies. Predictably, the concept of fractal dimension has inspired researchers in all disciplines to a host of exciting new works and fascinating speculations.

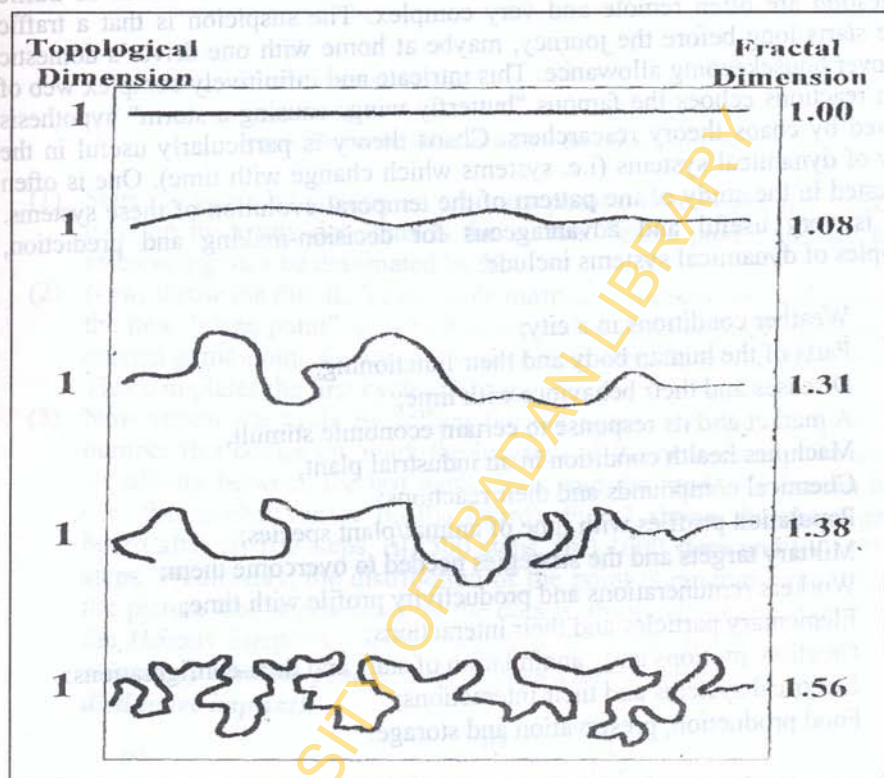


Fig. 5: Fractal dimensions of five rugged lines

Chaos

A close relative of fractals is chaos, which also first came to public attention in the mid-seventies. Fractals and chaos are perhaps the most exciting current areas of research [7]. Their powerful combination has radically questioned our understanding of equilibrium, stability, harmony and order. Consequently, it is becoming increasingly clear that no physical phenomenon is really random. In reality, a phenomenon appears random only through the incompleteness of our knowledge of the system involved.

The term "chaos" does not imply random disorder, rather it refers to *apparent disorder with hidden patterns*. For instance, the apparent randomness of daily weather forecast and the predictability of the seasons. Incidentally, our feeling of beauty is inspired by the harmonious arrangement of order and disorder as it occurs in natural objects. Some of us can already see that *chaos* is, indeed, a form of *order*. We tend to acknowledge this, even in some of the

phrases we occasionally employ, a popular one being: "*chaos is the order of the day*".

Chaos theory seeks to show how seemingly trivial factors affect larger systems. For example, behavioural scientists suspect that the causes of traffic congestion are often remote and very complex. The suspicion is that a traffic wave starts long before the journey, maybe at home with one driver's domestic row over housekeeping allowance. This intricate and infinitively complex web of chain reactions echoes the famous "butterfly wings causing a storm" hypothesis beloved by chaos theory researchers. Chaos theory is particularly useful in the study of dynamical systems (i.e. systems which change with time). One is often interested in the study of the pattern of the temporal evolution of these systems. This is very useful and advantageous for decision-making and prediction, examples of dynamical systems include:

- Weather conditions in a city;
- Parts of the human body and their functioning,
- Diseases and their behaviour with time;
- A market and its response to certain economic stimuli,
- Machines health condition in an industrial plant,
- Chemical compounds and their reactions;
- Population profiles with time of animal/plant species;
- Military targets and the strategies needed to overcome them;
- Workers remunerations and productivity profile with time;
- Elementary particles and their interactions;
- Creation, motions and annihilation of stars and then-configurations;
- Electrical systems and their interactions;
- Food production, preservation and storage.

Chaos experiments to show how randomness can create deterministic shapes and forms akin to those found in nature have always been of great excitement and fascination to the general public. This is exemplified by the popular "*chaos game*". To play the game, simply draw an equilateral triangle and label the vertices 1,2, and 3 as shown in fig. 6, this is the game board. One also needs a device to generate the numbers 1,2 and 3 randomly. An ordinary die that is used for a "Ludo game" generates the number 1,2,3,4,5 and 6 randomly. The ordinary die can also be used for the chaos game, simply by identifying the faces 6 with 1, 5 with 2, and 4 with 3, by re-labeling. The die will now be the generator of random numbers from the reservoir of 1,2, and 3. By throwing this die repeatedly, the random numbers which appear, for instance, 3, 1, 1,3,2, 1,2,2,2,3,2, 1.....will drive a process. The rules of the game are very simple.

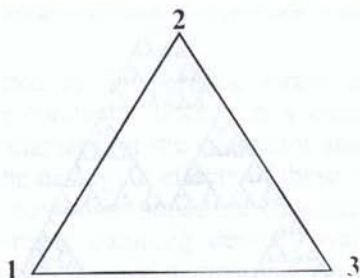


Fig. 6: This is the game board for the chaos experiment

- (1) Start the game by picking an arbitrary point on the board and mark its location by a tiny dot. This is the current "game point" and for easy referencing may be designated by X_0 .
- (2) Now, throw the die. If, for example number 3 appears, we now generate the new "game point" x_1 , which is located at the mid-point between the current game-point X_0 and the vertex with label 3, on the game board. This completes the first cycle of the game.
- (3) Now repeat the cycle by rolling the die again, and depending on the number that comes up, mark the location of the new game-point which is halfway between the last game point and the randomly chosen base (i.e. the labeled vertex on the board). Fig. 7 shows the chaos game board after (i) 100 steps, (ii) 500 steps, (iii) 1000 steps and (iv) 10,000 steps. Predictably, the distribution of the point is random but curiously the picture that is generated by the dots is absolutely deterministic. It is the famous Sierpinski gasket, which is shown in fig. 8. **Perhaps any seemingly random process has its own characteristic signature (i.e. a distinctive imprint),**

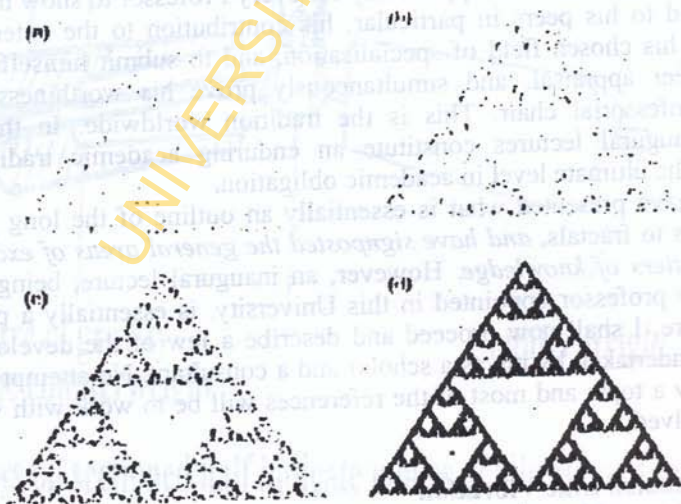


Fig. 7: The game board after 10 000 steps

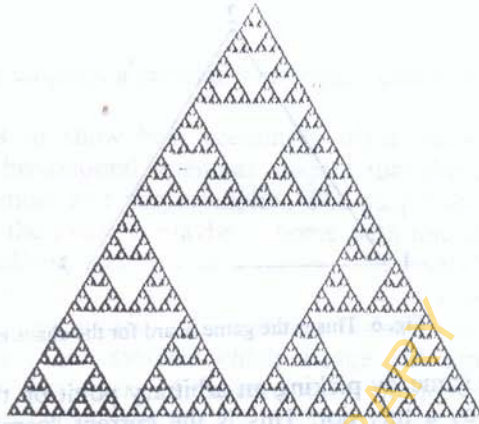


Fig. 8: The Sierpinski gasket

Scientists, ever so eager to crack the mysteries of nature, were predictably excited by the discovery of fractals and chaos theory. Sensing the possibility of a quantum leap at the frontiers of knowledge, the study of the nature and features, of the interplay between order and chaos, is inducing useful collaborations among researchers, in a wide range of disciplines. Enormous time, effort and talent are being invested at these frontiers, with the belief that, all forms of, nature must ultimately surrender their intrinsic codes that drive forms and processes (i.e. their recipes and numerical secrets) and draw themselves through numbers alone; *using iterated algorithms as the facilitator, while computer graphics remains the effort amplifier and a reliable pointer to the index of possibilities.*

The Journey So Far - An Overview

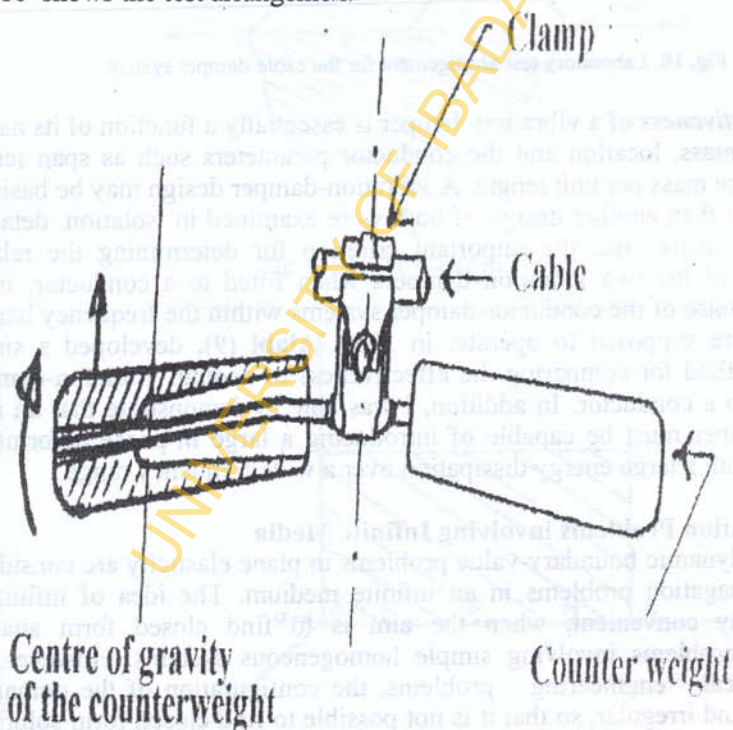
An inaugural lecture offers the opportunity for every Professor to show the world in general, and to his peers in particular, his contribution to the extension of knowledge in his chosen field of specialisation, and to submit himself to both public and peer appraisal, and simultaneously prove his worthiness to the prestigious professorial chair. This is the tradition worldwide. In this great institution, inaugural lectures constitute an enduring academic tradition, in fulfillment of the ultimate level in academic obligation.

So far, I have presented what is essentially an outline of the long journey from vibrations to fractals, and have signposted the general areas of excitement along the frontiers of knowledge. However, an inaugural lecture, being a debt owed by every professor appointed in this University, is essentially a personal affair. Therefore, I shall now proceed and describe a few of the developments and research undertaken by me as a scholar and a consultant. No attempt will be made to review a topic and most of the references will be to work with which I have been involved.

Power Transmission Line Vibration

One of the major problems confronting the power transmission engineer is the fatigue failure of overhead power lines; this is usually caused by aeolian

vibration which is excited by the periodic forces generated when alternating vortex shedding by the conductor occurs in a cross wind. It usually has an amplitude less than the diameter of the conductor and a frequency between 5Hz and 60Hz. Because of the damaging effects of these vibrations and the attendant disruption of electricity power transmission, damping devices are fitted to most conductors. There are many damping devices available, of which the most popular is probably the Stockbridge damper, shown in fig. 9. The efficiency of the damping action depends on the system parameter such as damper location, conductor span and tension. In 1984, Alabi (8), developed a method for determining the best location of vibration dampers on a conductor for optimum vibration attenuation over the aeolian frequency range. Only by correctly locating the damper on a conductor can the maximum damping of conductor vibration be achieved. Therefore, correct location can lead to economics in the size of damper, or allow longer conductor spans to be used, since the dynamic stress levels are bound to be reduced. The method was successfully applied to a short span cable in a series of laboratory tests conducted at Imperial College, London. Fig. 10 shows the test arrangement.



Arrows on sectioned half indicate modes of vibration of the damper

Fig. 9: An illustration of the Stockbridge damper

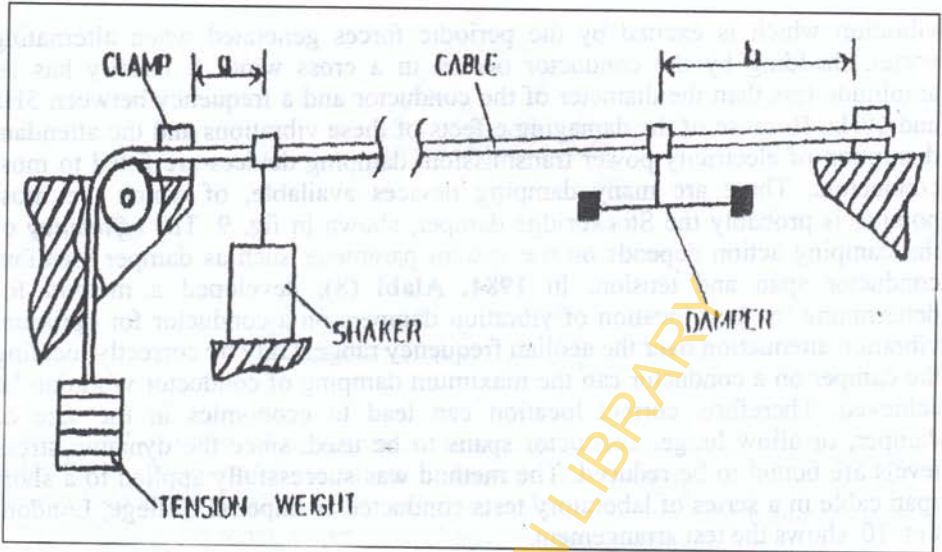


Fig. 10: Laboratory test arrangement for the cable-damper system

The *effectiveness* of a vibration-damper is essentially a function of its natural frequencies, mass, location and the conductor parameters such as span length, tension and the mass per unit length. A vibration-damper design may be basically more efficient than another design, if both were examined in isolation, detached from the conductor. But the important criterion for determining the relative effectiveness of the two vibration dampers when fitted to a conductor, is the dynamic response of the conductor-damper systems within the frequency band in which they are supposed to operate. In 1989, Alabi (9), developed a simple analytical method for comparing the effectiveness of aeolian vibration-dampers when fitted to a conductor. In addition, I was able to demonstrate that an ideal vibration-damper must be capable of introducing a large in-phase deformation force along with a large energy dissipation over a wide frequency range.

Elastic Vibration Problems involving Infinite Media

A variety of dynamic boundary-value problems in plane elasticity are considered as wave propagation problems in an infinite medium. The idea of infinity is mathematically convenient, when the aim is to find closed form analytic solutions to problems involving simple homogeneous systems. However, for most practical engineering problems, the configuration of the domain is complicated and irregular, so that it is not possible to find closed form solutions, and recourse is made to numerical methods of solution, such as the traditional finite difference, lumped parameter, finite element and the boundary element methods. Unfortunately, these methods pose serious difficulties when they are implemented directly for cases involving infinite systems, for two main reasons:

(1) only a finite number of elements or nodal points can be considered; and (2) the difficulty of simulating the radiation condition at infinity in a finite model.

In 1979, Alabi (10) developed a *general mapping finite model* for the solution of elastic vibration problems involving infinite media. In this method, the original infinite problem domain is condensed by mapping into a considerably smaller, finite, rectangular domain by implementing a suitable orthogonal curvilinear coordinate transformation, as can be seen in fig. 11(a) and 11(b). The radiation condition at infinity is satisfied through a change of the dependent variables. The model generated a lot of interest and excitement all over, because of the attendant huge savings in computer resources (11,12,13). The model is of particular interest to naval forces with fleet of submarines, and having a permanent need to operate quietly to avoid detection by enemy acoustic listening devices. When implemented to investigate the acoustic field of a submarine inside the belly of the ocean, the savings is enormous and may run into millions of dollars.

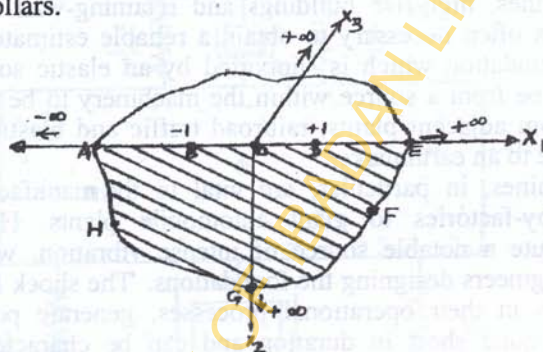


Fig. 11(a): The Elastic half-space

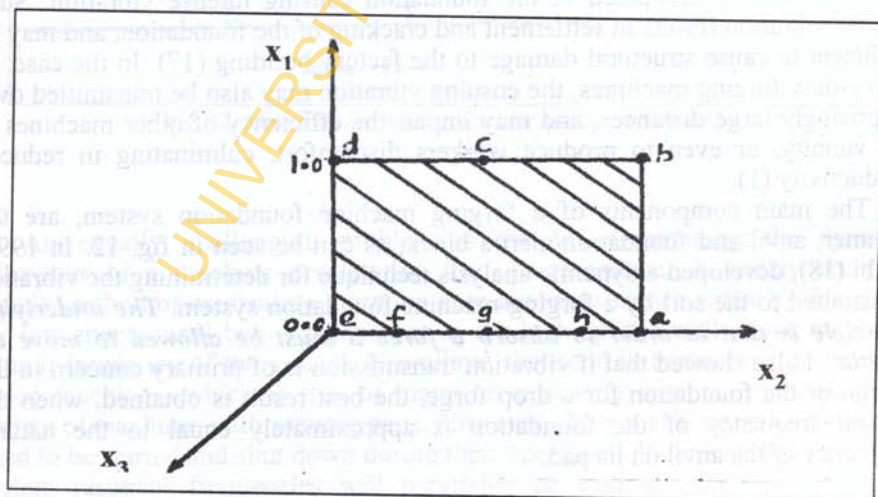


Fig. 11(b): Mapping of the region ABCDEFGH of Fig. 11(a) into the region abcdefgh of the x_1, x_2 curvilinear coordinates

Another set of problems of considerable interest is that of a reservoir embedded in an elastic medium, often encountered in the investigation of surface deformation associated with volcanism, detonation of buried charges during oil exploration and many other areas of seismology. In examining this problem, it is often assumed that the source of dilatation is a spherical reservoir, while the matrix is an elastic medium of infinite extent (14). In 1985, Alabi (151), developed and introduced an advantageous numerical method, for the evaluation of the displacement field generated inside the soil, by time-harmonic tractions applied to the surface of an embedded cylindrical reservoir, whose cross-section has an arbitrary shape. In this case, I also used mapping primarily to condense the physical problem domain (16).

Vibration of Foundations

Foundations constitute a prominent feature of many engineering structures such as forging machines, high-rise buildings and retaining-wall of dams. At the design stage, it is often necessary to obtain a reliable estimate of the dynamic response of a foundation which is supported by an elastic soil. The vibratory disturbance may be from a source within the machinery to be supported on the foundation or from adjacent plants, railroad traffic and blasting of rocks with explosives, or due to an earthquake.

Forging machines, in particular, are vital to the manufacturing industries, ranging from toy-factories to giant automobile plants. However, forging machines constitute a notable source of intense vibration, which is of great concern to the engineers designing the foundations. The shock load produced by forging machines in their operational processes, generate powerful dynamic effects, that are quite short in duration and can be characterized as pulses. However, only a fraction of the shock energy is used in the forging process, while the rest is dissipated in the foundation causing intense vibration. Such intense vibration results in settlement and cracking of the foundation, and may be sufficient to cause structural damage to the factory building (17). In the case, of heavy-duty forging machines, the ensuing vibration may also be transmitted over surprisingly large distances, and may impair the efficiency of other machines in the vicinity, or even to produce workers discomfort, culminating in reduced productivity (1).

The main components of a forging machine foundation system, are the hammer, anvil and foundation/inertia block, as can be seen in fig. 12. In 1991, Alabi (18), developed a dynamic analysis technique for determining the vibration transmitted to the soil by a forging machine foundation system. ***The underlying principle is that in order to absorb a force it must be allowed to move an inertia.*** I also showed that if vibration transmission is of primary concern in the design of the foundation for a drop forge, the best result is obtained, when the natural frequency of the foundation is approximately equal to the natural frequency of the anvil on its pad.

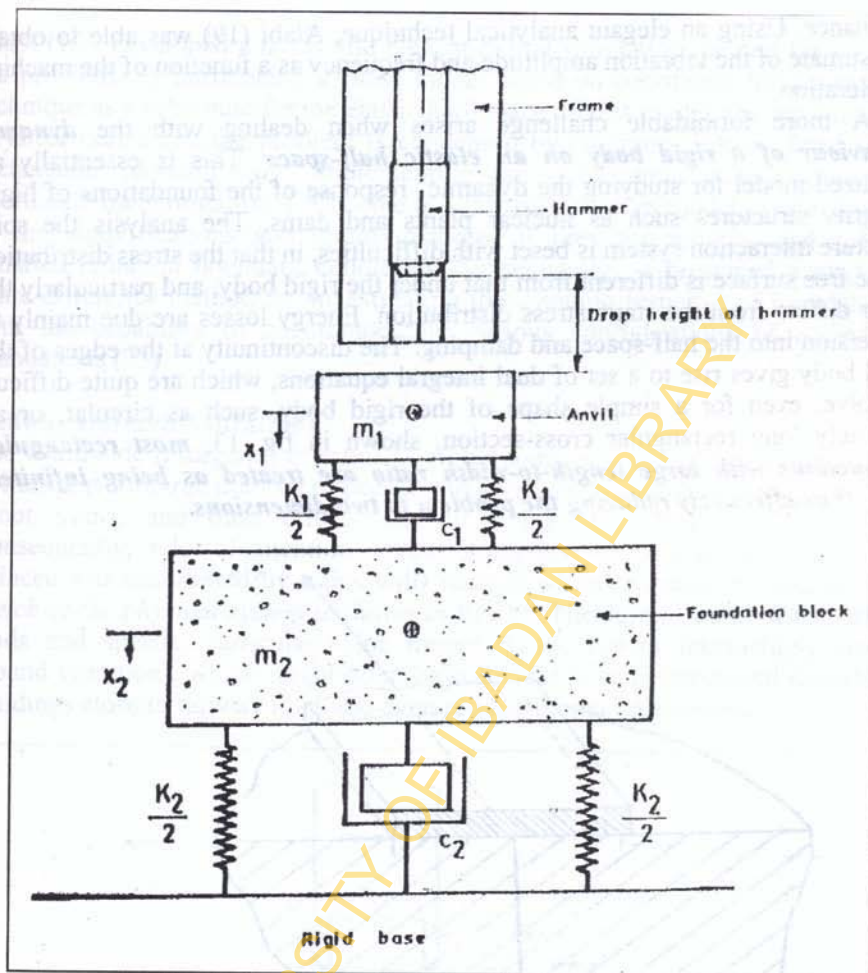


Fig. 12: Sketch of the forging machine foundation system

An equally challenging problem is that of determining the dynamic behaviour of a machine accelerating through resonance. A widely accepted simple method of controlling vibration is to avoid resonance either by designing for low speeds well below resonance, or for high speeds well above twice the natural frequency of the system. Nowadays, the trend in engineering is for high speed machines, which is true of many reciprocating engines, turbines and a variety of machines with rotating parts. However, these machines will necessarily need to be started and shut down during their operation. In which case, mounting system resonant frequencies will inevitably be excited, albeit momentarily, during this starting/stopping sequence. A problem of great interest to the engineers, in this connection, is the relationship between the magnitude of vibration and the rate at which the machine is accelerated or decelerated through

resonance. Using an elegant analytical technique, Alabi (19) was able to obtain an estimate of the vibration amplitude and frequency as a function of the machine acceleration.

A more formidable challenge arises when dealing with the *dynamic behaviour of a rigid body on an elastic half-space*. This is essentially an idealized model for studying the dynamic response of the foundations of high-integrity structures such as nuclear plants and dams. The analysis the soil-structure interaction system is beset with difficulties, in that the stress distribution at the free surface is different from that under the rigid body, and particularly the latter differs from the static stress distribution. Energy losses are due mainly to dispersion into the half-space and damping. The discontinuity at the edges of the rigid body gives rise to a set of dual integral equations, which are quite difficult to solve, even for a simple shape of the rigid body, such as circular, or an infinitely long rectangular cross-section, shown in fig. 13; *most rectangular foundations with large length-to-width ratio are treated as being infinitely long, thus effectively reducing the problem to two-dimensions.*

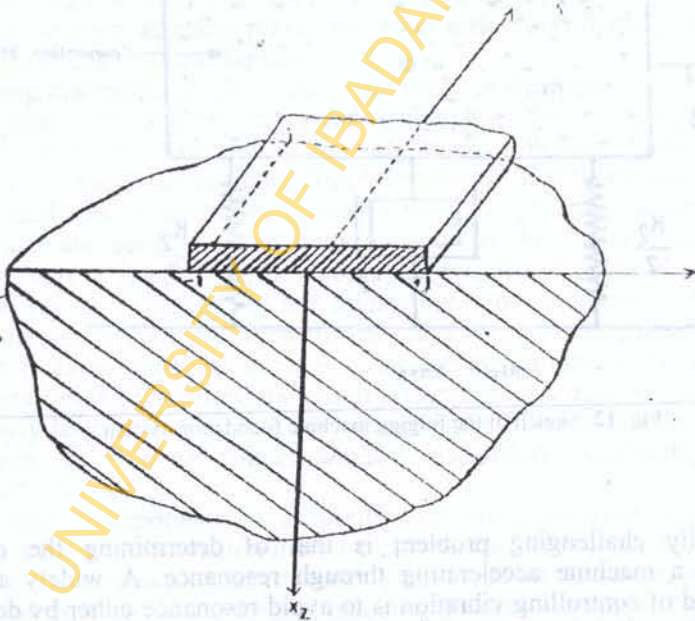


Fig. 13: An infinite long rigid body on an elastic half-space

In 1964, the mixed boundary-value problem was ingeniously formulated in terms of a set of dual-integral equations by Awojobi (20). He had to take a recourse to numerical integration approximations in his search for a solution to the problem. Eventually, he was able to establish solutions for the vertical and rocking modes of vibration (21), although there was some controversy about the vertical mode for an infinitely long rectangular body (22). Thereafter, in 1979,

Alabi (10), developed a novel and elegant digital simulation method for solving the problem, by introducing a finite model based on coordinate transformation technique as a substitute for the elastic half-space. In this model, the semi-infinite physical domain of the problem is condensed by mapping into a fixed finite rectangular domain, by implementing an exponential-polar orthogonal coordinate transformation. I was able to show that my own model, avoided some of the simplifications and approximations of previous models, and readily satisfied radiation boundary conditions. Subsequently, I presented a mapping finite-difference method for investigating the dynamic response of foundations, with the capability of accommodating various configurations of embedded foundations (23).

Railway Induced Vibrations

The worldwide resurgence of trains as an economical, safe and convenient mode of transport for large number of people and goods, has created a renewed concern about trains, and their effects on our living and working environment. Consequently, a lot of attention is now being given to the ground vibrations, induced and transmitted by trains (will) flanged wheels running on steel rails. *A sketch of the physical system is shown in fig. 14.* The current trend of increasing loads and speeds, particularly for freight trains, causes increasingly severe ground vibrations, which might often be sufficient to cause structural damage to buildings close to railway lines and even produce human discomfort.

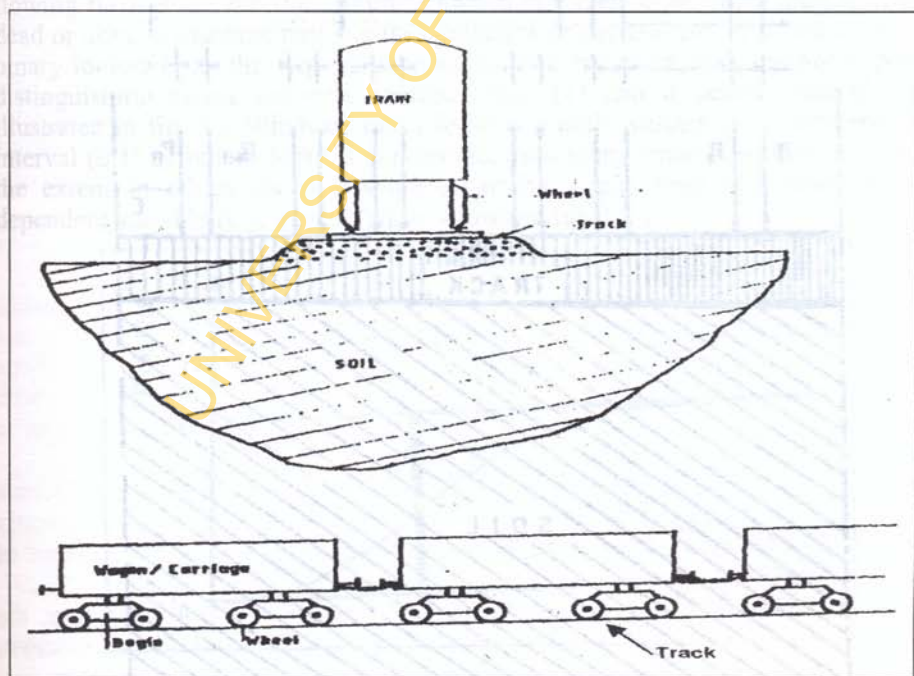


Fig. 14: Schematic diagram on the physical system

The problem of predicting the associated ground motions is complicated by the variability and in-homogeneity of the soil. Even if uniform soil properties are assumed, the mathematical formulation of the problem is still quite complex and formidable. However, a simplified three-dimensional model of the earth as an elastic half-space, with the train as a moving load on the surface, may be employed to gain useful insight into the complex vibration problem (24). When a railway track has not yet been constructed, or when it is possible to re-align it, then the best solution is to vibration isolate the track. A basic rule in vibration isolation is that in order to absorb a force, it must be allowed to move a mass and, similarly, in order to absorb a couple, it must be allowed to move an inertia. In which case, the suspended mass under the railway track and above the resilient isolators should, therefore, be as large as practicable.

An opportunity arose in 1986, to join in the search effort for a solution to the excessive ground vibrations being transmitted by a particular stretch of railway track in South East, England. *Based on a parametric study of the physical problem*, I developed a method of solution, using Lamé's potentials and a systematic integral transformation approach, which led to a mapping of the complex inverse integral transformations, to give the spatial distribution of the ground displacements due to forces transmitted to the ground from the wheels of a moving surface train through the track 125, 26,271. A representation of the forces acting on the physical system is shown in fig. 15.

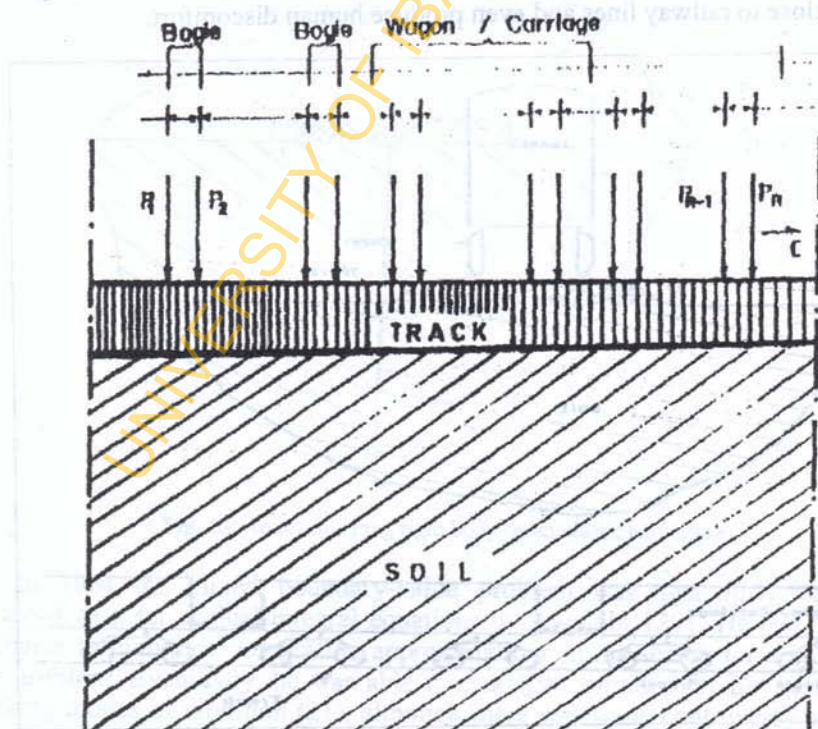


Fig. 15: Representation of the forces acting on the physical system

Vibration of Bladed Disks

Catastrophic theory is a relatively new branch of mathematics. It is closely related to *bifurcation theory*, and is sometimes known as *singularity theory*. It is very useful in the study of a physical system that exhibits **unexpected and drastic changes** when only small and smooth changes in excitation are impressed externally. Some of the underlying mathematical techniques have found applications in civil engineering and physics.

A complex vibrating system, such as a bladed disc assembly, is often analysed in terms of its constituent sub-systems. Thus, one analysis is made for the disc only and another one for the uncoupled blade (28). Subsequent to the separate analyses, the dynamic behaviour of the complete system is predicted by accounting for the influence of coupling (29).

Knowing fully well that modern engineering relies heavily on exploring the boundaries of ideas and expertise, in 1992 Afolabi and Alabi (30) used catastrophe theory for the first time to furnish a clear insight into the occurrence of unequal vibration amplitudes which has been observed in the past, in both theoretical and experimental studies of bladed disc assemblies in turbine engines (31).

Engineering Applications of Fuzzy Logic

The well-known binary logic is a two-dimensional scheme based on the assumption that for an event, there are only two possible outcomes. In the binary logic scheme, an event occurs or it does not; current is either flowing or not flowing through an electric circuit; a switch is either on or off; a man is either dead or alive; a machine part is either defective or perfect; etc. In which case, the binary logic admits the step function as its base structure, and imposes explicit distinguishing factor between a perfect state (1) and a defect state (0), as illustrated in fig. 16. Whereas, fuzzy logic is a multi-valued logic, whereby the interval (0,1) of binary logic is sub-divided into many small segments to reflect the extent to which the independent variable (e.g. time t) belongs to the dependent variable (e.g. event $e(t)$), as shown in fig. 17.

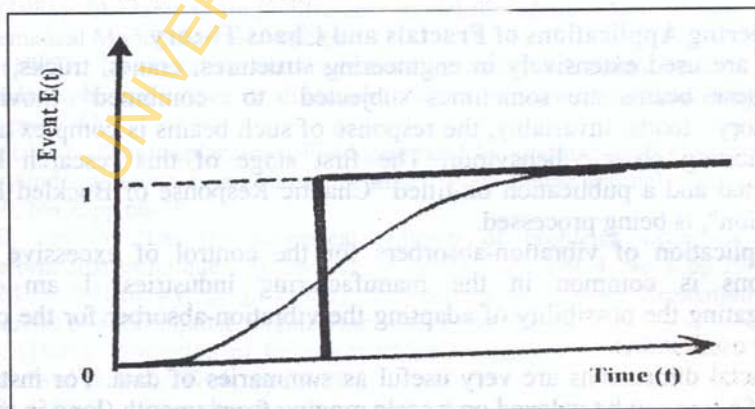


Fig. 16: Schematic illustration of the binary logic scheme

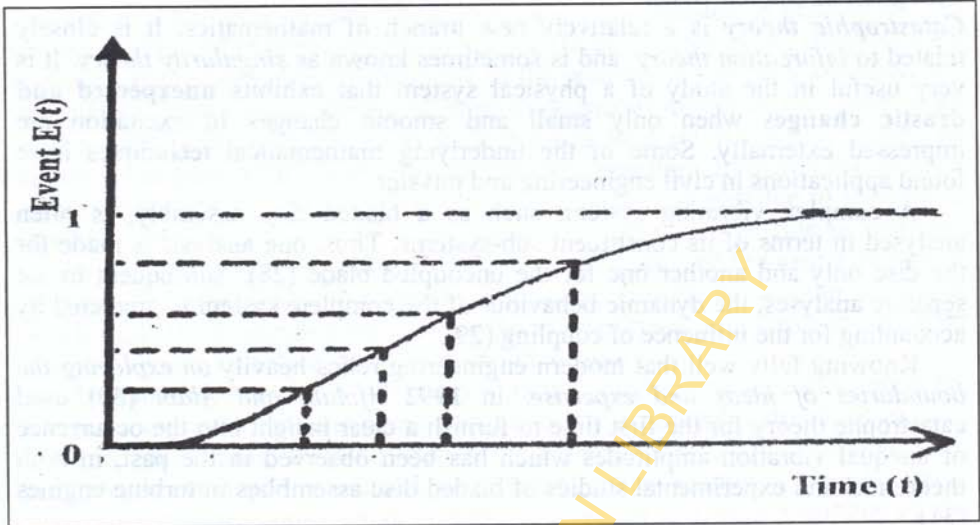


Fig. 17: Schematic illustration of the fuzzy logic scheme

Zadeh (32), introduced the concept of fuzzy logic about four decades ago. Since then, Fuzzy logic has developed immensely in theory and applications, thus earning recognition and acceptance by many researchers, and being put into practice by many engineers and managers. *The* fuzzy boom has generated many successful consumer products, ranging from cameras to tunnel-digging machines. In 1996, Alabi and Adedeji [33], developed and presented some aspects of fuzzy logic which could be applied advantageously in machine failure diagnosis. Unlike binary logic, fuzzy logic takes into account useful pieces of information, about the transitional stage between the perfect state and the defect state of a machine.

Engineering Applications of Fractals and Chaos Theory

Beams are used extensively in engineering structures, cranes, trucks, factories, etc. These beams are sometimes subjected to combined moving and oscillatory loads. Invariably, the response of such beams is complex and prone to exhibiting chaotic behaviour. The first stage of this research has been completed and a publication on-titled "Chaotic Response of Buckled Beams to Excitation", is being processed.

Application of vibration-absorbers for the control of excessive machine vibrations is common in the manufacturing industries. I am presently investigating the possibility of adapting the vibration-absorber for the control of chaotic oscillations.

Fractal dimensions are very useful as summaries of data. For instance, the tread of a tyre can be indexed on a scale ranging from smooth (long in service) to rugged (new). In general, as a tyre wears, the tread becomes smoother (i.e. reduced ruggedness). Fractal dimension is essentially an index of the ruggedness

of a boundary. Presently, I am supervising a Ph.D. student, who is investigating whether fractal dimension can be used advantageously for the characterization of various branded tyre tread patterns, tyre wear and tyre wear rate.

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DEMOCRACY WITHIN AND OUTSIDE THE IVORY TOWER

J. D. Ojo
Faculty of Law

When the Faculty of Law finally came into being in 1984 August 1, it had existed 3 years before that time under the umbrella of the Faculty of the Social Sciences that first brought it into being. This is why it is necessary to pay special tribute to the founding fathers, many of whom are still here with us like Professor Tekena Tamuno, when he was Vice-Chancellor conceived the plan, and sold the idea to Prof. Reuben Udo, the Dean of the Faculty of the Social Sciences. The members of the Committee that was saddled with making a case for the establishment of a Department of Law under the Faculty of the Social Sciences, included the then Sub-Dean of the Faculty of the Social Sciences late Dr. William A. Ajibola, (people's Ajib) who sustained a fatal accident on the way to his home town after the last meeting, the very day the Committee completed its assignment on Friday, July 15, 1977, and died 5 days later on Wednesday, 20 July, 1977. Lastly, but not the least, the great colossus late Prof. S.O. Olayide, the Vice-Chancellor who steam rolled the plan to make law a reality in this University. But for the men of vision, may be "Law" would still be existing in the minds of many of us today. Before these activities the necessity to have a Law Faculty here at then University College, Ibadan (now University of Ibadan) was appreciated by the Colonial government of Nigeria. In 1959, Alhaji Abubakar Tafawa Balewa, the Nigerian Prime Minister offered Ibadan a Faculty of Law with the full support and weight of his government strangely, Ibadan rejected the offer on the ostensible ground that "Law was not its priority". May be, the then principal of the College, late Prof. Kenneth Dike, at the time, that lawyers "are trouble makers" and he did not want to compound his problems with having people who would see "white and call it black".

By the time, this University embarked on having the discipline of law within its fold in 1981, the Federal Government had lost all interest in the Premier University that refused to champion the teaching of law and the course of justice within the Nigerian University system. It had found new allies that were flexible and more amenable to the sound of the times.

From inception until 1995, all we had as buildings were two residential quarters converted into offices and classrooms and the Adeola Odutola Library which was meant to be a two storey building, but which due to lack of immediate use, ended up as a bungalow. What a tragedy!!! Late 1995, we had another residential quarter converted into a large lecture room and another boy's quarters converted into staff rooms. The threat of closure by the Council of Legal Education forced the University to start on a large Lecture theatre, under the tenure of Prof. Adewoye, as Vice-Chancellor. The work was still at the foundation level when he left. But with greater zeal and commitment by Prof. Olorunsogo as acting Vice-Chancellor, and the new dynamic group under Prof. Falase as Vice-Chancellor, the work has been completed. Today, we now have a good edifice in Law which is the pride of staff and students. We are indeed, ladies and gentlemen, grateful to the University for coming to the rescue at last. We hope that the Faculty would not be allowed to suffer any neglect again.

With the new structures, the Faculty was emboldened to recruit more teachers and to embark on our postgraduate programme, which, by God's grace, will be starting in October, 2001.

The Journey So Far

In this lecture, Mr. Vice-Chancellor, I shall narrate my involvement with the Law Faculty at Ibadan sharing with you the highlights of the events at the various milestones reached in my journey so far in the Ivory Tower of the University of Ibadan. When I was looking for a topic on Criminology for my Ph.D thesis, I had a chat with Prof. A. K. R. Kiralfy, of King's College, London, who advised that I should consider a topic on Constitutional Law which, he felt, would be more useful to us in Nigeria than one in Criminology. On further discussion, he was frank that Nigerians needed more research on Constitutional Law and Constitutionalism to find out why our Constitutions were breaking down. It was agreed that my research should focus on a comparative study and analysis of the Executive in a number of Countries.

My first paper, after my Ph.D., was an examination of *"The Future of Parliamentary Democracy in Nigeria"* where I was able to say (in Ojo; 1975: 161) that

"African rulers, unlike some of their opposite numbers in Europe, tend to hold on to the reins of power regardless of the climate of opinion. The average African still finds it difficult to accept a situation in which he should surrender power voluntarily and execute rather than give orders. For that reason, many governments in Africa have gone to extremes to maintain themselves in power. Many have suppressed the rule of law and

inflicted severe infringements on the democratic system. They have, in so many cases, rigged elections, bribed voters and victimised political opponents for the sole purpose of staying in power. It is difficult to imagine that the European concept of the rule of law can ever take root in Africa".

This article had the misfortune of being published in Germany when no Nigerian Journal was willing to consider it for publication for fear of government reprisals or the incarceration of its editors. What a tragedy that people were not prepared to fight injustice and bad government. All we were prepared to do was to grumble in beer parlours, and in the sheltered corners of our rooms. In quick succession, I made attempt in further papers to examine the tools that could make democracy realisable: freedom of the press (Ojo; 1976), the doctrine of the separation of powers (Ojo: 1977), the role of traditional rulers in the changing political set-up (Ojo 1976) and how trade and commerce could be harnessed to sustain a democratic culture (Ojo: 1981).

With the promised return by the military government of General Murtala Muhammed in 1975 to return to a civilian set-up in 1979. I shifted my attention to the University system. Education and the Law where there was far less attention than Constitutional Law I discovered, most disappointingly, that there were very few reported decided cases in that virgin field. It was frightening that when the University of Ibadan Vice-Chancellorship became vacant in 1971, the oldest University in the country, there was a prolonged interregnum as the Premier University could not fill the vacuum for months. Personal and inter group rivalries dominated debates and when the Gowon government realised that Ibadan would not produce a Vice-pressure or interference, decided to on impose the University of Ibadan (Amendment) Decree. 1972 which now prescribed among others the procedure for the appointment of the Institution's Vice-Chancellor. Thus, by inaction or a reckless disregard of its duties under the University of Ibadan Act, 1962, Council lost the power to appoint its own Vice-Chancellor to the government. All attempts by the Academic Staff Union of Universities (ASUU) to wrest this power from government since then and reinvest it in the Universities has been a lost battle.

With this and the way many members of staff in the Universities were subsequently sacked in 1975 by the Visitor without reference to the University Governing Councils or the contracts of appointment of the affected staff it became imperative to study the various University Acts and find out why the Nigerian Visitor has suddenly become a hydra-headed monster that could easily devour the men in the Ivory Tower without weighing the cosequences of such slaughter. Not only this, the way our students were killed or maimed during student demonstrations while students in other developed countries hardly sustained injuries, during their demonstrations, made it necessary to conduct research into student crises in the Universities.

Early attempts to do meaningful research in this area ran into problems, as Nigerian journals were afraid to publish any incisive criticisms of government. Even editors who I felt should brave it chickened out on the pretext that they

would not like to be made scapegoats. An examination of the Criminal aspects of April 1978 students demonstration in Nigerian Universities was published in Germany (Ojo: 1980) while that on the Constitutional aspects of the 1978 April students Crisis was published in the Phillipine Political Science Journal (Ojo: 1980). These articles tried to show that, not minding the excesses and the nuisance value of these demonstrations, killing or maiming students was not the solution. Rather, a more acceptable and humane approach like using tear gas, water hose rather than live bullets, was better

With the spate of removals and killing of students unabated, a comprehensive work became necessary and this resulted in a book entitled *Law and University Administration in Nigeria* (Ojo: 1990) It attempted a critical examination of the power of the Vice-Chancellor, the University Administrator, academic freedom, University autonomy, students and the law within the Nigerian University system, tuition, quota system, admission freedom of expression, right to private life, etc, personnel issues in administration and the role of the University Counsel.

The work has also shown that there is a need to revisit the place of the visitor within the Nigerian University system. It showed that, rather than have Head of State as visitor to all the Federal Universities and the Governor as visitor to all the State Universities, it is now time to allow the Chancellors, whose roles are purely honorific in the Universities to take over the functions of the visitor since the Chancellors are the nominees of the Head of State or the Governor as the case may be (Ojo, 1990; 79-87).

Secondly, the visitor should be made to confine himself to the traditional role of the visitor in a British University. A situation where the Nigerian Visitor dabbles into every minor crisis in the University leaves much to be desired. Prof. J. F. Ade Ajayi and Yemi Akinseye George in a book which is being published by Spectrum on *Kayode Eso: The Making of a Judge* hold the tenacious views that "nothing has undermined the autonomy as much since the visitor in Nigeria was not a highly placed individual as in the United Kingdom" (Ajayi and Akinseye-George, forthcoming, 2001:248)

Harvey, for saw this in his *Freedom. University and the Law: The Legal Status of Academic Freedom in the University of Black Africa* that

My concern, which possibly many will share, related to the creation of governance mechanisms allocating broad discretionary powers over the University to those who may not only be insensitive to its special ethos and needs, but also vulnerable to the temptation to deal with it as only one aspect of the general political and governmental matrix (Harvey: 1978 : 49).

With the increased ferocity in institutional killing of students by fellow students, all in the dreaded name of cubism further work was embarked upon on institutional violence. With a small research grant by the Senate Research Grant's Committee of this University in 1990. I was able to visit most universities in

Nigeria to find out their problems and the reason why students started to kill other students in the name of cults. The research became so fascinating that almost my whole salary went into it every month. When it became unbearable, Prof. and Chief (Mrs.) J. F. Ade Ajayi decided to assist with financial the work entitled "*Students Unrest in Nigerian University: A Legal and Historical Approach* published by Spectrum Books. At last in 1995, the work surfaced (Ojo: 1995). This showed that, not minding the serious criticisms of students, most students were well behaved and that only a microscopic minority was involved in frivolities that tended to damage the good name of the students' populace and the University in general.

It was shown that, with more forbearance by students and staff, creating more avenues for sporting activities, more literary and debating activities and the involvement of Parents, Teachers and Students' Association, in the management of students, this menace that was eating deep into the body politic of student unionism could be curbed and tamed if not completely eliminated. I also showed that, rather than an outright ban on students' secret societies, an attempt should be made to unban them and let all student cults, fraternities and confraternities register with University authorities. That was the situation in the seventies and eighties. By that time, the identities of the students in the various organisations were known and those who flouted University rules and/or regulations could easily be detected, and punished. The present system, which tends to drive secret societies underground is not the best for the country. After all, students are to be trained in both character and learning. How can we perform these creditably well when the identities of those to be trained are unknown?

With the return of democratic government in 1979, one felt that one should count one's blessings and thank God for driving the Khaki men into the barracks and bringing back the agbada men. Unfortunately, we forgot to realise, in time, that having an old wine in an old bottle would eventually break the bottle. Most of the men who returned in 1979 were those who brought about the fall of the first Republic. We forgot that it was not the Constitution that made good government but the calibre and the commitment of those who were chosen to run the government.

Dr. Ambedkar, the father of the Indian Constitution warned during the Indian Constituent Assembly Debates in 1948 that

However good Constitution may be, it is sure to turn out bad because (sic) those who are called to work it happen to be a bad lot. However bad a constitution may be, it may turn out to be good if those who are called to work it happen to be good lot. The working of the Constitution does not wholly depend upon the nature of the Constitution" (Ambedkar: CADX 995).

Similarly, Wheare emphasised in his *Federal Government* the importance of leadership and he felt that a great deal would depend on the leadership or statesmanship at any given time – (Wheare: 963.39). Within two months of the take-off of the Second Republic, cracks were already appearing. The government

had started to lose a sense of direction. They achieved a near miracle in that, within the space of four years, the people who showed such hatred of the military in 1979 began to yearn for them and danced for joy at their return on New Years Day January 1, 1984.

In January 1980, Shugaba, the leader of the GNPP in the Borno State Assmbeley was, one morning whisked off by security agents on the orders of the then Minister of Internal Affairs on the grounds that he was a State Security risk and that he was not a Nigerian. He was deposited at the Chadian border. The problem here was that neither his Governor nor his family was informed of this deportation. He managed to smuggle himself back into the country and in *Shugaba v. Minister of Internal Affairs et al.*, 1981 the Court ruled that Shugaba was a Nigerian and that the deportation was illegal, null and void. The Court awarded damages against the Government but the Government refused to pay the damages.

Just as the dust was settling on at case, the impeachment of Alhaji Balarabe Musa on trumped up charges by the Kaduna State House of Assembly (NPN controlled house) was hatched and executed with such venom that in comparison, Hitler's execution of the Jews at the gas chamber during the second world war could as well be regarded as a friendly act. His absolute faith that the courts would save him fell hollow. Adenekan Ademola JCA delivering the judgement of the Court in *Alhaji Abdulkadir Balarabe Musa V. Auta Hamza & Ors.* On 16 July, 1981, about a month after his removal, held that S.170 (10) Nigerian Constitution, 1979 was inserted in order that "no court can entertain any proceeding or question the determination of the House of the Committee" (Ibid at p. 245). By this decision, the hope of Alhaji Balarabe Musa of ever getting justice in his case was dashed to pieces.

With the political situation as it was, it then dawned on me to complete the work which I started in Philadelphia when I was a Visiting Fellow at Temple University School of Law on the Development of the Executive under the Nigerian Constitutions 1960-81. The work was completed in 1983 with this frustrating comment which is at the introduction of the work that

Whether the 1979 Nigerian Constitution would provide a permanent cure to constitutional instability in Nigeria is too early to say. The discussion in this book shows that we are not out of the woods yet. Whether we begin to find our way out of the depth of disaster or sink deeper in the complicated labyrinth of government will be determined to a large extent by the conduct and consequences of the 1983 elections". (Ojo 1985: xiii)

At the end, I came to the conclusion that, with the way our leaders were carrying on the functions of government, it was certain that Constitutional Government would certainly collapse and that the consequences of that catastrophe would be difficult to imagine. The work was accepted for publication with some trepidation by University Press Ltd. in August 1983 which warned me that there could be reprisals from the NPN Controlled Federal Government. By December

31, 1983, while the work was still in press, the Constitution had broken down and the prediction in this work came true. The publishers wanted me to write a postscript, but I turned down the request as unnecessary.

From that time to now. I have been busy examining issues in local government as a third tier of government. I examined the provisions of the 1989 Local Government Decree, the various amendments and the impact on national development (Ojo; 1978 1-42). Legal Issues Promoting Conflict in our societies, (Ojo: 2000:58) and the role of the police under the various Constitutions. (Ojo: 1992: 13).

One can see from the above that most of my work has dealt with the leadership role of those at the helm of affairs in both Government and the Universities and what effect such roles, have in steering the ship of state aright. This shows that the success or failure of any administration depends to a large extent on the way the executive conducts the primary business of government.

Definition of Democracy

In 1986. Prof. Folarin Shyllon gave the first inaugural lecture for the, Faculty of Law on *Freedom. Justice and the Due Process*. 15 years later I am now standing before you to give this as the second inaugural. This shows something our situation the Faculty of Law. For several years, the Faculty had only one Professor with the remaining staff as junior Lecturers, only one being Lecturer I. With such staffing, it was impossible to project into the future. Now the Faculty of Law has arrived. We have 3 Professors, one Reader with others in the pipeline. It is hoped that from now on the Faculty of Law would be able to maintain its slot in the schedule of inaugural lectures and keep its place in the comity of scholars in this university Community.

What then is democracy? The *Longman Dictionary of Contemporary English* define democracy as:

- "(1) Government of the people, by the people and for the the people, (2) government by elected representatives of the people (3) a country governed by its people or their representatives (4) and the right to take part in decision making".

But the most popular definition is that by President Lincoln in his Gettysburg address on November 19, 1863, during the American civil war, that "this nation under God shall have a new birth of freedom and that government of the people, by the people for the people shall not perish from the earth" This shows that however popular or benevolent a military government may be, it is still a dictatorship and that democracy has gone by the board when a group of officers seizes the govern-ment, pushes, the constitution aside, and abolishes or suspends political parties and elections. Since the basic concept of democracy is rule by consent, where ever a government depends on popular support, it is by definition a democracy. (R. Emerson: 1962: 283) Rupert Emerson, criticizing this statement said that

This is a claim to be rejected. A government controlled by the military may be doing an admirable and necessary job, as in attacking corruption, undertaking land reform in West Pakistan, or cleaning up Rangoon, but it is debasing the currency of political terminology to call it a democracy even though it has the honest intention of creating conditions under which democratic institutions can be restored" (Emerson 1962 284).

Therefore, for democracy to reign in any country or society, the following are the necessary concomitants as stated by Robert Dahl (1998:38) effective participation, equality in voting, gaining enlightened understanding (4) Exercising final control over the agenda and inclusion of adults and that such democracy is likely to produce the following desirable consequences (a) avoiding tyranny (b) up holding essential rights (c) sustaining a feeling of general freedom (d) self determination (e) and the moral autonomy of individual citizens.

Can we boldly say that in Nigeria today there is a democracy? One may give a qualified affirmative answer. Our elected representatives came in through the ballot box. There is uninhibited freedom of expression. No one dictates to the members of the Houses what to do and how to go about their business.

Having said this, can one really say that a society which is largely illiterate, where most of the people cannot read and write can exercise the vote wisely and without hindrance? Can't such people be swayed by the extravagant promises of irresponsible charismatic leaders? Pylee, commenting on the situation in India, said that

One of the most serious weaknesses of democracy in India is the widespread illiteracy and ignorance of the masses. The introduction of adult franchise at one stroke among a predominantly illiterate people has its own inherent dangers. So long as they are unable to exercise the franchise in an intelligent manner, after analysing the political issues in a rational way, democracy is not safe (Pylee: 1965 773).

Of course, there is the argument that a visit to motor parks and markets in this country will sever the level of political consciousness in our people and that with or without western education, they know their rights and how to demand for these when necessary. One cannot but agree with these. But with a bit of education. Such political consciousness will be heightened and the people would be able to make more intelligent contributions to political debates. de Smith was of a similar opinion when he said that

In recent years western commentators have probably tended to underestimate the importance of illiteracy and ignorance in the political process, particularly in unsophisticated rural societies. We have observed clear demonstrations in India and elsewhere that illiterate persons are quite capable of, exercising a

reasonable choice at an election - at least a choice that may be as rational as the exercised by voters in western countries. Nevertheless, in between elections it becomes extremely difficult to explain a government immediate problems to people who can have no adequate conception of the larger context in which those problems have arisen. (de Smith, 1964 : 237)

How can we honestly talk of democracy in Nigeria when most of the goodies of life are denied the general citizenry who lack the right to education, health facilities and even the right to work?

If the resources are well harnessed, and all squandermania eliminated, this country has the wherewithal to fund free education up to the secondary school level. But the problem with us is that, most of our leaders, are living above their means and corruption has engulfed the fabric of the society. The money that should have been used to develop the people and make life better and easier for the masses is now being looted by some of these leaders and invested illegally in foreign banks. Today, some of our leaders are richer than the country while most of the citizens are wallowing in misery and abject poverty: What 3 paradox ! !

Claude Ake believed that, for democracy to be meaningful in Nigeria, the people have to

Be transformed by a programme of upliftment, a programme which gives them access for health education, wealth, leisure and most importantly power" (Ake, : 1996; 10)

This is what our Government should strive for and accomplish. We should shelve white elephant projects and grandiose schemes, which does not benefit the masses.

The Executive

As stated earlier on in this lecture, it was emphasized that the Executive must provide the leadership and perform the tasks that could weld the various units, within the country together. (Ojo, 1985: 9). A similar view was held by Lord Eustace in *his Democracy on Trial* (Eustace, 1951:29) that the focusing function of government must be discharged not by a representative legislature but by the executive that can blend, with the strong light of national power, all the various colours of national life.

This is why it is necessary to vote in leaders who would rise above partisan politics and give good leadership in government. Chief Afe Babalola, in his *Work on Leadership and Good Governance* was also of the view that "There is a consensus of opinion that it is only good leadership that can bring about good governance". (Afe Babalola (SAN.) 2000:8). He said further that a study of world leaders shows that good leadership is characterised by among others, wisdom, learning, charisma, vision, courage, integrity, honesty, probity of character, transparency and accountability (Afe Babalola Ibid: 9). All these help to show

that Nigeria now needs statesmen not politicians. The problem the country has been facing for some time, is to have several small men in big or giant boots.

Moreover, how can we make saints out of ill equipped representatives? Many of our representatives in the National Assembly and State Houses of Assembly are products of the era when "might was right". Many of them were born during the political crisis or the Nigerian civil war. Many of these people did not know peace and what makes for peace. The younger ones are now products of cults in the secondary schools and in the universities. How easy is it for anyone to tame such representatives? This is difficult. No wonder, during hot arguments in the Houses, "Honourable members" descend so low as to engage in physical combat to settle scores"

What good can one expect of such gladiators? One strongly suggests that all representatives must be properly screened by the leaders of the political parties and any one with a shady past must be disqualified. Similarly, any one who misbehaves or does not live up to expectations should be disqualified, in addition to the disqualifications listed in ss.66 (1) and 107(1) of the Nigerian Constitution, 1999. It should also be enacted that any member of Parliament or a House of Assembly who misbehaves during the sitting of any House must be made to lose his seat in the House and a bye-election immediately held to fill such a vacancy.

Information Flow

One of the ways by which democracy can be sustained is through a ready flow of information. The Nigerian Constitutions are written in English. Most Acts of Parliament and Laws are in English. In a society where most citizens are not literate in English but knowledgeable in their indigenous languages, efforts should be made to translate the constitution and many important Acts and Laws into the indigenous languages. Attempts should also be made to hold seminars and workshops to enlighten the people on these documents. Such seminars, workshops and the use of jingles may help to simplify difficult translations or ambiguities.

In addition to the above, members of the National Assembly, Houses of Assembly and Local Governments must be made to disclose their salaries and remunerations, and other salient issues affecting their jobs as representatives of the people. A situation where salaries and allowances of representatives of the people are classified as "secret" does not augur well for democracy. How can we challenge a member of Parliament who recklessly exhibits his ill-gotten wealth to dazzle the less privileged ones when people do not know the source of such wealth? How can we accuse such a person of corruption under the Anti Corruption Act when his source of affluence is not laid down or is shielded from the people? In other developed countries, the Gazette would carry the salaries, allowances and other entitlements of public officers, why is this not so in Nigeria? We should insist on this as a right. We have a right to know.

The Nigerian Government and the University Systems

Just as there are National, State and Local Governments with specified powers, under exclusive, legislative and concurrent legislative lists, are there powers

vested in the constituent authorities within the University system like Council, Senate, Faculties and in the various Committees and boards handling institutional governance at the lower levels. There is no over concentration of power in any person or body and the principle of separation of powers as enunciated by Montesquieu that if there is too much concentration of power in a particular person or in the same body of magistrates there would be tyranny. (Montesquieu: 1748) This principle is greatly respected in the universities. But the impractical nature of full separation of powers has been vividly brought out by Woodrow Wilson, who maintained that "the trouble with the theory is that government is not a machine but a living thing. No living thing can have its organs offset against each other as checks and live. Government is not a body of blind forces. It is a body of men with highly differential functions. Their cooperation is indispensable, their warfare fatal". (Woodrow Wilson: 1909:56). It is clear from the above that this doctrine has substantial relevance to the University system as Ojo said elsewhere that no university ever concentrates too much power in any of its organs of government so that they can work in collaboration to foster the objective of the University (Ojo: 1999:17)

Just as there are representatives to run the affairs of government, so are there people elected or selected to run the university system, even though the idea of government by the people and for the people is alien to the culture of the University system. A University, is strictly speaking a meritocracy not a democracy.

Prof. Idris Abdulkadir, a one time Executive Secretary of the N.U.C., examining the democratisation of student campus life which meant the full participation of students in all aspects of University administration, agreed that this was a legitimate demand but felt that there were limits. He strongly believed that the representation of students in the University Senate or University Councils which consist mainly of government appointees charged with the formulation of policy for the administration of the campuses, could not be a legitimate request. (Abdulkadir: 1987) He however supported student representation on all other committees. J. D. Ojo however disagreed with the views of Prof. Abdulkadir on this issue. He believed that efforts should be made to reform the University system so that all the bodies and units in the University (are fully) represented and that there should not be a feeling of being left out. He strongly felt that students should be allowed representation on Council and Senate but when sensitive issues like examinations that affect students directly are being considered, they should be asked to withdraw temporarily until such issues are disposed of (Ojo: 1985; 94).

The same view holds for the non-teaching staff that they too should be allowed representation on all boards and Committees of Council and Senate where their interests are affected (Ojo: 1981;51). But to insist on having congregation split its representatives on council by conceding one out of the two representatives to the non-teaching may be difficult now that there seems an intense rivalry between the teaching and the non teaching staff. In fact, Prof. Babs Fafunwa once said that some senate members are of the view that the entire administrative function of a University should be brought under Senate control,

"since, they argue that a University is an academic enterprise and not a trading or manufacturing company where top management (administration) reign supreme" (Babs Fafunwa: 1971:216).

One is not surprised at the views of Prof. Babs Fafunwa. He was here expressing his views as a thorough bred academic. Some years later, when he became the Federal Minister for Education, most of his decisions were in favour of the academics, the sector he very much believes in and loves.

Dr. Kenneth Mellanby, the first principal of the then University College, Ibadan had this to say on University administration, that "Administration is inevitable. It should try to be efficient; it should make sure it is unobtrusive. Its job should be to see that the academic work of the college goes on as smoothly as possible, remembering that the College cannot live without the academic members however much their habits may irritate the administration, whereas the academic staff at least imagine they will get on quite well with no administrators." (Mellanby: 1958: 130)

In similar vein, Charles Carter, one time Lancaster's Vice-Chancellor, in his comments on this issue says that "Many academic persons.... believe themselves to be wiser, more intelligent and more honest than their colleagues" (Carter: 1957:257-258). While one agrees that the universities are more of an academic enterprise, yet one cannot ignore the feelings of the other members in the group who help to make the venture a realistic one. Having seen both sides of the divide, I can boldly say that such a group deserves some say in the system.

From the above discussion, it is clear that the idea of a democratic governance is difficult to apply in its totality in the Universities and that this should be applied with much greater care if it should be applied at all (Moodie and Eustace: 1974:224).

May be, it is better to describe the university system rather as an oligarchy i.e. rule by a few who are mostly professors which shows that a few people are more politically active and hence more influential than the others and that such as identifiable small group exercises despotic power over a mass of people (Moodie and Eustace : 1974 : 224) This may be unfair to categorise all the professors as despots since we know that many of them assume their positions by virtue of their administrative positions and they do not exercise absolute powers but act after wide consultations. Is it not safe to say then that what applies in the universities is the principle of "meritocracy"

Concise Oxford Dictionary; has defined "meritocracy" as government by persons selected competitively according to merit (2) a group of persons selected in this way" while *Longman Dictionary of Contemporary English* defines it as "a social system which gives the highest positions to those with the most ability (2) the people who rule in such a system" Even the two Dictionary definitions are defective for whatever merit you may have, if you do not belong to the class that rules, your views would only be taken as advisory.

Having said this, universities are nor as segmented as all that. Once a person can propagate his views convincingly, no matter the class he belongs to, people would consider them. As Eustace and Moodie (Eustace and Moodie, 1974:219) emphasize "To draw no governmental distinction between teacher and taught,

between intellectual and non academic worker or between student and employees is, in turn, to assume either that the purposes of an organisation are irrelevant to its form or that the professional authority hitherto claimed by and for academics is irrelevant to the decision making process".

The universities are not closed shops. They are open to new ideas and embrace new thinking. There have been members of the non-teaching staff like Mr. Olufemi Eperokun then of the University of Ibadan and Mr. Adegboro also of the Federal University of Technology, Akure, who had at one time or the other become members of their councils through being members of Congregation. This shows that dynamic and trusted members of the non teaching staff can still win election to Council without the imposition of a quota system. In the above cases, the people elected won their seats purely by merit. Their position as non-teaching members was not allowed to frustrate their ambitions. But democracy of one man one vote by adults cannot work in the Ivory Tower. What operates is meritocracy.

Prof. J. F. Ade Ajayi, in his First Foundation Day Lecture at the then Obafemi Awolowo University now University of Ado Ekiti on 25 March, 1983 said that for a good university to emerge "The principal officers of the University must be carefully selected, as people capable of understanding that sense of destiny and offering necessary leadership to fulfill it." (Ajayi. 1983:11)

Unless the leadership forges this sense of unity through tact, understanding and diplomacy, where necessary, universities may be difficult to run. A situation where the non-teaching staff are regarded as under dogs may not be in the best interest of the University system.

Prof. Ajayi in his concluding remarks in his lecture on "The University as an integrated system." quoted the prayer of an Indian Philosopher. Rabindranath Tagore (Ajayi in Ojo and Fadupin: 1983:22).

"Where the mind is without fear and the head is held high; Where knowledge is free:

Where the world has not been broken up into fragments by narrow domestic walls;

Where tireless striving stretches its arms towards perfection, Where the clear stream of reason has not lost its way into the dreary desert sand of dead habit:

Where the mind is led forward by thee into ever widening thought and action.

Into that haven of freedom, my Father, let my country awake!!"

All I have said so far comes to this that there is no way we can talk of democracy within the larger society without examining what democracy is within the Ivory Tower. That our failure to inculcate decent behaviour into our students has led them to become thugs in the Houses of Parliament where free for all fight is the norm over minor disagreements. Let us inwards and reform our products. Let us deliver to the Nigerian society cultured and well behaved products that can redeem our battered image. Let the Government and the people embark on those

programmes that make for a viable democratic system. Let me end this inaugural with what Cassius told Brutus in William Shakespeare. *The Tragedy of Julius Caesar* that "the fault, dear Brutus is not in our stars.

But in ourselves, that are underlings."

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LEARNING IN TONGUES, EXPRESSING MYSTERIES: LESSONS FROM NIGERIAN LANGUAGE EDUCATION PRACTICES

Ayorinde Dada

Department of Teacher Education

Introduction

It is my honour and privilege to stand before this august and very distinguished audience to deliver the 7th in the series of Inaugural Lectures for this academic year. I am doing this on behalf of the Faculty of Education, and the Institute of Education. I am from the department of Teacher Education, a singularly cosmopolitan department with its tentacles spreading to virtually all departments in the Faculties of Education, Arts, Science, the Social Sciences and very soon Agriculture. I belong to the language unit of that department, again a central unit in the whole University, because everyone needs language in order to learn, teach and conduct research.

My journey into language education started in 1966 when I was admitted for a 3-year B.A. History degree course and on getting to the University I joined the French beginners class out of curiosity. My performance in French at the end of the session earned me a bonus trip to the Universite de Dakar for a 5-week *cours d'ete*. There were fifteen of us thus honoured out of a class of about 200 students. Coming back for the following session, I registered fully as French major – although it was to cost me one extra year abroad. I however passed out with 2nd class (Hons.) Upper Division in French. After teaching for 3 years I resigned my appointment to go to France for my Postgraduate studies. There I had a Diploma in language Education, my Masters and my Doctorat de 3e cycle (Ph.D).

In 1982, I was in the Graduate School of Education, University of Pennsylvania. There I did courses in The Teaching of English to Speakers of other Languages (TESOL). Educational Linguistics and Ethnography of speaking. I also taught a course on Language and Education in Africa.

The biblical connotation of the title of my inaugural lecture is deliberate since it is inspired by the communication theory as expounded by St. Paul the

Apostle in his First Epistle to the Corinthians, Chapter 14 verses 2, 9, 10 and 11 as quoted below.

2. For anyone who speaks in a tongue does not speak to men, but to God. Indeed, no one understands him, he utters mysteries with his spirit.

9. So it is with you. Unless you speak intelligible words with your tongue, how will anyone know what you are saying? You will just be speaking into the air.

10. Undoubtedly, there are all sorts of languages in the world, yet none of them is without meaning.

11. Yet if I do not grasp the meaning of what someone is saying, I am a foreigner to the speaker and he is a foreigner to me. (*Holy Bible: NIV*)

The principles enunciated above are true of any communicative event. The message that goes from the sender (encoder) to the receiver (decoder) must be put in a code (language) that is mutually intelligible to both interlocutors. Otherwise communication will be ineffective. In our day-to-day interactions as human beings we need this mutual intelligibility to get along meaningfully with one another. More importantly, however it is in the business of education that we need this effective communication most.

The teacher has to impart knowledge in a manner that can easily help the learner to learn. In the same way the learner has to express himself in such a way as to provide an accurate feedback to help his growth. Good education depends on effective teaching and learning which in turn depend on the ability of both teacher and learner to share a common code. Krashen (1972) talks about the teacher providing a comprehensible input from which the learner obtains "a meaningful intake."

During the military rule, it was widely reported once that a state Governor was asked: "What mineral resources do you have in your state?" To which he answered: We have many mineral resources like Coke, Fanta, Seven Up and Africola." Obviously there was a breakdown of communication in that situation because both interlocutors did not share the same meaning for the code "mineral resource".

In the same way, when we were students in a French class, a series of questions accompanied some pictures and we were asked to read the questions and provide answers. This was what one of us produced.

Qu'est'ce qu'il y a dedans?

Il y a poissons beaucoup

It took the lecturer sometime to realize that the student was trying to speak French.

The Nigerian Language Situation

Nigeria has been credited with having between 400-513 languages, depending on whether we use the classification by Greenberg-Hoffman (1963) or that of the Ethnologue. In any case, the most conservative figure is 250 (Bamgbose 1976). Languages in these classifications imply mutually unintelligible linguistic systems and would not include what we popularly call dialects. These languages are unevenly distributed across the country and are classified either as major or minor following criteria which include numerical strength of their speakers and what socio-linguists would call the entrenchment of each language (Fig. 1).

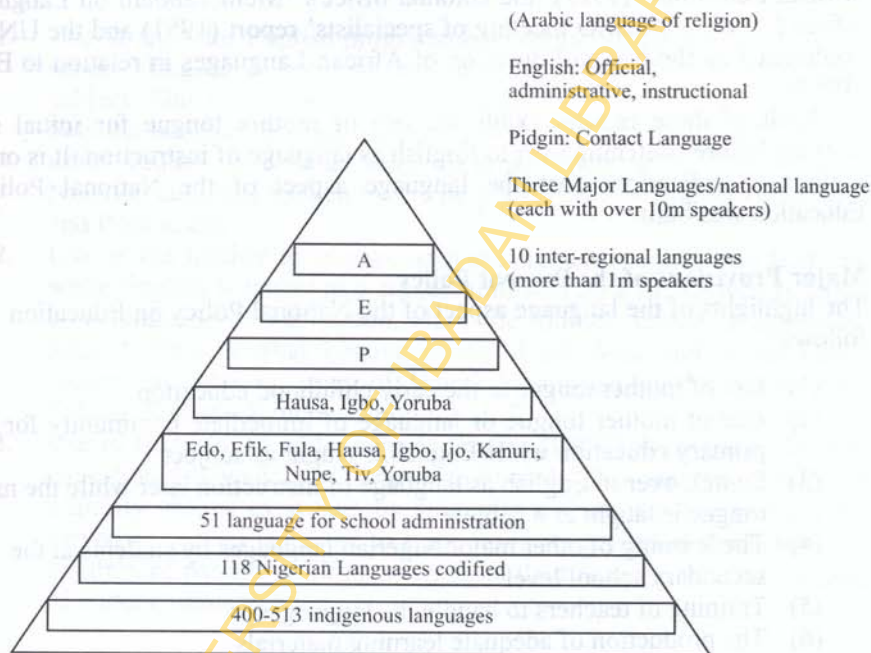


Fig. 1: Languages spoken in Nigeria

Source: C.M.B. Brann (1976)

Each of the languages that exist in Nigeria is situated in a socio-linguistic context in which it is used as mother tongue and has a considerable number of monolingual users. Only Arabic and English are exolects (i.e. non-natives of Nigeria) although there is a local variety of Arabic spoken by the Shuwas as mother tongue.

In addition to these, many of the indigenous languages (i.e. the endolects) are spoken as second languages by sizeable proportions of the other minority language groups. These would include the three major languages – Hausa, Igbo and Yoruba, as well as others that are used inter-regionally such as Kanuri, Fula, Nupe etc. In Plateau State, for instance, there are a number of minority language groups that use Hausa as second language.

It is in addition to these endolects that English is spoken by those who have gone through the education system sufficiently to use it for communication, while Arabic is used extensively for religious purposes in the Muslim areas of the country.

Language in the Education Policy

Historically, the language question has often come up in discussions of the educational system in Nigeria and Africa during the colonial times. For instance, the Phelps-Stokes report (1922); the Policy statement by the British Government Advisory Committee for Education in Africa titled "The Place of Vernacular in African Education" (1927); the colonial office's "Memorandum on Language in Africa (1943), UNESCO meeting of specialists' report (1951) and the UNESCO conference on the Use in Education of African Languages in relation to English (1952).

Each of these reports extols the use of mother tongue for initial school learning before switching over to English as language of instruction. It is on these various considerations that the language aspect of the National Policy on Education was built.

Major Provisions of the Present Policy

The highlights of the language aspect of the National Policy on Education are as follows:

- (1) Use of mother tongue in the early childhood education.
- (2) Use of mother tongue or language of immediate community for initial primary education while English is taught as subject
- (3) Switch-over to English as language of instruction later while the mother tongue is taught as a subject.
- (4) The learning of other major Nigerian languages by students at the secondary school level
- (5) Training of teachers to handle the languages
- (6) The production of adequate learning materials

A critique of this document was published in Dada (1985) where among others the following points were highlighted:

- The question of the heavy linguistic load to be carried by learners
- The problem of which Nigerian language to teach to which group
- The problem of proficiency level to which learners can go in each language before it is either used as language of instruction or abandoned for another language as language of instruction.
- The problem of providing specialist teachers to teach the languages
- The attitude of each ethnic group to the learning of the languages of other groups

A major conclusion from that paper (following a major research report on the last point) was this:

English language, which has been highly favoured by subjects in this study, although not so favoured by many of the educated Nigerians who are behind a lot of cultural and linguistic revival, may eventually remain with us for a longer time as official language, than we envisage – not because it might gain more admirers, but because it is probably the least of all practicable linguistic evils.

Language Education Practice

It is important to consider how the policy is executed in the school system. Three major patterns can be identified:

1. The Straight-for-English programme whereby right from the first day in school, English is used as language of instruction and taught as a subject. This is contrary to the recommendation of the National Policy. Schools involved include all private fee-paying schools and schools in urban centers as well as those in areas where there is no dominant Nigerian language spoken by the people e.g. Rivers State/Bayelsa, Delta and Plateau etc.
2. Use of the mother tongue as language of instruction in the first years while English is taught as a subject followed by a switchover to English as a language of instruction while the mother tongue is taught as a subject. This is what obtains in the South-West and South East of Nigeria as well as areas of Hausa dominance in the North: Kano, Sokoto, Kaduna, Bauchi (Omojuwa 1977).
3. Use of language of wider communication (LWC) as language for initial education followed by switchover to English. This occurs in areas where minority groups exist side by side with a dominant group e.g. Hausa served as second language to some minority groups in the North. Also children of parents working away from their homes learn in a language of wider communication.

Eventually, in all these situations, learners end up at one stage or the other using English for classroom communication both in English lessons and in other subjects.

By and large therefore, learners within the education system are brought up as bilinguals (trilingual or polyglots). However, the degree of competence in each language will differ from person to person from school to school, or from region to region, according to the degree of exposure of learners to each language whether within the school or within the community outside the school. The type of bilingualism developed is generally the compound bilingualism rather than the coordinate one. A compound bilingual is one who learns a target language through the medium of a source language and expresses himself through the process of mental translation. On the other hand, a coordinate bilingual learns his two languages separately and keeps them apart in use.

My Major Research Interest

Because of my experience in two exolects, my research has been in two directions:

- (a) Language Learning (as a subject)
- (b) Language of learning as a tool of communication

Language learning research in Nigeria has focused mainly on second language learning and/or the learning of other languages – apart from the mother tongue or first language. My research in this area has been in the aspect of the learning of French at both the primary and the secondary school levels. (Dada 1976, 1979, 1980, 1985, 1991, 1995). These studies have been able to isolate certain important variables pertinent to the effective learning of the language. In my Thesis titled: *L' apprentissage du francais au Nigeria relation entre motivation, contexte Pedagogique et performance*, it was discovered that both motivation and the learning environment are strongly related to achievement whereas attitude – especially positive attitude – may or may not affect achievement.

Other variables isolated in the other studies include:

- (a) The necessity to provide good models in the areas of pronunciation, grammar, reading, writing styles etc.;
- (b) Exposure to the target language – The provision of what Krashen (1972) calls comprehensible input;
- (c) Home processes i.e. the encouragement received from home by the learner;
- (d) Aptitude: The "Knack" for language learning;
- (e) Peer encouragement.

In the next phase of this lecture, I am going to present some findings that relate to some of the above variables mostly in a descriptive form in the areas of the use of English as language of instruction by teachers and as language of self expression by learners. Hitherto a lot has been said on the poor performance of learners in the English language – which is their ultimate language of learning. It is the language in which they eventually receive lectures, do all their reading, express themselves orally in both the intellectual and social domains and do all their writings: formal and informal. Studies such as Ayodele's (1988, 2001), and WAEC yearly reports all show us that all is not well considering the very high number of failing candidates in English. My studies on the other hand tried to look at the nature of the learners' performance and the kind of input that the teacher gives that might have contributed to that kind of performance.

The Input of Teachers

Language(s) of Instruction

Between 1985 and 1990, I led a group of scholars to study classroom interaction in terms of the input of each participant to the communicative events. It was an ethnographic study whose center of interest was the language(s) of instruction

used by the teacher and the linguistic responses of learners. In Dada and Ogunyemi's (1988) study, the classes involved were primaries 4-6 where learners were supposed to be instructed in English according to the National Policy on Education. In addition to recording the communicative events in the classroom we were there as participant observers and were able to interact with both teachers and learners. The major observation was that there were three languages used for instruction in every lesson, although the proportion varied from subject to subject and from class to class. The following graphs illustrate the point (see Figs. 2a-c).

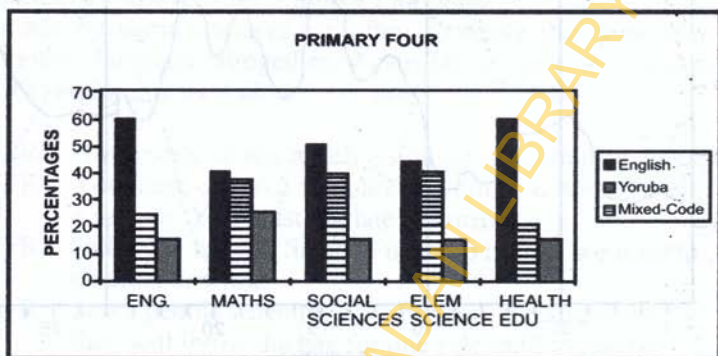


Fig. 2a. Primary four

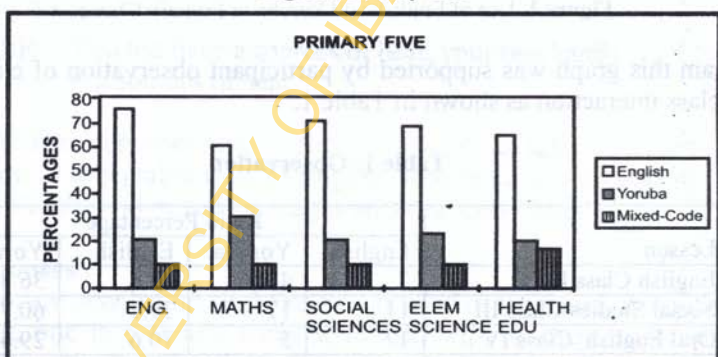


Figure 2b: Primary five

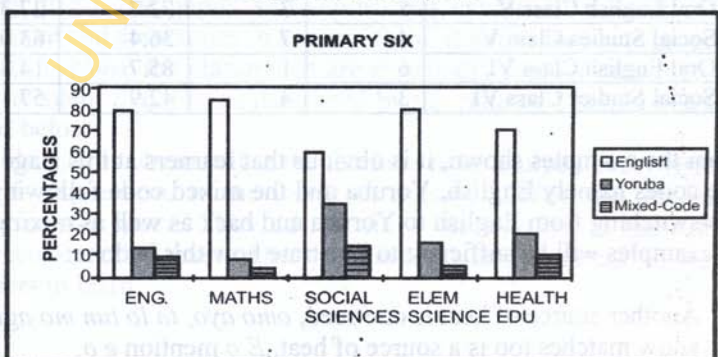


Figure 2c: Primary six

These findings are supported by another study by Dada (1985) where teachers estimated the proportion of the languages used in various situations – both formal classroom teaching and the non-formal interaction with pupils and other teachers in out-of-class contexts. The following graph illustrates this interaction (see Fig. 3).

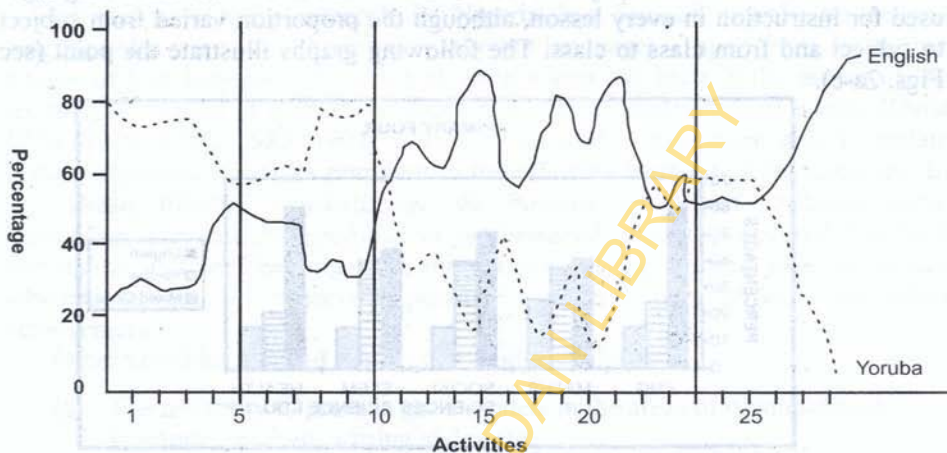


Figure 3: Use of English and Yoruba in Primary Classes 4-6

Again this graph was supported by participant observation of classroom and out of class interaction as shown in Table 1.

Table 1: Observation

Lesson	Ratio Percentage			
	English	Yoruba	English	Yoruba
English Class III	7	4	63.6	36.4
Social Studies Class III	11	17	39.3	60.7
Oral English Class IV	12	5	70.6	29.4
Social Studies Class IV	5	8	38.5	61.5
Oral English Class V	8	3	72.7	27.3
Social Studies Class V	4	7	36.4	63.6
Oral English Class VI	6	1	85.7	14.3
Social Studies Class VI	3	4	42.9	57.1

From the examples shown, it is obvious that learners at this stage are learning in three codes namely English, Yoruba and the mixed code following the pattern of code-switching from English to Yoruba and back as well as mixing codes. One or two examples will be sufficient to illustrate how this is done:

Another source of heat is one seed, *omo ayo, ta lo tun mo agbaarin?* You know matches too is a source of heat. *E o mention e o.*

- TEACHER: What is the work of carbohydrate. *Kini ise carbohydrates?*
- PUPIL I: They give energy
- TEACHER: What is the function of vitamins ?
- PUPIL II: It deforms our body
- TEACHER: *Se e ri omo yi pelu ki o ma se nkan lodilodi.* Molarase vitamins *maun* deform *ara wa ni?* (meaning look at Molarase behaving abnormally: Do vitamins deform our body?).

Use of Substandard Variety of the English Language

The errors made by some teachers are often so many that their own variety constitutes another language altogether. Again let us look at a few examples. Ogunyemi 1990 highlights the following errors.

TEACHER: How many of you watch last night *kini*, em play, em ball

TEACHER: You these children what are you doing at home? *Anu e se mi o.* You must not late tomorrow.

TEACHER: Sadiq you haven't finish? Finish up in time we want to do another work.

TEACHER: Some people when they got home in the afternoon, they will throw the bag for one side until tomorrow morning.

TEACHER: You too have a sources of heat, your two hands is a sources of heat.

All we are here demonstrating so far is that pupils do learn in tongues. In this case they learn in acceptable form of English, they learn in substandard English, they learn in Yoruba and mixed languages all at the same time.

Pupils' Responses

When learners are assailed on all fronts by a myriad of languages in the course of their learning, one is naturally tempted to ask, what is their response to this challenge? Naturally, just like the new Police slogan in Nigeria, they try hard to return "fire for fire"! The pupils' self-expressions exhibit all the features of the input they receive and sometimes in a worse form, if not in the same proportion.

First of all, because the classrooms are essentially teacher-dominated pupils often act as the silent majority as illustrated by the ratio of Teacher talk to pupil talk presented below

From Table 2, it is obvious that the teachers have usurped every right of the learner to self-expression. In the words of Stevick (1976), the teachers have occupied the *learner space*. They do not allow the learners to learn properly. Stevick has recommended that teachers should teach and teach and get out of the way for learners to learn.

Table 2: The ratio of teacher-talk to pupil-talk in primaries 4-6

	TEACHER	PUPIL
PRIMARY 4		
ENGLISH	9	2
MATHEMATICS	8	1
SOCIAL STUDIES	9	1
ELEMENTARY SCIENCE	4	1
HEALTH EDUCATION	7	1
PRIMARY 5		
ENGLISH	9	2
MATHEMATICS	9	1
SOCIAL STUDIES	5	1
ELEMENTARY SCIENCE	8	1
HEALTH EDUCATION		1
PRIMARY 6		
ENGLISH	10	3
MATHEMATICS	6	1
SOCIAL STUDIES	4	1
ELEMENTARY SCIENCE	9	2
HEALTH EDUCATION	7	1

Secondly, when learners have a chance to speak they also prefer to speak in tongues using as many codes as they have acquired from their teachers. However, their speeches are Yoruba-dominated.

Examples:

TEACHER:

Awawu, do you know what Milton is ?

PUPIL (I):

Ibiti nwon ti nse apejo ni ma (It's a meeting place)

PUPIL II:

Olomi ni ninu igo lo ma nwa (It is a liquid and it is normally bottled)

TEACHER:

Ki ise mitini ni o ohun ti won ma nbu somi ni o.

TEACHER:

Do you know what bridge is ?

PUPIL:

Afara ni ma ti won fi nkoja lori odo (It's a bridge that is built over streams for passage).

TEACHER:

What kind of fish do you like best ?

PUPIL:

Alaran (Mackerel)

TEACHER:

Why do you like that particular fish?

PUPIL:

(laughs) *Nitoripe oma ndun ma a si tun ma fi nmu gaari ni ile.*

(It is palatable and we also use it in taking *gaari* at home)

Their responses in English are usually full of errors.

- I'm not come to school when you have do it. I'm not do the English.
- My school have a good playing ground

- Electricity bulb is a sources of heat.
- I saw many childrens in the zoo

A glimpse at their written work reveals also the same problems. Here is a student's rendering of a dictated passage:

You poor animar. I ill satngla and I gave you som teng to it side we were u was Very kind. And se gn jenrop and orepe ome in

The teacher's version is this:

"You poor animal, I'll certainly take you home and give you something to eat" said the hare, who was a very kind animal. And he picked ijenicher up and hurried home with him.

This kind of communication is a common occurrence at the primary school level. It even easily extends to the secondary school where many learners find it difficult to express themselves in English. There was an occasion when pupils of an adjacent class were disturbing a teacher on teaching practice. I had to go there and I asked them to speak English. The effect was that they all became quiet. It was a JSS II class. I was so thrilled by this result that any time I found pupils making a noise in the classroom, all I needed to say was "Speak English" and there would be peace.

If this kind of language deficiency characterizes the foundation level of education, then one is not surprised when at regular intervals, one comes across a written text as the following example coming from a university student (Dada 2002):

- We need to know what English is English is a language speak by wite men which speak in London area protich, spain, etc. English is original collonice by britich which means London area is a second language to any African pupils because is their second aquare of language
- Environment problem can cause problem in a language learning to not develop the learner intelligent pycologically problem. He we behave like a villager because illiteracy we never be illtrate.

This example is definitely the height of expressing mysteries after so many years of trying to learn in tongues.

Observations

A few observations are necessary concerning the pattern of language use/function in the classroom (Fig. 4).

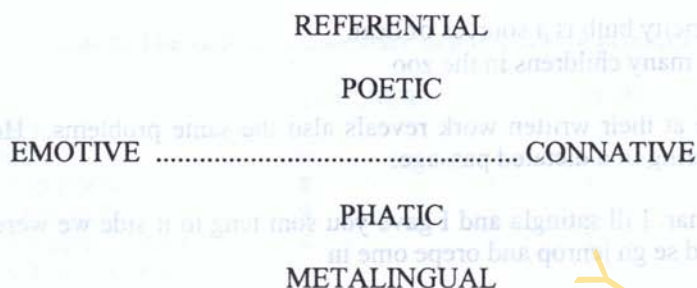


Fig. 4: A model for functions of language.

Source: Roman Jakobson (1960)

There seems to be a functional distribution of the languages in use. What Roman Jakobson calls the referential function of language is usually performed in English. The Metalingual (ie. the glossing) function is presented in either Yoruba or a mixed language. The phatic and connative functions are usually performed in Yoruba. This is the aspect of maintaining contact with the addressees or affecting their behaviour (rebuking, directing, instructing etc). The emotive function which reflects the speaker's attitude to the subject matter is usually done in Yoruba. Such a pattern is not very clear in language use by learners. This may be due to their lower competence in the English language. However, there is usually an attempt to answer the question asked in English in that language. This pattern sort of lays the foundation for what sociolinguists call diglossia (or triglossia) namely the functional distribution of languages in society.

Secondly, in the analysis of varieties of English in societies around the world, Richards (1982) identified certain varieties classified according to their distance from the standard variety. He talks of the Acrolect (the standard), the messolect and the basilect (the most distant). It is probably during the process of schooling that people acquire their own "lect" although the possible influence of societal language on individuals cannot be ruled out. Nemser talks of approximative systems in the process of language development between the source language and the target language and observes that fossilization can take place at any point when no new input is forthcoming from the target language and the language learner can satisfy his communicative needs without necessarily acquiring the acrolect. This is most likely responsible for the very many types of English that abound within Nigeria and in the English speaking communities around the world. In fact, John Pride (1982) talks about "New Englishes".

Thirdly, the extent to which each language is learnt or acquired is much limited by the way English and the mother tongue are used together in the same situation whereas in some other education systems like in the United States of America (an equally multilingual nation like Nigeria) the languages are kept apart and each is learnt at a considerable depth.

In the fourth place pupils' learning cannot but be affected if they cannot handle each language as an efficient tool of communication. Obemeara (1991)

has tried to demonstrate this point. Furthermore it is a known fact that in our public primary schools each teacher handles all subjects whether he or she specializes or not. It is very important that in language teaching, specialist teachers be employed. In a survey on language teachers at the primary school (who are not specialists in language education) by Dada (1979), it was discovered that most of them were not conversant with most of the modern ideas and concepts on language teaching as illustrated in the table below. The habit of engaging non-specialist teachers in teaching English has even crept into the secondary schools and the inputs that learners receive from teachers in English as well as in other languages leave much to be desired.

The bilingual education offered by the country needs to be re-examined and streamlined. A language education that leaves its products inefficient in any of the two languages being used is not good enough. Experimentally, it has been proved that learners perform very well in both languages when these languages are properly separated and each is learnt in a different context and long enough. The Ife project is a case in point (Afolayan 1976). The products of that experiment performed significantly better than their control group counterparts in both English language and the subjects taught in the mother tongue. In that project, English was handled by specialists while the other subjects were taught entirely in Yoruba.

Table 3: Mean Attitude Score on Concepts in TESL

Quest. Item	Regular Participants at language courses (55)	Non-participants at language courses (254)	Teachers with English as best subject (121)	Teachers with other subject interest (188)
1.	2.05	1.79	1.78	2.06
2.	3.74	3.14	3.52	3.36
3.	3.02	1.36	2.16	2.22
4.	1.38	0.70	1.07	1.02
5.	3.10	3.06	3.37	2.79
6.	2.33	1.21	2.29	2.25
7.	2.34	0.88	2.05	0.17
8.	1.22	1.1	1.14	1.05
9.	3.12	2.4	3.06	2.46
10.	2.10	1.78	3.32	1.56
11.	1.26	1.08	1.12	1.22
12.	2.22	2.16	2.31	2.06
13.	2.14	2.11	2.18	2.08
14.	3.12	0.66	1.81	1.97
15.	3.08	1.12	2.60	1.60
16.	3.09	3.11	3.14	3.06
17.	2.05	1.53	2.16	1.42
18.	1.66	0.62	1.19	1.09
19.	1.32	1.16	1.26	1.22
20.	2.05	1.95	2.21	1.79

The teaching/learning situation needs to be improved. Not enough is done by pupils in the classroom in form of practice activities. As I said earlier, teachers teach so much that they prevent their pupils from learning. Hyman sees the teaching/learning situation as one that brings together three major elements (Fig. 5).

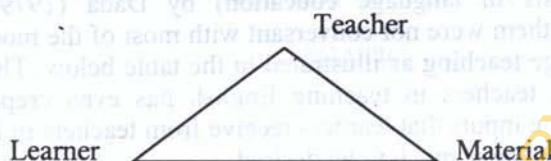


Fig. 5: Elements in a Teaching/Learning Situation.

A good teacher is one who is able to organize well the interaction between learners and the learning materials. Finally, Nigeria needs to pay more attention to language planning as part of social planning in order to come up with an efficient language policy of which language in education will be an integral part. This will involve a lot of socio-linguistic research. In a conference presentation (Dada 1985), I made a proposal for language planning and implementation activities as follows (Fig. 6):

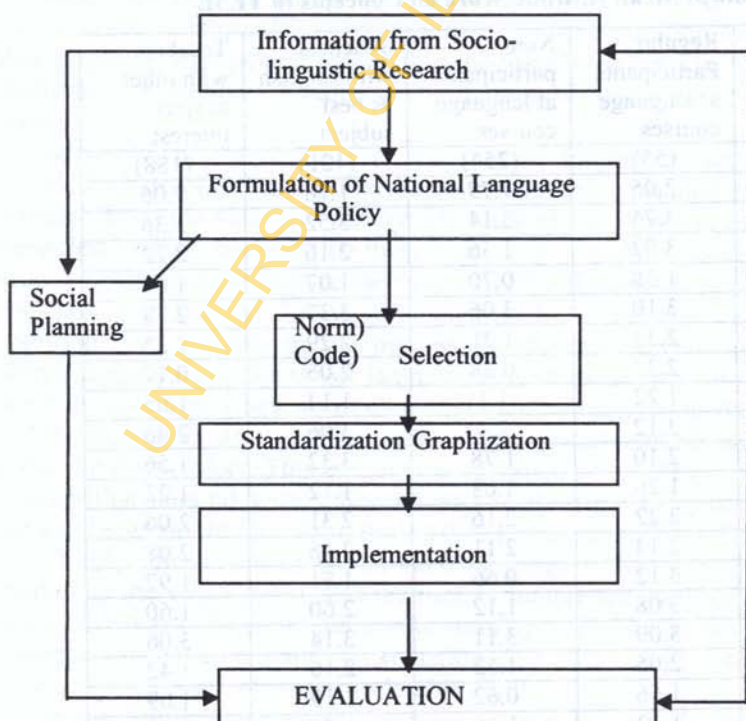


Fig. 6: Proposed Scheme of Language Planning and Implementation Activities

I came up with the following conclusions: From the above analysis, it will be seen that language planning in any society (especially one like Nigeria in which hundreds of languages are involved) is probably more complex than any other issue, given the degree of emotion that usually accompanies decisions in this area. Language allocation for instance is not just a question of compartmentalizing languages into national languages, languages of wider communication, official languages, etc. It involves an intricate network of relationships. This fact underscores the need for a very careful consideration of the issues involved and the adoption of a long term approach to planning. We definitely need a lot of socio-linguistic information to start with – information that can be obtained through surveys, experimentation, consultations, etc. This requires government-sponsored team research and an adequate information, analysis, storage and retrieval system.

Next, there is need to establish a global frame of reference within which individual issues in language planning will be discussed, because a comprehensive coherent language policy should be the ultimate aim – one that involves the whole society rather than deal with only certain aspects or isolated issues.

In terms of participation, all the various sectors of the society should be involved: Government and its agencies, the media houses, various sectors of the economy, specialists and researchers and the people at large.

Ritchel and Webber (1972) have described language problems as "wicked problems" that require solutions that progressively tend towards acceptability, workability and efficiency both internationally and intra-nationally. Language policy cannot be formulated in a hurry; it is not a once and for all exercise and cannot be undertaken in a sporadic fashion. We need time, we need information and we need massive participation.

Recommendations

The recommendations from this presentation therefore are the following:

- (1) Our bilingual education programme needs to be revisited. There is need to encourage learners to acquire a sound foundation in English before using it as a language of instruction. This means studying it as a subject for a longer period possibly throughout the primary level. In addition, teachers of English at this learning stage should be specialists in the teaching of English. By the same token, the Nigerian language used as language of instruction should be well mastered. If the foundation is well laid, then remedial courses at the secondary and university levels will yield better results.
- (2) More work may need to be done in the area of codification of the Nigerian languages, in order to avoid the code-mixing and/or code switching that is characteristic of the speeches of teachers and learners. The National Language Centre can harness available resources and coordinate research efforts in this direction.

- (3) Development of language learning materials needs to be intensified. The quality of such materials should be very high, and should be available in abundance so that learners and teachers can have their choices according to needs and interests.
- (4) There is the need to monitor what goes on in schools especially at the primary level. One of the greatest defects in the National curriculum implementation is the lack of adequate monitoring. We have a formidable crop of specialists in the Faculty of Education in general and the department of Teacher Education in particular to assist Government in putting in place a monitoring outfit.
- (5) The University of Ibadan needs to organize its calendar in such a way that education students will have adequate time for their professional practice. The way the programme is organized at present whereby students go to their schools only during their period of teaching and rush back to attend lectures, or in case of clashes, miss either their practice or their lectures is very unsatisfactory. We need our full six to eight weeks of intensive practice, free from university lectures in other faculties. This will help us to produce teachers and not cheaters.
- (6) It is significant that the University Senate is getting more worried about the quality of language use by students and the apparent ineffectiveness of the GES 101 – Use of English – in providing the required remedy. If the foundation at the primary school be destroyed, what can the righteous people of the Ivory Tower do? Greater effort needs to be directed at the teacher training level in the grade II Colleges and Colleges of Education. Also, an interview system may be necessary to determine the genuineness of candidates' qualification at the entry level in order to provide a more teachable set of university undergraduates.
- (7) At the national level, greater attention should be paid to language planning and policy in order to render the nation more united and more efficient.

Conclusion

In concluding this lecture, I need to pay special tribute to the pupils of the public primary schools, for their fortitude in enduring attacks from all and sundry – the teachers, the languages, the poor learning materials and condition, the Government etc. They are the veritable P.I.V's – the Poor Innocent Victims. In paying this tribute, I want to quote W'Elsschot (1961):

Il parle deja bien et il faut que ce soit un enfant courageux, sinon il serait passe depuis longtemps a la greve du silence, plutot que d'etre plonge chaque fois dans un autre bain. Car il

doit attaquer tour a tour le francais, le flamand, l'allemand et le polonais et je ne comprends pas comment il parvient a les maintenir separees et a empecher que tout ne se fonde en une sorte de jazz, ou personne ne voit plus clair.

(He already speaks very well and he must be a courageous child, otherwise he would have gone on silence strike a long time ago, rather than allow himself to be immersed each time in a new pool. For he has to attack in turns French, Flemish, German and Polish and I am yet to understand how he succeeds in keeping them apart and preventing them from getting mixed up in a kind of jazz that leaves everyone confused).

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RESTRUCTURING NIGERIA'S EQUINE AND RUMINANT LIVESTOCK FOR SUSTAINABLE POLO, FOOD SECURITY AND POVERTY ALLEVIATION

Lanrewaju A. Oladosu

Department of Veterinary Medicine

Introduction

On the theme of my lecture today, and when reflecting upon what is currently happening in the world, it is impossible to ignore the fact that livestock, food security and poverty level of mankind are crucial issues. The attendant social crises of insecurity of lives and property, instability, famine and reduction in livestock population, are far behind the extraordinary scientific and technological achievements.

The world population has already grown to beyond six billion people, two thirds of who live in unbearable backwardness and poverty. In fifty years from now, as predicted by Cuban President – Fidel Castro – no fewer than three billion more people will share an already overbloated planet.

In the case of Nigeria, by whatever measurement, poverty is still widespread today. At least 66% of our estimated 120 million people were living below the national poverty line in 1996; while it was 43 per cent in 1992. This means that two out of every three Nigerians, survive on less than a dollar (or ₦132) per day. The scenario today, is definitely more serious. Only those unlucky enough to find themselves in this category, would understand what poverty means. It is certain that in the face of acute hunger, only a few people would not trade their integrity.

The increasing demand for food in sub-Saharan Africa, by continuously increasing population, cannot be over emphasized. The majority of people live in rural areas where they cultivate land and own large numbers of domestic livestock.

Agricultural systems, which increase production of livestock and food from animal origin, will provide more economic security (monetary income upon sale), food resources at times of need and increase the nutritional status for rural populations. In smallholder farming systems, farmers generally raise crops and

livestock under traditional management. More than 250 million herds of large domestic livestock are kept by small holders and by pastoralists in Sub-Saharan Africa.

Nigeria has over 70% of its people engaged in agricultural activities. Such people derive their livelihood from agricultural production either directly or indirectly. In terms of personal and national revenue (apart from oil revenue) crop and livestock production is by far the most important economic activity in Nigeria, especially in the rural areas. Yet, Nigeria continues to experience acute food shortage both in quantitative as well as qualitative terms, despite the great potentials, available for both crop and livestock productions.

It is in recognition of this worsening food supply situation, that renewed efforts are being made by all stake holders including governments, research scientists and clinicians, to restructure and correct the situation through research and developmental programmes. Over the last 27 years as a veterinary clinician and researcher of University of Ibadan, I had the total commitment to large livestock research as a tool for alleviating poverty in Nigeria and to promote food security.

To achieve this, I have identified and restructured the usual clinical services and research and emphasized on those relatively obscure but needed areas. These include: experimental surgery for rumen fistulation (Oladosu 1972, Oladosu and Akpokodje 1975, Oladosu 1992); Equine Medicine and Clinics (Oladosu, Falade and Akpokodje 1986, Oladosu 1988, Oladosu and Olufemi 1991, 1992. Others include Abattoir studies on carcass condemnation due to cattle tuberculosis (Wintope and Oladosu 1999); ovine and caprine tuberculosis (Odebiyi and Oladosu 1999). Similarly, we studied parasitic problems of polo horses (Olaide and Oladosu 1994; Ajayi and Oladosu 1999; Desbordes and Oladosu 1988). I have also investigated on human and animal drug evaluation (Oladosu 1978, Oladosu and Garner 1991) and studies on poisonous plants that are hepatotoxic and nephrotoxic to man and animals (Oladosu and Case, 1979).

The bulk of my research initiatives in Nigeria and in many other countries of the world visited, with other collaborators, focused on equines and ruminants livestock in several aspects. These are mainly on Equine babesiosis (Oladosu 1981; Oladosu and Dipeolu 1981a, b; Oladosu 1987a, b; Oladosu and Olufemi 1990; Oladosu and Aliyu 1993).

The cardinal objective is to bring new science to bear on the constraints of health and production of these domestic livestock, for overall benefit of man. The control of major emerging diseases, the surgical modification of ruminants for various nutritional experiments and new drug evaluations especially on the antihypertensive diuretic-piretanide which is now being marketed in Britain and USA. In the course of this lecture, slides and transparencies are used to provide a broad overview of the presentation. Experiences on clinical services and research on equines (horses and donkeys in particular) and ruminants (cattle, sheep and goats) are emphasized.

The relevance, the importance and appropriateness of animal traction using cattle, horses and donkeys as successfully practised in most developing nations are given adequate attention. This is because animal traction provides cheap,

alternatives to tractors, for rural farmers, and youths, being mobilized for employment under poverty alleviation schemes of Governments. The socio-economic implication of animal traction is also fully discussed.

Restructuring with Animal Traction (Plates 1 – 3)

Nigeria's position as a developing country has been very precarious since the world-wide recession period of the 1970s. The situation was further exacerbated by the unfavourable terms of trade and drastic devaluation of the Nigerian currency (Agwuma 1985).

The unfavourable monetary and fiscal situation made most imported agricultural equipment out of the reach of the average Nigerian farmer. The price of farm machinery and implements skyrocketed, making it increasingly difficult for most small-scale farmers to either own equipment or get them on hire.

The continued high rate of foreign exchange made it difficult to maintain or replace old farm equipment. Farm operations that hitherto depended on use of tractors and other modern farm equipment suffered serious set-back. The drop in local food production became a national problem that needs immediate attention and possible reversal (Babatunde 1993, World Bank 1985).



Plate 1(a): Showing the use of cattle for farm operations in Animal traction



Plate 1(b): Cow traction in Northern Nigeria. Note the simple and cheap Resource for extensive farm work.



Plate 1(c): Showing animal traction and ploughing with ruminant livestock (Cattle Farm works using the Bunaji and Sokoto Gudali breeds).



Plate 1(d): Showing Bull traction experiences for animal farming in some African countries.

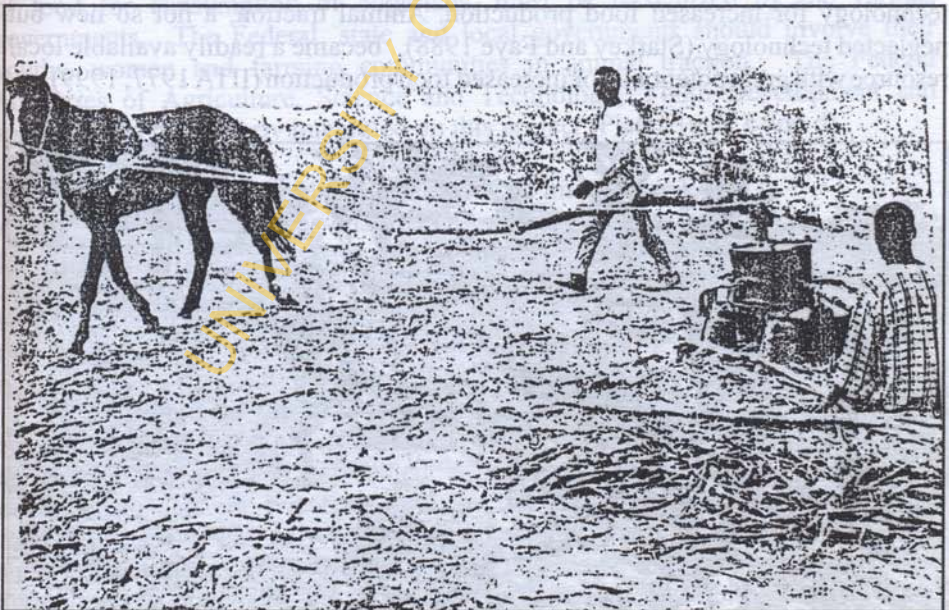


Plate 2(a): Showing the use of horses for animal traction and rural Agricultural Development.



Plate 2(b): Showing Equine Livestock village traction with horses for farm work in place of mechanized farming with tractors.

The need arose therefore to “re-look inwards” for appropriate intermediate technology for increased food production. Animal traction, a not so new but neglected technology (Starkey and Faye 1988), became a readily available local resource with great potentials for increased food production (IITA 1977, 1999).



Plate 3(a): Showing the use of donkeys for ridge making and farming by young adults and children in some Northern States of Nigeria especially in Bauchi, Katsina, Kano and Sokoto



Plate 3(b): Showing the use of donkeys for planting by young adults and children in some Northern States of Nigeria especially in Bauchi, Katsina, Kano and Sokoto.

The importance of Nigeria's equines and ruminants: horses, donkeys, cattle (Plates 1 – 4) as animal traction for ploughing in raising the quantity and quality of food for consumption of Nigerians, must be recognized by the various governments. The Federal, state and local governments should involve their youths, women and farming communities in animal traction. The Federal Ministries of Agriculture, Science and Technology, Youth Development and sports should be properly integrated on this project (Plates 1a, b, c and d).

Nigeria's Animal Power Usage (Tables 1 – 2 and Plates 1 – 6)

Animal traction usage was introduced into Nigeria as far back as 1922. Its popularity dwindled during the era of the oil boom. The economic buoyancy during that period is no longer visible. Animal power usage, should once more, become popular throughout the country although it is being primarily utilized for ridging and remoulding of ridges in several countries in Africa and in some states in the Northern part of the country (Starkey *et al.* 1988.)

Pronouncements should be made by governments to indicate official approvals for promotion of draught animal power usage (Plates 4 – 6) in agriculture. The high import content of motorized mechanized agriculture has continued to dent the country's slim foreign exchange reserves. The nation's food requirements can only be met by enhancing the productivity of millions of small-scale farmers. The use of animal power will increase local food and agricultural supplies by the farming population. It is readily available and affordable with low operational costs. It could also be an additional source of

family income as work animals can be hired out to other farming youths and full time farmers who do not own any.

Table 1: Animal traction initiatives in Nigeria (Plates 1a, b, c and d)

<i>Will promote:</i>	<i>Especially with:</i>
<ul style="list-style-type: none"> • Food Security • Poverty alleviation • Cheap rural farming • Increased Agricultural Production 	<ul style="list-style-type: none"> • Economic depression • SAP • Naira devaluation • Youth unemployment

Table 2: Nigeria's Animal Traction Statistics

<ul style="list-style-type: none"> • 1964 – 1987: <ul style="list-style-type: none"> – Potential number of draft cattle = 900,000 – Based on 7.5% of National herd. – Animal traction users had doubled to 70,000 • Predominantly in: <ul style="list-style-type: none"> – Bauchi, Katsina, Kano and Sokoto States • Limited in Kaduna and some Northern States • Animals worked 2-3 years then sold
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At the end of their work life, the animals would have been fattened, thereby providing the much-needed animal source of protein to Nigerians. In our quest for viable alternatives to poverty alleviation and food security schemes, animal transportation, traction and ploughing with cows, horses and donkeys will assist in meeting our food production needs (Tables 1 – 2, Plates 1 – 6).

Constraints are:

- Diseases
- Inadequate technology
- Ignorance of benefits
- Development of traction equipment

Because of the difficult terrains and power maintenance culture, most of the equipment including trailers and farm implements have short life span and are not supported with adequate spare parts, the frequent breakdown and irreplaceable parts of farm equipment are commonly seen in different parts of the country. The incredibly high costs (initial and running costs) of these farm machines and equipment make it impossible for the peasant farmer to own them. Where tractors and farm machinery hiring services are available they often come very late. This results in late preparation of the fields and subsequently, leads to poor crop yield.

It is in the face of these and other difficulties that it has become necessary to look for another alternative means of enhancing agricultural production especially at the farm family level. *The present administration's efforts to revamp agricultural production, alleviate poverty and promote food security, though commendable, it nevertheless must be redirected towards the use of animal traction at rural level as illustrated in Plates 1 – 5.*



Plate 4: Equine animal traction with Donkeys by rural poor in place of tractors.

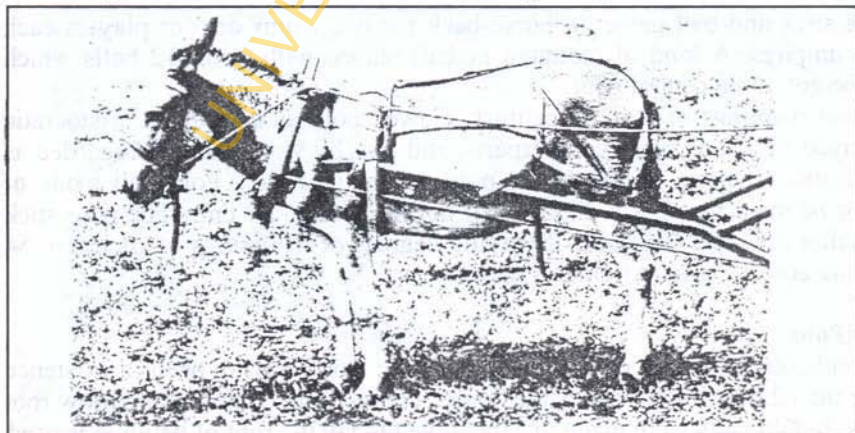


Plate 5: A closer view of the donkey being used for animal farming with traction attachments.



Plate 6: Showing equine livestock usage of donkeys for farm transportation in Northern Nigeria.

POLO AS A FACTOR OF NIGERIA'S UNITY AND COHESION

*"Let other people play at other things
The king of games is still the game of kings:"*

Please permit me to say a little about Polo, its origin, horse breeds used for polo in Nigeria and notable Polo clubs and Polo enthusiasts in the country.

What is Polo?

Polo is a stick and ball game on horse-back for two teams of four players each and two umpires. A kind of mounted netball played with up to 12 balls which have to be got into a central goal.

Persian paintings of the 16th century showed polo as an elegant aristocratic game played by Kings, their counterparts, and also by women being regarded as a co-educational sport. International polo started in 1886. Polo ball made of willow or bamboo root has a diameter of not more than 7.5 cm. The polo stick called mallet in U.S.A is a cone of varying degrees of whippings 48 inches to 54 inches long according to individuals needs.

Ancient Polo

Polo is probably the oldest organized sport in the world having been in existence for more than 2,500 years. The name "polo" comes from "pulu", the willow root from which polo balls were made in Tibet (even today the root of bamboo is used



Plate D1: Two Teams of Polo Players during the 1998 Ibadan Polo Tournament of the Nigerian Polo Association (NPA)



Plate D2: The two umpires and the NPA officials including Senator Idris Ibrahim Kuta wearing the white hat and backing the camera. Shehu Muazu (extreme right) is watching with interest during the 1999 Ibadan Polo Tournament.

to make polo balls). Although the origins of polo are obscure there is much evidence of the game's history in Asia. As mounted armies swept back and forth conquering and re-conquering kingdoms, polo was adopted as the most noble of pastimes by the Kings, and Emperors, Shahs, Sultans, Khans and Caliphates of the ancient Persians, Arabs, Mongols and Chinese.

The great rulers of those times were expected to be brave warriors, skilful hunters and *exceptional polo players*.

Modern Polo

Polo was played in Lagos at the beginning of this century and the Lagos Polo Club was formed in 1904. The game was introduced into the North of Nigeria at Kano, Zaria and Kaduna about 1918 and in Katsina, the major Polo centre, in 1922; it spread rapidly throughout the country and was first played in Ibadan in the 1930s. Polo is now played in Nigeria at Daura, Ibadan, Kaduna, Abraka, Kano, Katsina, Kazaure, Lagos, Maiduguri, Jos, Sokoto, Yola, Guzau, Minna, Zaria and Port Harcourt; the Nigerian Army and the Nigeria Police also play it. It is expected that the polo will soon reach Abuja where it would be given national attention, which it richly deserves. In Ghana polo is played mainly in Accra. Fifteen polo clubs are affiliated to the Nigeria Polo Association, which is itself affiliated to the Hurlingham Polo Association.

In order to maintain uniform standards, players are classified or 'handicapped' twice a year by a Nigerian Polo Association Committee. His Highness the Emir of Katsina was one of the original players when polo was introduced in Katsina in 1922. In 1953 the Emir retired from tournament polo, but he continued to be the main inspiration of polo, not only in the North but in Nigeria as a whole. For many years he was the President of the Nigerian Polo Association.

After the Emir of Katsina, the descendant of the Emir- Late Major General Hassan Katsina for many years, became the national President of Nigerian Polo Association. The great polo enthusiast late Major General Hassan Katsina became the pillar of polo nationwide. Along with other prominent southern polo players like retired Brigadier General Oluwole Rotimi, retired Honourable Justice Akpara, retired Brigadier Mobolaji Johnson, former Governor of Lagos State, polo became a factor of national unity and cohesion.

The Game of Polo

The 2500 year-old game of polo is one of the fastest, roughest, and most dangerous sports played today. It is gaining increasing popularity as a premier spectator sport can be an easy game for the first-time spectator to enjoy. Imagine the excitement of seeing players on thoroughbred horses bumping and jostling with each other as hockey on horseback, racing at to speeds down the field while striking a small ball with the precision of an experienced golfer.

Polo is played on a 10 acre grass field, 300 yards in length by 160 yards, which is the approximate area of ten football fields. Goal posts are set eight yards apart on either end of the field. The object of the game is to move the ball down-field, hitting the ball through the goal for a score. The team with the most scores



Plate D3: Showing a crucial moment of Polo during the January 1999 Ibadan Polo Tournament



Plate D4: Showing the Polo team in full action during the weeklong 1999 Nigerian Polo Association, Ibadan Polo Tournament

Plate D6: A Sudanese Horse with the Polo Player in action in a match in 1999. The player is raising up their stick to salute the audience during 1999 NPA Ibadan Polo Tournament. L-R: the manager, Mike Mair; Yonno Yusuf; Daula Babu and Babu Khan (extreme right).

at the end of the match is deemed the winner. Teams then change direction after each goal. Two teams made up of four players each, are designated by shirt-color. The players wear high boots, knee guards, and a helmet of their own selection. By tradition, players wear white pants in tournaments. The mallet made of a bamboo shaft with a hardwood head is the instrument used to hit the polo ball, formerly wood, now plastic, about 3 to 3½ inches in diameter and 3½ to 4½ ounces in weight. In fact, the English word POLO is derived from the Tibetan word, "pulu" meaning ball.

Nigeria's Polo Activities, Polo Veterans and Nigeria's Polo Association

Horses in Common Use for Nigeria's Polo

Until about 1973 all the polo ponies played in Nigeria were of West or North African origin; recently however larger and heavier horses from Argentina have been introduced into polo mainly in Lagos, Kano, Jos, and Kaduna; such horses confer an advantage by virtue of their greater speed and strength and it is of interest to see how polo is developing with the two different breeds of horses playing in opposing teams.



Plate D5: Showing the Polo team raising up their sticks to salute the audience during 1999 NPA Ibadan Polo Tournament. Lt – Rt: the unempire: Mike Magid; Yenma Yusuff; Daule Baba and Baba Kiari (extreme right).

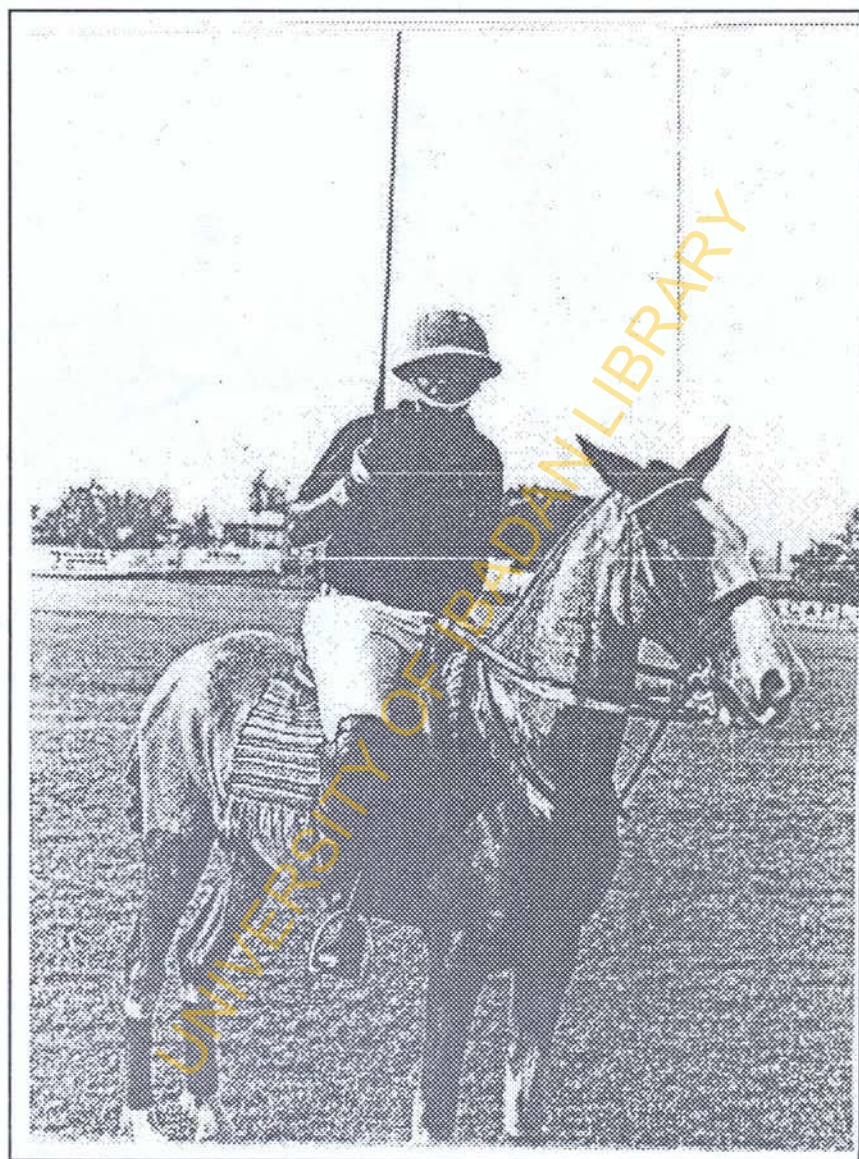


Plate D6: A Sudanese Horse with the Polo Player in readiness for another 7½ minutes chukka.

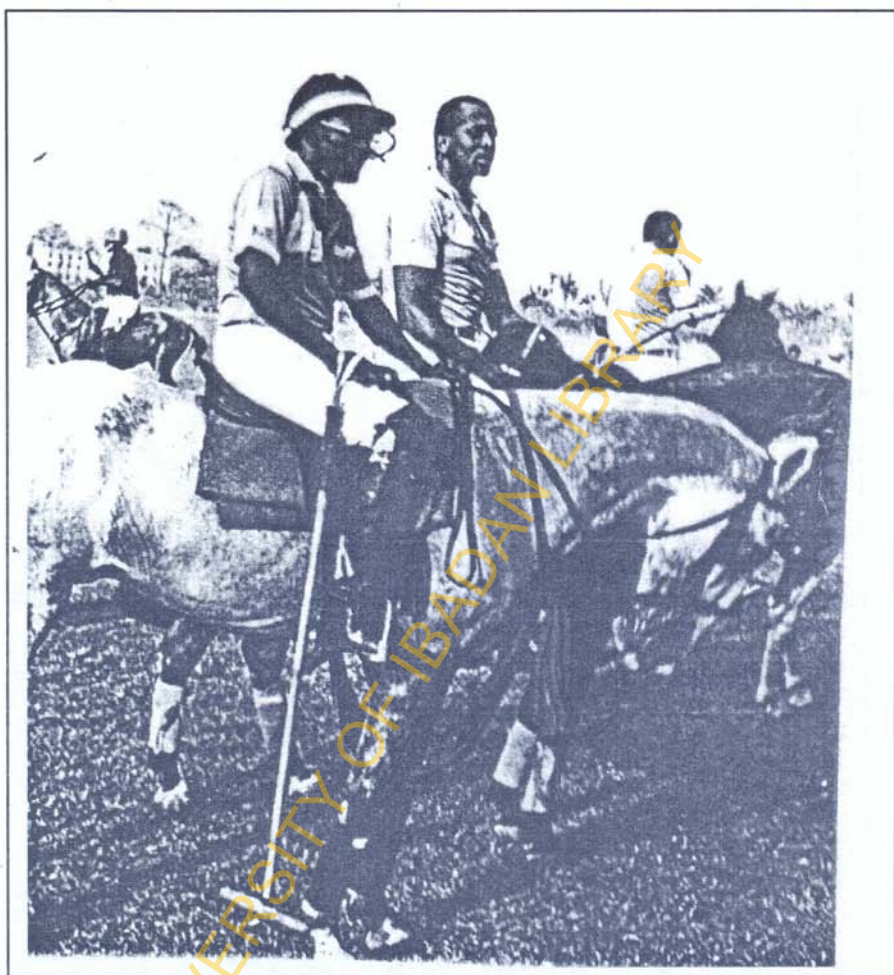


Plate D7: Showing three Polo players on horses in readiness for another Polo Chukka. In the middle was Seantor Toks Okubanjo of Lagos Polo Club. All three players were using the imported Argentinian horses.

The Ibadan Polo Club

The date when the Ibadan Polo Club was founded is not precisely known but polo has been played in Ibadan since 1930s. Since 1950, a Nigerian Polo Association tournament was in Ibadan each year, and attended by clubs from all over Nigeria and also from Ghana. Apart from the main Nigerian Polo Association tournaments, at least two friendly tournaments are played between Ibadan and Lagos each year. In addition, cups are competed for within the clubs at intervals during the season.

Prominent players in Ibadan polo history were the late Robin Atkinson, John Honey, Jim Mackenzie and Abel Comben; each of these players served as polo captain at their various times. Others are Drs Asuni and Awolaja, the Hanni Safiedenes, Messrs Ojeniyi, Alakija, etc. The current Chairman of Ibadan Polo Club is Mr. Tunji Adepeju. The immediate Past Chairman was Mr. Bankole Oyeniya.

The Retired Hon. Justice Akin Aparo was elected President of the club in 1978 with Mr. Mike Pratt as Vice President. Past Presidents include Brigadier-General Oluwole Rotimi (rtd.) and Chief Victor Allam. Both are now Polo veterans. The polo club became fully independent in 1975; the membership is continuously increasing and the activities are expanding to embrace not only various riding events but a range of social activities.

I was as far back as 1979 appointed as an Honorary member and Chief Consultant, Equine Clinical Services of Ibadan Polo club and the Nigerian Polo Association in recognition of the useful equine clinical services offered to the club. As previously observed (by Anon 1962; Akinwumi and Ikpi 1985 and Anosa 1985) in ruminants, the major disease problems of Nigeria's polo horses are Trypanosomosis and Babesiosis. These diseases are however, put under control from time to time, by our prompt intervention.

Cultural History of Nigeria's Horses and Polo as Symbols of National Unity

Horses and horse raising in Nigeria, especially in the North, are phenomenal in the collective cultural history of the people. Mostly identified with Hausas, Fulanis, Kanuris and Hausa-Fulanis, the first set to be introduced into the semi-arid, Sudan and Sahel savannah regions are believed to have arrived during the Tran-Saharan trade era, although some experts speak of earlier accounts. With flourishing commerce and exchange of goods and services with North African Arabs, the Phoenicians and other early settlements, in major cities like Kano, Sokoto, Maiduguri, Bauchi, Kaduna, down to Ilorin became beneficiaries of trade network in return for this large, strong animal with mane, fluffy tail and hard feet.

Over time, horses or stallions within the region have experienced major socio-economic changes. From beasts of burden and means of locomotion and 'objects' of war, their integration appeared to run full cycle when they became symbols of means and royalty. Today, these sturdy and gorgeous animals are status symbols and their values have appreciated even more considerably with the advent of polo games, horse raising, betting and advert status at global scale. Lately, prospecting for profitable horses and seeking large dividends from betting on the Internet have added to a legion of big-time businesses built around horses.

Notable Nigeria's Polo Players

Today, Nigeria parades a remarkable club of aristocrats who individually have dozens of horses tucked safely away in their stables. Some horses as a matter of fact, are provided with air conditioners and special lighting systems to provide an ideal climatic setting.

Notable among these owners are late Major-General Hassan Katsina, Chief Hanni Saffiedene, Brigadier-General Oluwole Rotimi (Rtd.); Alhaji Sanni

Dangote, Chief Albert Esiri, Ishyaku Rabi, Alhaji Dan Kabo, Aminu Dantata, Kunle Tinubu (younger brother of Governor Bola Tinubu), Atedo Peterside, and Dapo Ojora.

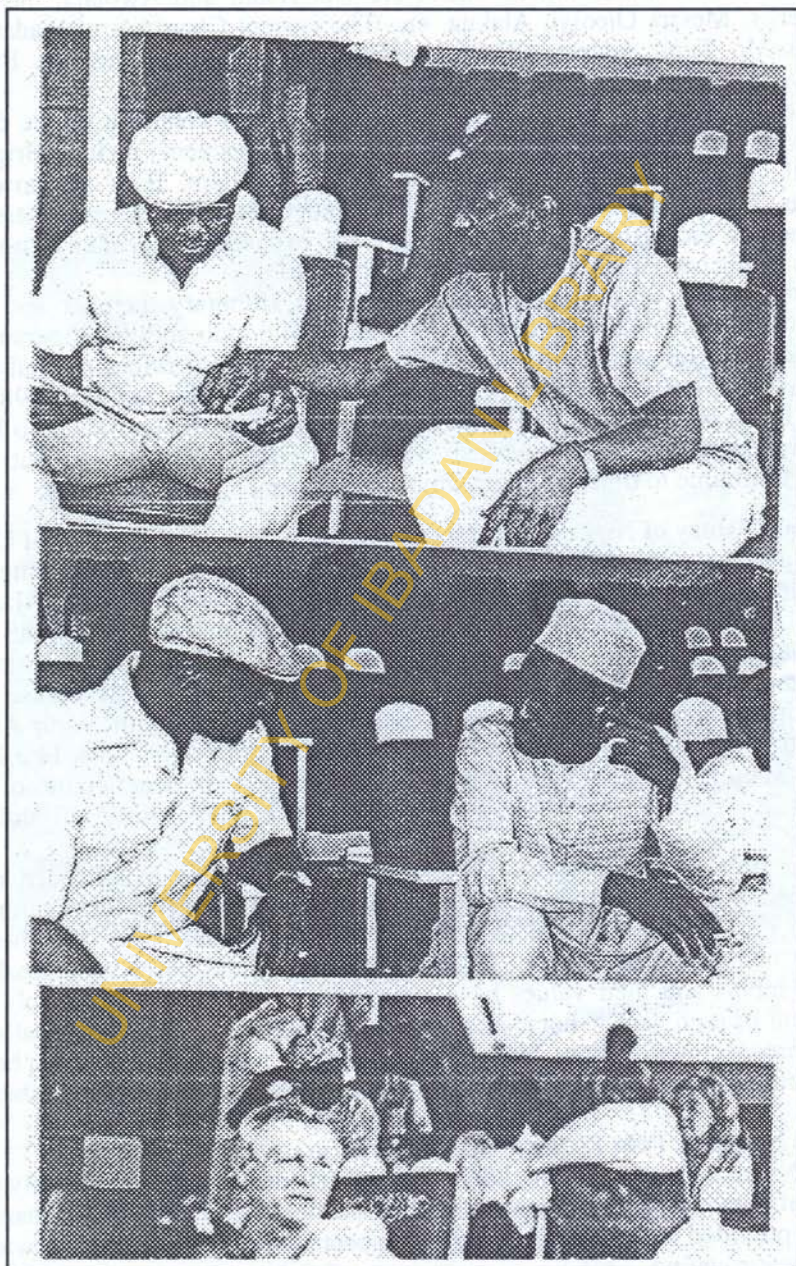


Plate D8: Showing Brigadier-General Oluwale Rotimi, (Rtd.), Top Left; the Secretary, Nigeria Polo Association Mr. Shehu Muazu (middle and top right) and another veteran, Chief Victor Allan (Bottom Left) during the 1999 Ibadan Polo Tournament.

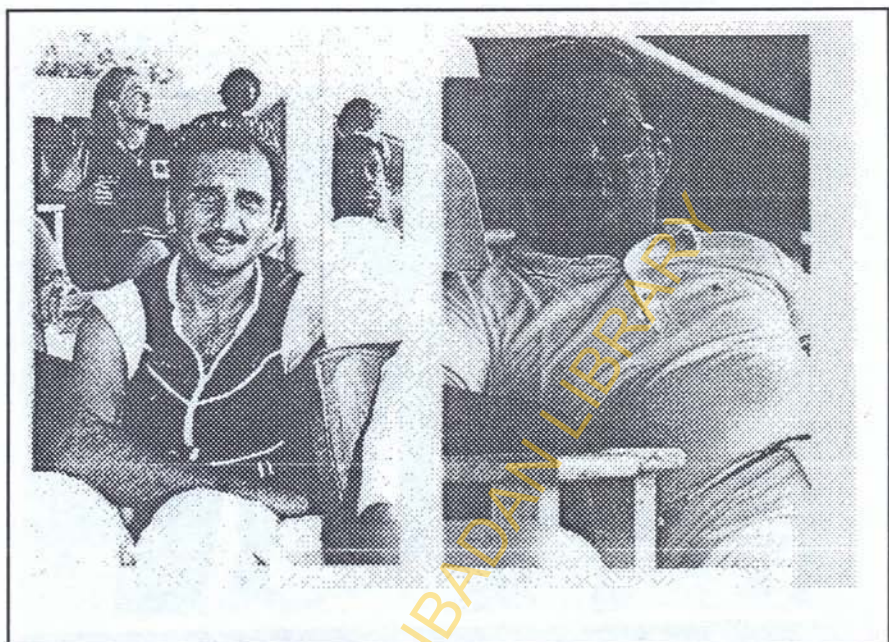


Plate D9: Showing Polo Veterans: Hanni Saffiedene (Right); and Secretary Lagos Polo Club Mr. Uzama (Left) during the Nigerian Polo Association Ibadan Polo Tournament.

For so long, the game of soccer has occupied a prime position in the hearts of sports lovers in Nigeria. This is not unconnected with the country's landmark escapades on the African and global scenes.

However, quite unlike soccer, Polo is relatively unknown to many, particularly to the masses as they consider it the game of the rich. Perhaps this is true. Even while polo is witnessing an obvious transformation from one generation to another, it is unthinkable to associate the game of the poor with this game of the rich. Polo now in Nigeria is witnessing an obvious transformation from one generation to another.

New Generation of Polo Players

A list consists of established aristocrats like Dawule Baba, fondly known as "Teacher, Mallam Ahmed Dasuki, Deputy Senate President Ibrahim Mantu, the Vice President Atiku Abubakar, who is also the President of Yola Polo Club to mention a few. Muhammed (Muha) Babangida, the scion of the Babaginda family is a leader in this generation of young polo players who would fly the flag of polo in Nigeria into the next generation.

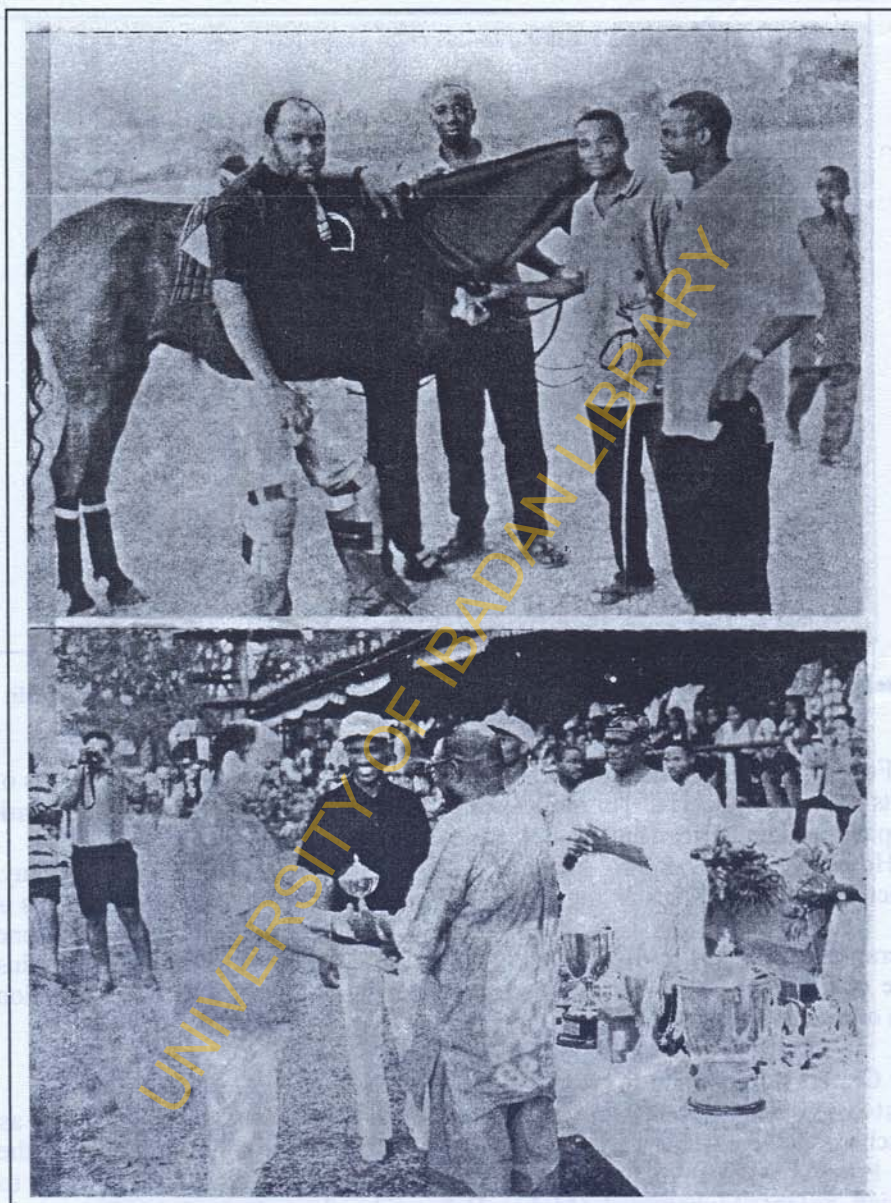


Plate D10: Showing a notable Polo Player, Alhaji Ahmed Dasuki with his Argentinian Polo horse immediately after playing the Polo tournament (Top)

Bottom picture shows one of the enthusiastic Polo Players Mr. Ade Alakija receiving the special trophy award from the Veteran, Retired Hon. Justice Akin Aparo. The 1999 Vice-President of Ibadan Polo Club, Mr. Tunji Adepeju and others were watching with admiration.



Plate D11: Showing New Generation of Polo Players whose team won the various valuable prizes during the 1999 NPA Ibadan Polo Tournament. Polo Aristocrat, Ibrahim Audu, Captain of the team is on the extreme right while Mumuni Dagazao held the gold award in the middle.



Plate D12: Showing the Kaduna Polo Team led by Major Umar (Extreme Left) shortly before the Lagos Polo Tournament

Muhammed Babangida is not alone in this enterprising sport. His contemporaries include Sulaiman Abubakar, a multi-millionaire with chain of business in Nigeria and South Africa. Others in the far north include youthful millionaire, Ibrahim Zakari, the proud owner of the Kaduna ICN, and emerging polo force in Africa. Royal Fathers are not left out at the most polo tournaments, among the regulars at tournaments are the president of Nigeria Polo Association (NPA) and Emir of Katsina His Royal Highness, Alhaji Muhammadu Kabir Usman, Emir of Kano Alhaji (Dr.) Ado Bayero, Alh Rabi'u Musa Kwankwaso, Senator Idris Ibrahim Kuta, Alhaji Aminu Dantata, Alhaji Sani Dangote, Lagos Polo Club Chairman, Alhaji Hassan Hadeja, Kaduna Polo Club Chairman, Alhaji Tijani Hashim, Galadiman Kano, Major General MA Garba (rtd), Alhaji Audu Usman Nagogo, Majidadi Katsina, Ambassador Zakari Ibrahim, amongst others. With the likes of Muhammed Babangida taking the future of polo in Nigeria, the country is yet to witness the beauty of the game.

This list is by no means exhaustive as some names were left out.

Evidently, however, some polo players have the largest collection of horses in the country with one individual having about 32 horses in stables scattered around Kano, Kaduna and other towns. The Argentinian horses are not only very strong and well groomed, they are relatively unbeatable.

Cost of Some Polo Horses

Argentinian horses are renowned worldwide for their pace, robust health and agility. A typical Argentinian horse may cost between N800,000 and N2.5 million. "Argentinian horses are expensive to maintain," "But they are a better bet". They know the ball and they know the mallet," are some of the ways the horses are described. Chief Albert Esiri from Orie, Abraka near Eku in Delta State is said to own many Argentinian horses and he spends fortunes in maintaining them.

Predictably, Nigerians today keep horses for different reasons. Some raise them to sell; others for top-flight competitions, but with the royalty, it is purely for class distinction. Although, not all horse owners are necessarily polo players, most polo players are inevitably desirous of having elegant gallopers.

CLINICAL SERVICES, DISEASES AND OTHER PROBLEMS OF NIGERIA'S HORSES

I now want to reflect on my clinical services and research, which has helped to sustain the equine livestock and polo industry in Nigeria. In particular, I wish to highlight those aspects, which have helped to promote the health of these animals.

Equine Studies:

Drug Evaluation Research

In advanced countries of the world, it is mandatory for manufacturers of new drugs to subject them to scientific evaluations not only for efficacy but also for safety when used by humans and animals. The Food and Drug Administration

Department of the United States of America, has over the years, been the authority on behalf of the government of USA, empowered to perform and coordinate drug assessment and safety trials. Over the years, newly manufactured drugs are imported into Nigeria, without due regard to food and drugs mandatory trials.

Although we have a similar regulatory arrangement in Nigeria, the enforcement of compliance to the regulation on Food and Drug Administration and Control has not been effective neither has it been. Judiciously monitored nor strictly adhered to by foreign and local new drug manufacturers.

For example, some five years ago, precisely in 1996, there was an outbreak of cerebrospinal meningitis (CSM) in Kano. The pharmaceutical company, Pfizer Inc. New York in what was thought to be a humanitarian gesture, rushed in its new drug 'TROVAN'. Trovan has not been sufficiently subjected to clinical trials before finding the Nigerian children as guinea pigs for the drug.

Recently, the *Washington Post* of USA in its Sunday December 17, 2000 edition published a report that the Pfizer's 1996 action was not altruistic. The newspaper claimed that the two hundred (200) Nigerian children on which TROVAN was administered were used as *guinea pigs*.

Eleven of the children were said to have died while some of the survivors became *deaf, blind, lame or suffered seizures*.

The newspaper said that since some of the children reacted negatively to the drugs, Pfizer should have discontinued administering the experimental drugs on them and reverted to the approved treatment of meningitis.

In a follow-up report on BBC on Wednesday December 20, 2000, it was reported that by the time Pfizer brought TROVAN to Kano, the drug had been banned in Europe and that the United States of America which had banned its use for children had to impose a complete ban when adults on which it was administered developed complications like liver damage.

Pfizer Nigeria Limited denied the report on behalf of its parent company in New York. The company claimed that Pfizer's action was a philanthropic gesture borne out of a genuine desire to save lives. This issue was fully documented in the Nigerian's *Vanguard Newspaper* of Wednesday December 27, 2000.

The new drug "Trovaflaxacin" was not approved for the company's marketing to the public. By December 1996, Pfizer had tried oral and intravenous Trovan on 13,000 people in 27 nations. Towards the end of that year Pfizer sought approval for the US Food and Drug Administration (FDA) to market the drugs. For undisclosed reasons the FDA did not approve the use of Trovan on children. This incidence clearly showed the significance of adequate clinical evaluation of drugs before being distributed to the public.

Diuretic and Tolerance Responses to Piretanide in Horses (Oladosu and Garner 1978, 1990, Plates 1 – 5)

The diuretic properties of piretanide, a new compound in the sulfamyl-aminobenzoic-acid derivatives was experimentally assessed for efficacy and tolerance in horses. The clinico-pharmacological and toxicological screenings of the drug in these animals were carried out using a 5 x 5 Latin square

experimental design. The results obtained showed that piretanide was capable of producing peak diuresis within the first 10-20 minutes post-medication with the effects of diuresis lasting for 45 minutes after intravenous administration. The drug also produced effective diuresis with minimal changes in haematological status and liver enzymes, signifying good tolerance and no apparent toxic effects.

Piretanide (Hoe 118) is the international non-proprietary name (INN) for a new loop diuretic with the chemical name 4-phenoxy-3 - (1 - pyrrolidinyl)-5 - sulfamyl-benzonic acid and chemical structure which relates to both furosemide (Lasix) and bumetanide. The drug has been investigated in rats and found in a preliminary report to be more potent than either furosemide and bumetanide (Merkel, Bormann, Mania, Muschawech and Hropot, 1976). In rats, Markel *et al.* (1976) also observed that it is not likely to produce renal failure by provoking hypovolaemia - a clinical complication of furosemide therapy reported by Lucas, Zito Carter, Cortoz and Stebner (1977) in critically ill volunteers.

Although piretanide has some clinical advantageous applications in human medicine (Merkel *et al.* 1976) very little work appears to have been carried out on its effectiveness and side effects in large domestic animals. In this investigation, we assessed the diuretic efficacy and tolerance of piretanide with horses as the large animal models. The aim was to: (1) observe the general response of the animals to piretanide levels, (2) observe the effect of altering the level of piretanide on some clinical variables of horses, (3) determine the effect of piretanide on urinary output and (4) monitor the side effect of piretanide on liver enzymes: SGOT, LDH and SAP.

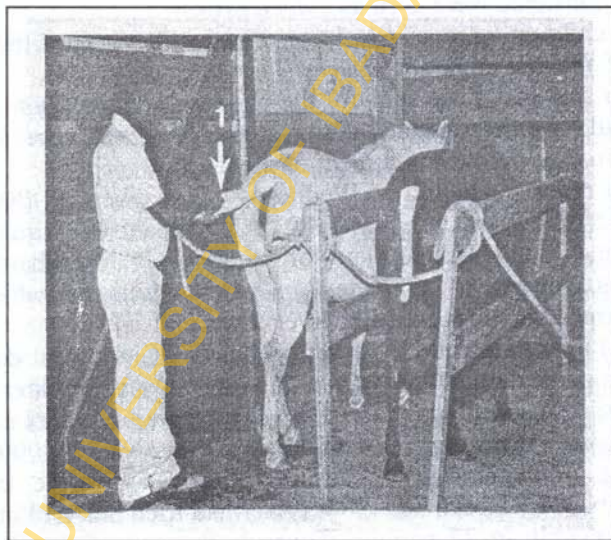


Plate 1: Tail bandaging prior to catheterization



Plate 2: Pereneal disinfection before urethral catheterization.



Plate 3: Foley's Catheter Insertion into the Urethra of the experimental mare



Plate 4: Exteriorization of the Inserted rod from the saline ballooned catheter



Plate 5: Horses with urine collection into the polythene bags after injection with diuretic drugs

Results

Dose effect on urinary output

Urine volume was significantly increased ($p < 0.0001$) by between 4 fold to 13 fold within 0-4 hours after intravenous piritanide administration (Tables 1 and 2) at the corresponding 0.05, 0.1, 0.2, 0.4 and 1.6 mg/kg dosage levels. Between 4 and 24 hours for all levels of drugs there was no significant ($p > 0.05$) change in urinary output compared to predrug volumes (Tables 3 and 4).

The urinary output for the first 2 hours shows that the urinary excretion after intravenous administration of piritanide peaked before 10-12 minutes (Figure 1). The urinary output was largely increased within the first 90-120 minutes and returned close to control values shortly thereafter.

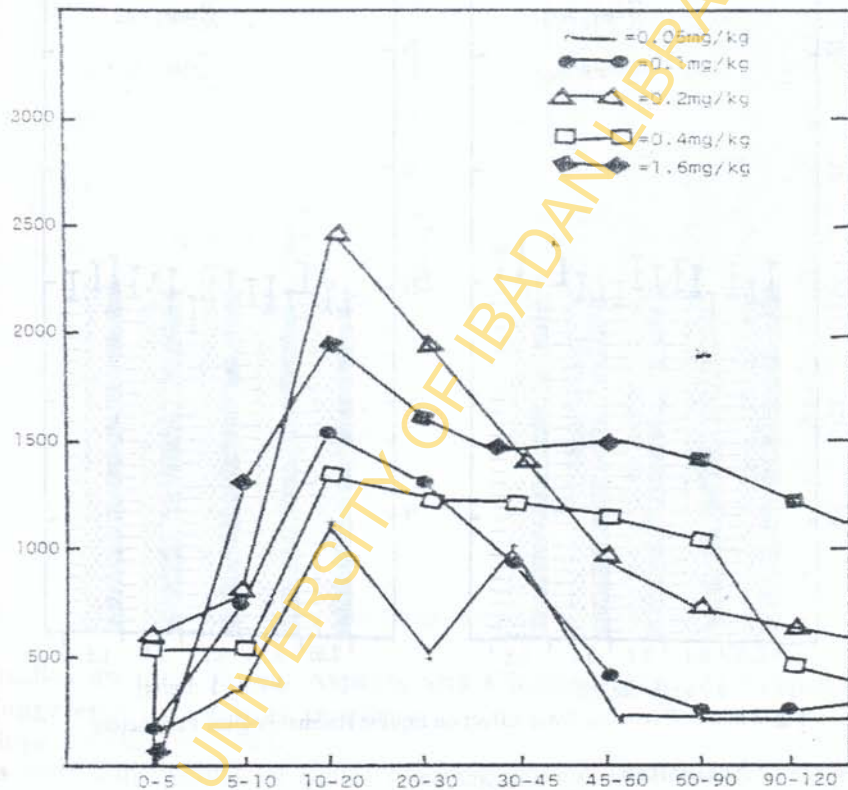


Fig. 1: Piritanide Dose Effect on Urine Output for first 2 hours

Note: Time of urinary output in response to intravenous piritanide showing all doses' diuretic effect which peaked between 10-20 minutes. Points represented Means of 5 horses with 5 x 5 Latin Square Design.

Drug Effects on haematological variables

Figures 2 and 3 show the histograms depicting the effect of all dosages of piritanide on a number of blood values. When compared with the controls all values were not significantly different ($p > 0.05$). The mean WBC/ul, mean

PCV%, the mean Hb gm/kg. were not significantly ($p>0.05$) different (Figs 2 and 3) using the methods described by Schalm (1967). Other evaluated haematological variables i.e the differential white cell count/ul and the platelet counts/ul were also not significantly ($p>0.05$) different compared with the controls.

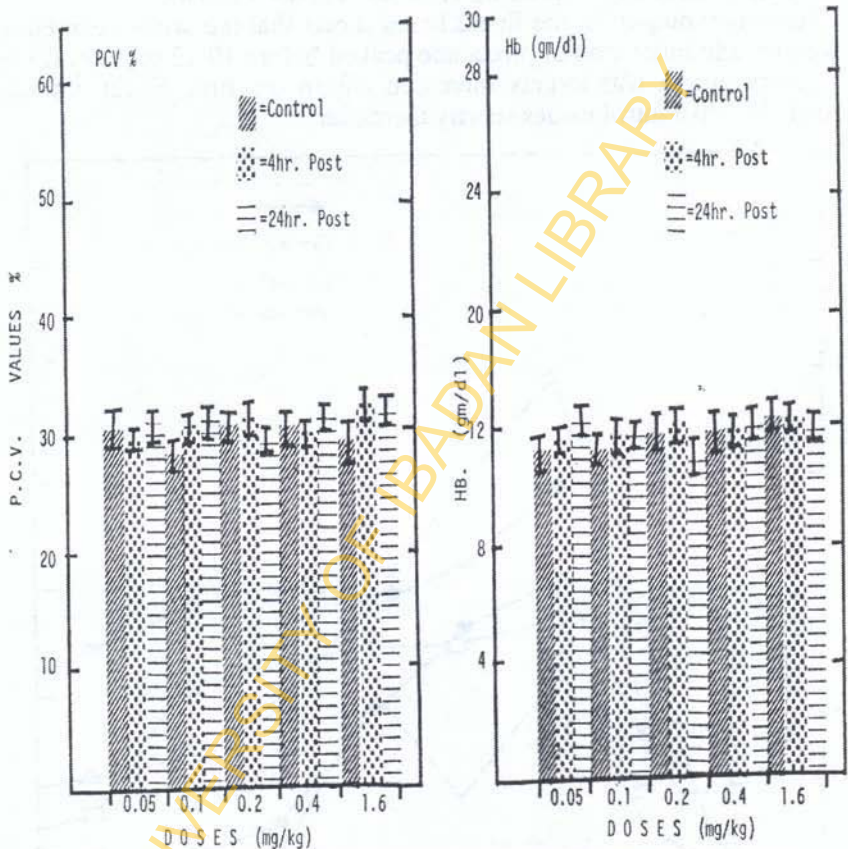


Fig. 2 and 3: Piritanide Dose Effect on Equine Haematological Parameters

Drug Tolerance Evaluation

Results of the liver enzyme analysed (Figs. 4 & 5) show no significant ($P>0.05$) changes between the controls and the post piritanide concentrations when the three major liver enzymes serum alkaline phosphatase (SAP), lactate dehydrogenase (LDH) and serum glutamic oxaloacetic acid were evaluated photospectrometrically employing methods described in the Sigma Chemical Company Technical Bulletin No. 505 (1967). Clinically there were no signs of abnormal salivation, perspiration, defaecation, depression, dyspnoea, convulsion or any other manifestations of systemic intoxication. This drug investigation

sponsored with over US\$50,000, has now been approved for use in humans and is now being marketed in Britain, USA and others parts of the world.

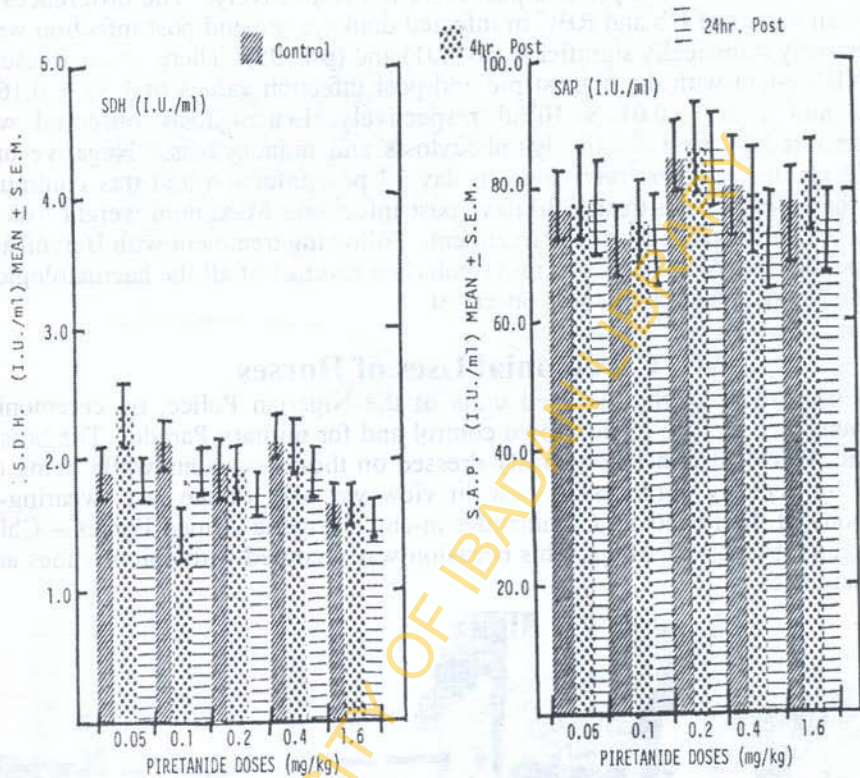


Fig. 4 and 5: Piretanide Dose Effect on Equine Haematological Parameters

Studies on the Clinical Aspects and Chemotherapy of Trypanosoma Congolense Infection in Donkeys

(Aliyu and Oladosu, 1993)

As part of the studies on equine livestock and for the purpose of confirming trypanosomoses as wasting in donkeys, experimental research was conducted on donkeys, which are subsequently treated with berenil.

In this investigation donkeys were experimentally infected with *T. congolense* and the cause of infection was studied before and after chemotherapy with Berenil. *T. congolense* produced disease in donkeys characterized by progressive macrocytic anaemia, anorexia and weight loss. The prevalent period observed in the infected donkeys was 4 days. Mouse inoculation was found to be the most sensitive in detecting infection followed by Buffy coat method while wet smear preparation was found to be least sensitive. Parasitemia was first detected on day 4 post infection with mouse inoculation and on day 6-post

infection with Buffy coat method. There were four peaks of parasitemia observed during the course of infection with the highest log parasitemia of 6.7.

All infected donkeys had a significant drop in PCV% with the lowest as $32.7 \pm 0.58\%$ and $24.0 \pm 1\%$ pre and post infection respectively. The differences in the mean values of Hb and RBC in infected donkeys pre and post infection were respectively statistically significant ($p < 0.01$) and ($p < 0.05$). There was increase in the WBC count with the highest pre and post infection values of $1.39 \pm 0.16 \times 10^4/\text{ul}$ and $1.86 \pm 0.01 \times 10^4/\text{ul}$ respectively. Leucocytosis observed was characterized by neutropenia, lymphocytosis and monocytosis. Negative unit weight change was observed as from day 12 post infection and this continued until the animals were treated 30 days post infection. Maximum weight loss of 4.5 kg was observed 2 days post treatment. Following treatment with Berenil at a therapeutic dose of 3.5mg/kg intramuscularly a reversal of all the haematological and biochemical aberrations was observed.

Ceremonial Uses of Horses

In addition to Polo, the mounted units of the Nigerian Police, on ceremonial occasions, use the horses for crowd control and for military Parade. The horses and the police riders are gorgeously dressed on these occasions while being on guard for security purposes. A case in view was that of the last swearing-in ceremony of the President, Commander-in-chief, Nigeria Armed Forces – Chief Olusegun Obasanjo at Abuja. This occasion was recorded with colour slides and transparencies.



Fig. B1: Mounted Troop Police Officers with their Horses Ready for Security Patrols and Crowd Control



Fig. B2: Use of Valuable Mounted Troop Horses for Crowd Control at the Federal Capital Territory, Abuja



Fig. B3: Mounted Troop Police Officers at Alert with their horses at Abuja Presidential Swearing in Ceremony in May 1999



Fig. B4: Governmental Ceremonial Use of Mounted Troop Horses



Fig. B5: Socially Important Ivory White Horses at Military Parade during the Presidential Inauguration at Abuja, May 29, 1999.

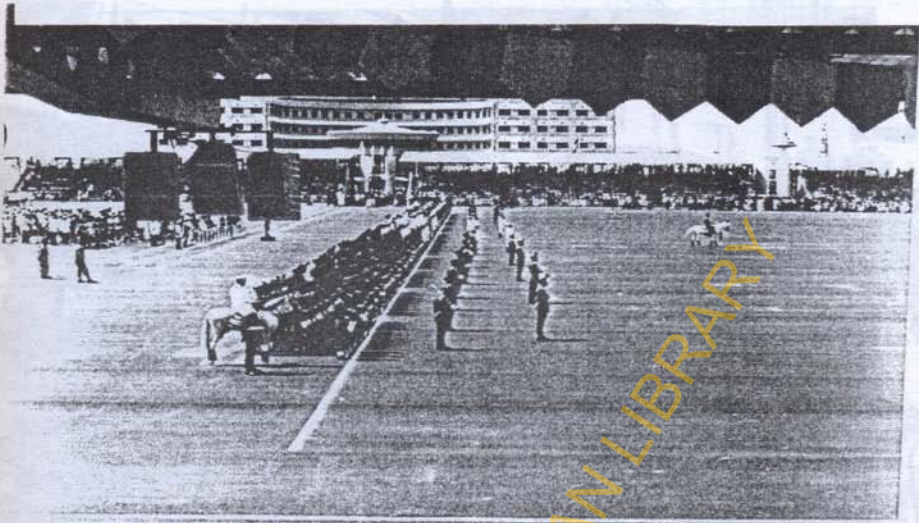


Fig. B6: Ceremonial Use of Horses for Military Parade at Abuja. Eagle Square, May, 1999.



Fig. B7: Mounted Troop Police Officers in action with their Horses in full regalia guarding the Government Ceremonial Function



Fig. 8B: The Abuja Presidential Inauguration Ceremony Being guarded with the Horses of the Nigerian Police in Fig. B7 above.

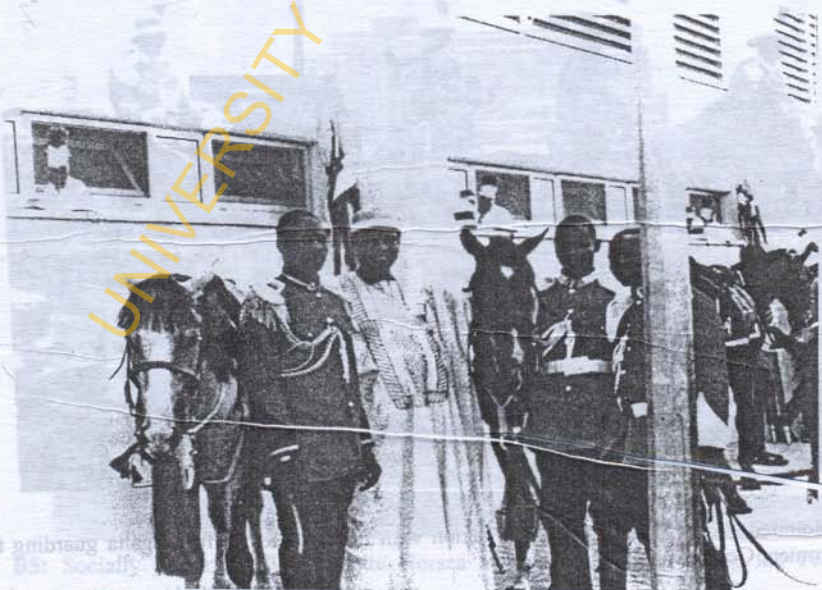


Fig. B9: Horse Health Monitoring Veterinarian with some of the Ceremonial Horses.

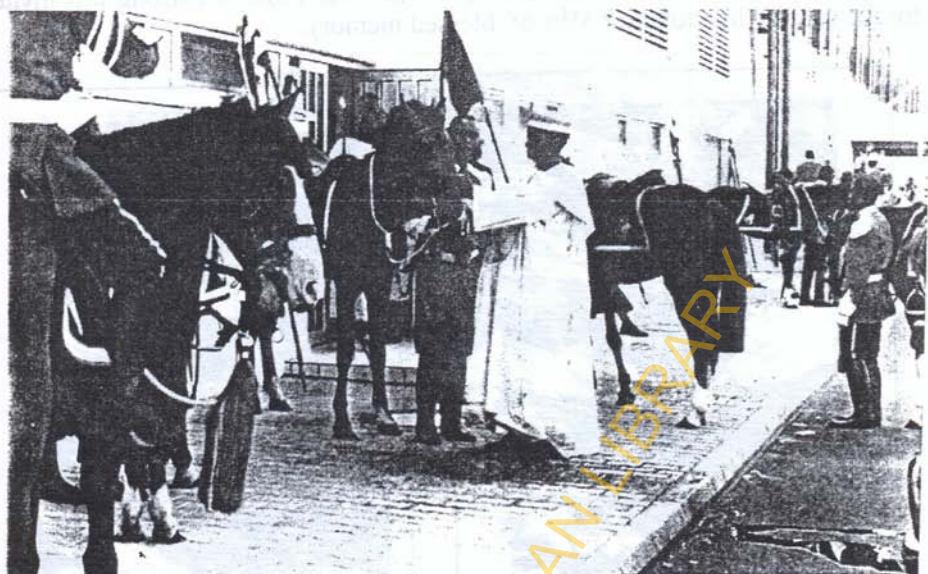


Fig. B10: Showing the horse health monitoring in progress by the Inaugural Lecturer

RUMINANT AND EQUINE SURGICAL RESTRUCTURING

Collaboration with ILRI on Rumen Fistulations:

(*Oladosu and Akpokoje 1972, 1975, 1987 and 1990*)

With the expertise developed in the early 70s I was invited by ILRI for collaborative research on surgical modification of West African dwarf rams. (Plates ILRI 1-2). I also assisted in monitoring the postoperative health cares of these animals. From time to time, when experiments were in progress, clinical services were also requested by ILRI should the modified ruminants develop postoperative complications (Plate ILRI 3).

Collaboration with Departments of Animal Science (IAR&T, OAU & U.I)

(*Oladosu and Akpokoje 1973 and 1975*)

My DVM Project (Oladosu 1972) on experimental surgery performed at the University of Ibadan Teaching and Research Farm was a motivating factor. Even when I was a Veterinary Officer at Ogbomosho with the Western Region Government, I was requested by the Animal Science unit of the Institute of Agricultural Research and Training (IAR &T) Animal Science unit, to assist on Ruminant Fistulation services. This needed consultancy continued with the Animal Science Department at the University of Ibadan when I joined the services of the University in 1973.

Prior to 1975, Professor D.G. Armstrong of the University of Newcastle Upon-Tyne used to be flown from Britain to assist in performing the rumen

cannulations for digestibility studies on Nigerian Ruminant Livestock. This was always at a high expense to the University whenever Prof. Armstrong was invited for the surgery by Professor Mba of blessed memory.

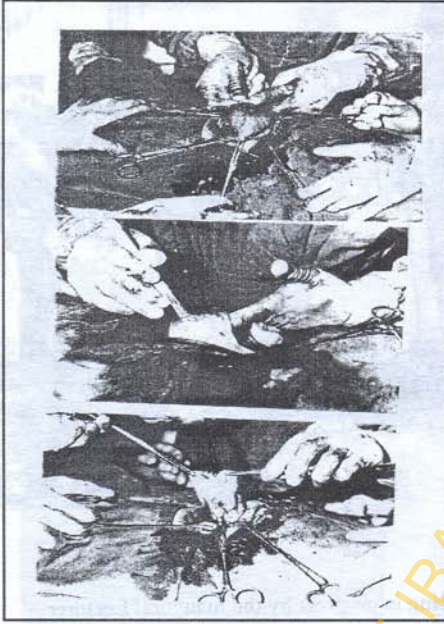


Plate 1: Fistulation Surgery on ILRI Rams at IITA, Ibadan. Note the stages of surgical modifications.



Plate 2: Cannula Exteriorisation Procedure: West African Dwarf Ram Fistulation. ILRI, IITA Collaborative Research

Surgical Modifications of Rams meant for digestibility experiments.

Collaboration with Department of Animal Science (IARST, U & IAD) (Oladosu & Armstrong 1971 and 1972)

My DVM (1968) (Oxford) on experimental surgery performed at the University of Ibadan, Ibadan, Nigeria was a major factor. Even when I was a Veterinary Officer at Oshodi, in the Western Region Government I was invited by the Animal Science Unit of the Institute of Agricultural Research and Training (IARST) Annual Conference to assist on Ruminant Fistulation services. This needed sponsorship continued with the Animal Science Department at the University of Ibadan when I joined the staff of the University in 1971.

Prior to 1975, Professor D.G. Armstrong of the University of Newcastle Upon-Tyne used to be flown from Britain to assist in performing the rumen



Plate 3: Rumen Livestock Fistulation Research and Services: The West African Dwarf Rams were fitted with rumen cannulae by the inaugural lecturer at ILRI, IITA, Ibadan. The Inaugural Lecturer was monitoring the health of the fistulated rams post operatively while the ILRI Collaborator from Australia assisted in the restraint of the patients.

On my initiative and desire to go and perfect the technique in the United Kingdom, a case was made for my sponsorship by the British Overseas Development Agency and the Inter University Council to enable me study the techniques. On my return, I continued to assist the Animal Science Department in the cannulations of their cattle (Plate ANSC 1-4), sheep, and goats (Plates ANSG 1-3) meant for use by their staff and postgraduate students. In this regard, I collaborated extensively with the Professors and postgraduate students in the Departments of Animal Science at the Universities of Ibadan and Ife.

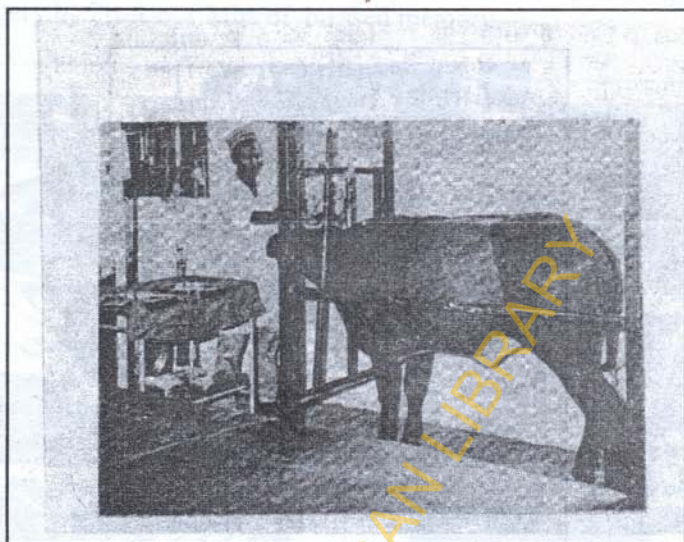


Plate ANSC 1: Preoperative restraint of cattle within an adjustable metallic confinement.

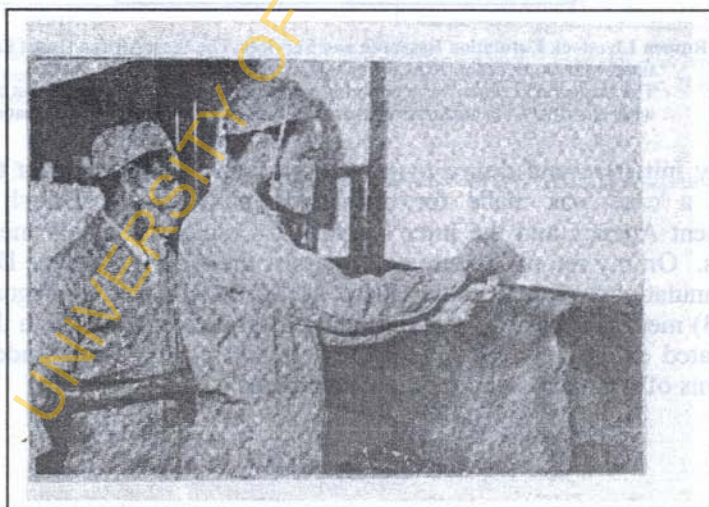


Plate ANSC 2: Paravertebral nerve blocks of thirteenth thoracic, first, second and third lumbar nerves performed by the Inaugural lecturer who is also the Consultant Surgeon in this surgical modification.

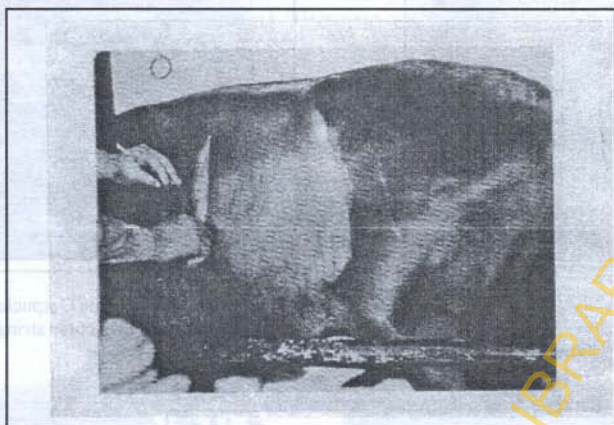


Plate ANSC 3: Paracostal incision technique Note the relative position from the vertebral column and the hook bone.



Plate ANSC 4: The fistulated cattle showing the relative position of the sutured incision and the exteriorized cannula

Cattle Surgical Modification For Digestibility Experiments

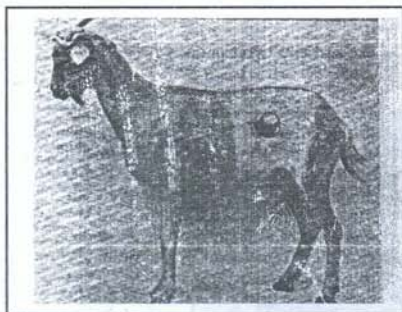


Plate ANSG 1: An Adult Red Sokoto (Maradi) Goat with left side rumen cannula in position.



Plate ANSG 2: The Outpuched intact rumen with purse string suture in progress.



Plate ANSG 3: Invagination of the lips of rumen incision after cannula implantation.

RESEARCH ON EXCITING REFERRAL EQUINE CLINICAL CASES

As the equine chief consultant, many referral cases were received from many horse stables and polo clubs from different parts of the country. This is because of the specialization, which we have developed at Ibadan equine unit of our Department of veterinary medicine in this University. I will here reflect on some exciting ones among those referral cases with a view to sharing with the audience some of our experiences and the excitements of the owners of these cases.

Equine Referral Case 1 :

A "Blue roan" *Dongola* Polo horse, owned by Ibadan Polo Club captain: Dr. Femi Oladele with *Traumatic Torticollis*.

This 8 years old beautiful horse which has participated in several tournaments, is the favourite horse of Dr. Femi Oladele. Most unfortunately, the groom reported sudden swelling and an almost 90 degrees cervical twist (Plate 1) on the horse to the owner. The resident veterinarian was alerted on this case. In spite of the initial treatment efforts abnormal neck distortion persisted and the neck of the horse was deviated along with the head to the right side. Although the

case was initially treated by the referring resident veterinarian who initially considered the case to be that of "Equine encephalitis", there was no apparent progress or improvement.

For this reason, the owner – Dr. Oladele obtained a referral letter from the resident veterinarian and opted to refer the case to the inaugural lecturer at the University of Ibadan for specialist attention.



Plate 1: An Ibadan Polo Horse owned by Dr. Femi Oladele with a 90 Degree Cervical Twist (Equine Traumatic Torticollis). Note the abnormal neck distortion with deviated head and neck.

When the case was received at our department, radiography was taken and on detailed clinical examination, a case of deformed convexity about the middle of the neck (Plate 2), was diagnosed and recorded as "neck torticollis". The right side sub-luxation of the cervical vertebrae was also noticed. (Plate 3). The neck was permanently twisted. (Plate 4).



Plate 2: The right side sub-luxation of the cervical vertebrae.



Plate 2: Note: Deformed Convexity about Middle of the Neck



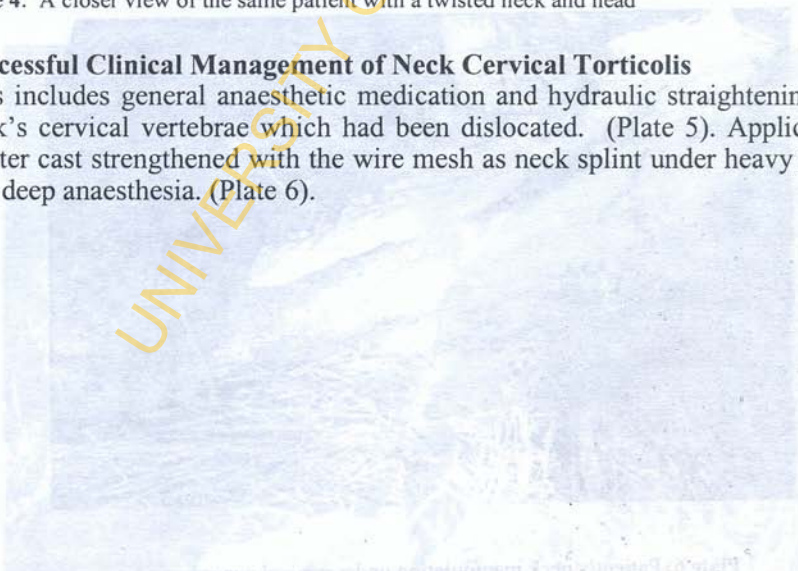
Plate 3: Note: The right side subluxation of the cervical vertebrae



Plate 4: A closer view of the same patient with a twisted neck and head

Successful Clinical Management of Neck Cervical Torticollis

This includes general anaesthetic medication and hydraulic straightening of the neck's cervical vertebrae which had been dislocated. (Plate 5). Application of plaster cast strengthened with the wire mesh as neck splint under heavy sedation and deep anaesthesia. (Plate 6).



Note: The cast was applied along the neck of the horse.

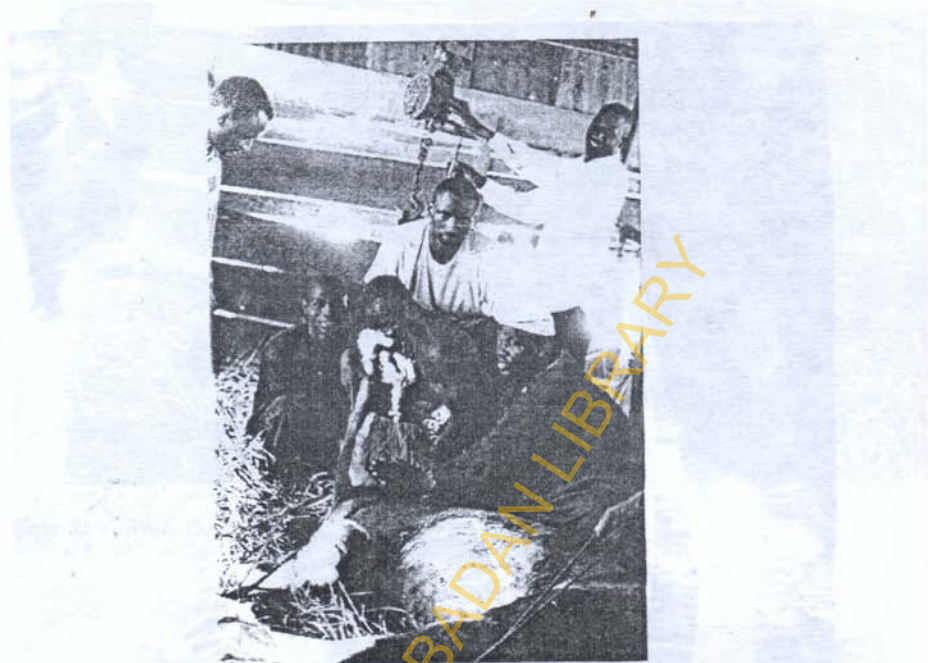


Plate 5: Head and Neck Being straightened with a mechanical pulley. This exercise was before POP Application under general anaesthesia.

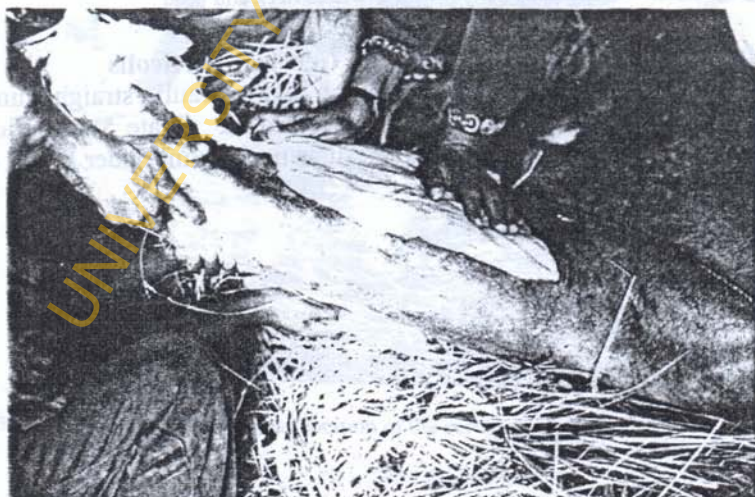


Plate 6: Patient's neck manipulation under general anaesthesia

Note: The cotton wool padded "Wire Mesh" neck splint applied along the neck of the horse.

Finally, the plaster of Paris (POP) was applied and the horse allowed to recover from general anaesthesia (Plates 7 and 8). The fully recovered horse after POP application was then allowed to recover with the POP on for about two weeks (Plates 9, 10 and 11). Recovery was attained after six weeks of corrective surgery and the horse went back to Polo fully recovered after six weeks (Plates 12 and 13).



Plate 7: POP corrected subluxated neck with horse under anaesthesia after surgery.



Plate 8: Patient in lateral recumbency under general anaesthesia after POP application.



Plate 9: Dorsolateral View of the straightened neck immediately after correction



Plate 10: Closer view of the same horse in standing position after anaesthetic recovery



Plate 11: Patient 72 hours after the corrective intervention with Plaster of Paris (POP) in place.



Plate 12: Right and Left neck sides of the fully recovered horse after being used for a Polo game at Ibadan Polo Club. These pictures were taken two weeks after surgical correction.



Plate 13: A closer view of the patient after full recovery at six weeks post surgical intervention. The neck is now straightened up when compared with the deformed (bent) neck in Plates 1 and 2

Equine Referral Case 2

An Ikeja Saddle Club's Thoroughbred Horse with rupture of sacrosciatic ligament and chronic lumbosacral haematoma

This case was referred from Ikeja Saddle Club. It was a beautiful "Show jumping" horse which had been lame on the hind-legs for long, with marked pain on the back. It was reported of having loin swelling and unresolved back pain problem even when several veterinarians in Lagos had attempted treatment (Plates 1-3).



Plate 1: Showing the referred horse with lumbosacral haematoma on arrival at the University of Ibadan Veterinary Teaching Hospital, Ibadan.

On clinical examination, serosanguinous fluid was removed from the lumbosacral region by the author who is the Referral Equine Chief Consultant (Plates 4-6).

Radiography was carried out by the Veterinary Teaching Hospital (VTH) Chief Radiographer, Mrs. O.T. Adene supported by the final year students in Equine Clinics. This case was surgically managed by the author (Plates 7 - 8). The latero medial radiography showed lumbosacral haematoma and rupture of the sacroschiatic ligament. The patient was put under general anaesthesia and the affected area opened up to remove the haematoma. The skin incision was resutured and dressed up for 9 days after which the patient was discharged to the owner in Lagos.



Plate 2: Showing the close up back view of same horse with painful lumbosacral haematoma



Plate 3: Physical examination at a glance of the horse with lumbosacral problem.

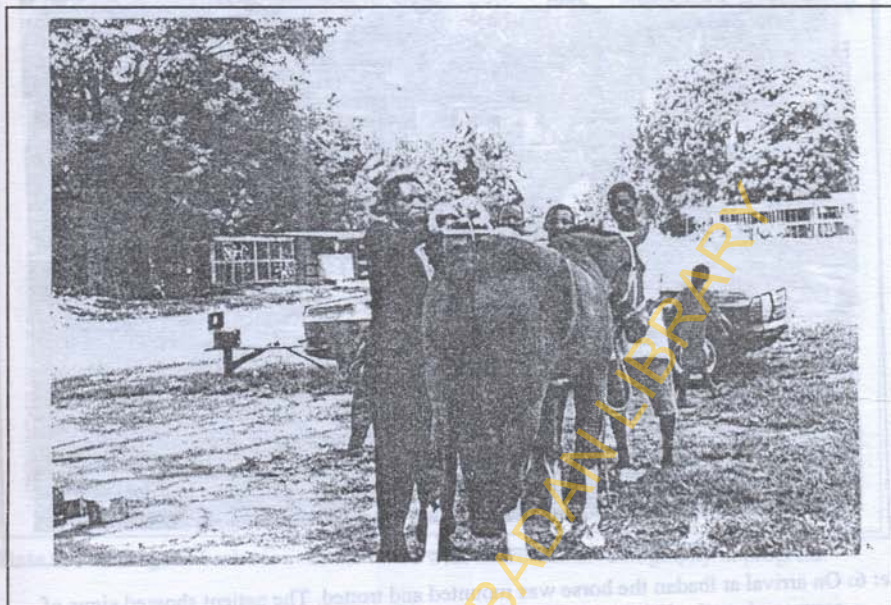


Plate 4: Showing the author and Equine Chief Consultant Surgeon performing the needle aspiration of the swollen lumbosacral haematoma.



Plate 5: With patient mounted and examined in standing position to assess the lameness.



Plate 6: On arrival at Ibadan the horse was mounted and trotted. The patient showed signs of severe pain and reluctance to move due to the lumbosacral haematoma.



Plate 7: Showing lateromedial radiography performed by the author on arrival at Ibadan.



Plate 8: Showing the back view of the horse with lateromedial radiography in progress.

Equine Referral Case 3: "Dourine" *Trypanosoma equiperdum* infection at Ibadan Polo

This was a case of Dourine (Equine Trypanosomosis) caused by *Trypanosoma equiperdum* infection. The case was referred from Ibadan Polo club with a complaint of an unusual swelling of the belly and the external genitalia especially the scrotal sac. The oedematous swelling was prominent from the side and the hind quarters of the patient (Plates 1-3).

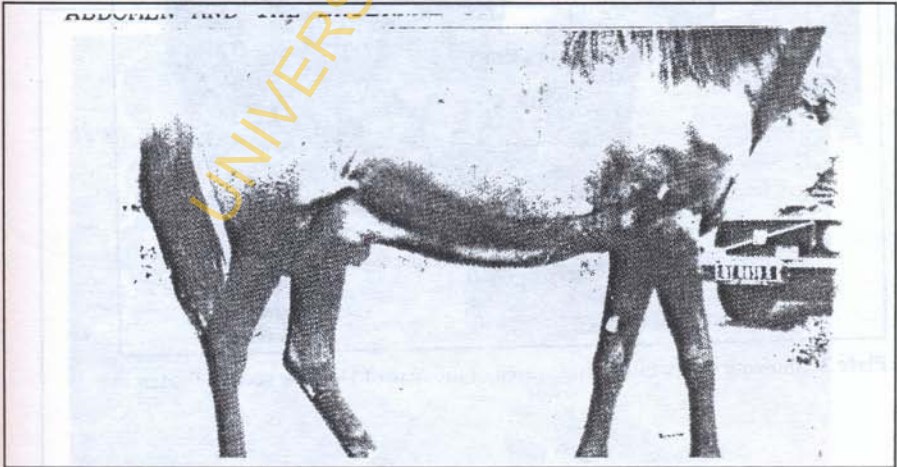


Plate 1: Showing the disease dourine in a Nigerian stallion with the closeup view of the oedematous ventral abdomen and the scrotal area



Plate 2: Showing the right side view of the case of Dourine presented by the owner Mr. Umoru at Ibadan Polo Club with the droopy head of the highly emaciated horse.



Plate 3: Showing the swollen scrotal area of the case of Dourine seen at Ibadan.

On the examination of the oedema tissues from the scrotal sac, large trypanosomes with prominent undulating membranes were detected on the stained blood smears of the animal. (Plate 4). Dourine was confirmed on this case. The case was however successfully treated with Antrycide prosalt solution. The case was discharged to the owner with a warning not to breed the animal after successful clinical management



Plate 4: Showing the back view of the same horse with marked oedema of the Scrotal sac

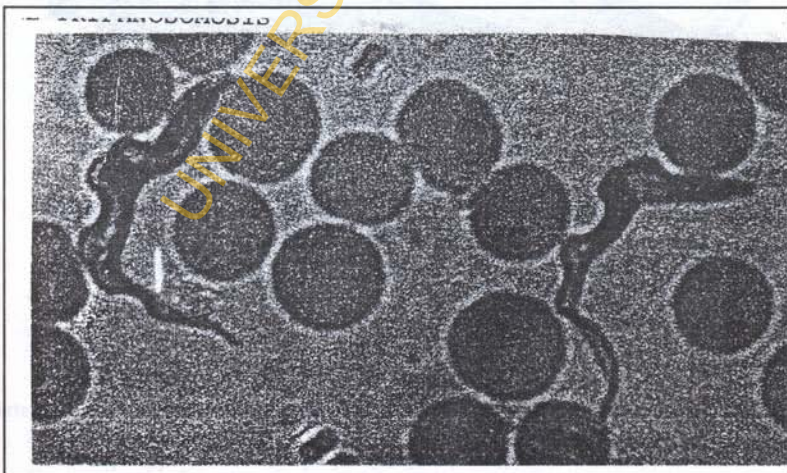


Plate 5: Showing the Trypanosoma equiperdum organism between the red cells of the patient with swollen scrotal sack

Equine Referral Case 4: Equine Trypanosomosis due to *T. vivax* infection.

This case was encountered at a local stable in a village at Ibadan. The horse has shown evidence of severe weight loss in spite of good feeding regime (Plate 1). It showed prominent ribs, scapula, marked pallor of visible mucous membranes and extreme weakness. There was no jaundice and no haemoglobinuria. The Hb and PCV were very low.

On examining, the blood smear showed *Trypanosoma vivax* infection (Plate 2). The case was treated with berenil-^R (diminazene diaceturate) at a dose level of 7 mg/kg body weight. The patient recovered fully some 3 months thereafter.

Ruminant livestock clinical Referral :

Case 5: Boran cattle intramedullary bone pinning for left foreleg fracture repair in Lusaka, Zambia with the inaugural lecturer as a Nigerian Federal Government's Technical Aid Professor of Large Animal Medicine and Surgery to the Government of Federal Republic of Zambia.

This case was referred to the inaugural lecturer from the Government Livestock Farm on the outskirts of Lusaka, Zambia. The case was encountered when I was on a sabbatical leave at the Samora Machel School of Veterinary Medicine in Lusaka, Zambia. I was then a Federal Nigerian Government's Technical Aid Professor of Large Animal Medicine and Surgery in Zambia.

The case involved a young Boran cattle which has forced it's leg in a stone pit and fractured the canon bone of the left foreleg. At the large animal hospital, the patient was reluctant to move but favoured the affected left limb (Plates RS1-3). The affected left leg has started to swell as seen on the 3rd day after injury when it was examined.



Plate RS 1.: Boran Cattle Bone Fracture Repair: *Note favoured left fore Limb

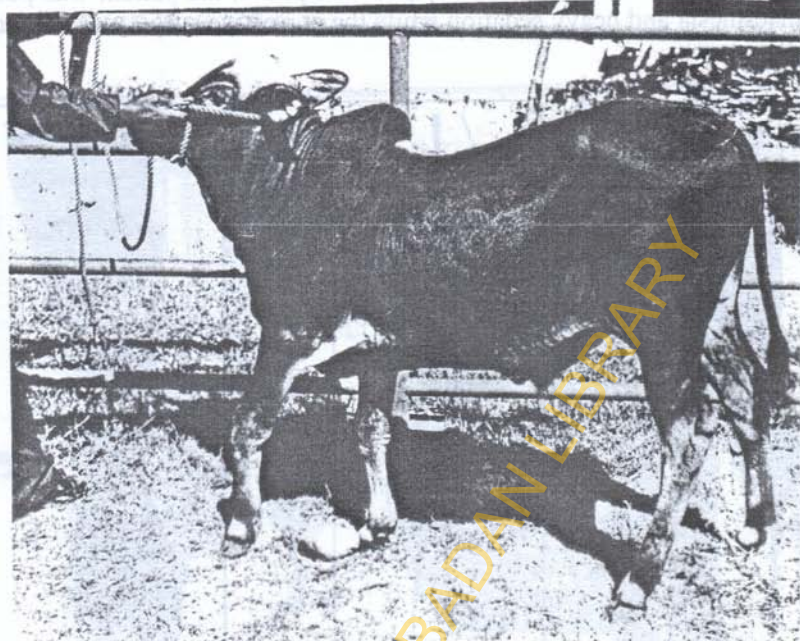


Plate RS 2.: Patient is reluctant to move due to left fore complete bone fracture and pain



Plate RS 3.: Ruminant (Boran Cattle) Restructuring Closer View: Fractured Left Fore. Note Swelling of the Carpus

Radiography revealed complete transverse fracture of the metacarpal bone as seen on the latero-medial and antero-posterior views. (Plates RS 4 and 5). Using

appropriate lengths of intra-medullary pins and plates, the patient was put under deep anaesthesia and heavy sedation while the corrective surgery was in progress (Plate RS 6).



Plate RS4: Boran cattle fracture radiography: *Note the over-riding transverse fracture as seen from latero-medial view.



Plate RS 5: Ruminant diagnostic radiography: antero-posterior view of cattle with complete transverse fracture.

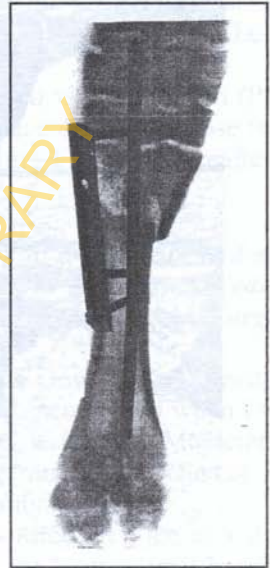


Plate RS6: Radiography of Boran cattle corrective surgery *Re-aligned metacarpal bone of same case. *Note intramedullary pinary and plating.

After surgical repairs, the patient and the surgeon who is the inaugural lecturer of today posed for a friendly photograph. (Plate RS 7). The patient then "opted for a personal photo to bid good-bye" to the Veterinary hospital shortly before being discharged back to the farm some nine weeks after corrective surgery (Plate RS 8).

Ruminant Tuberculosis Studies

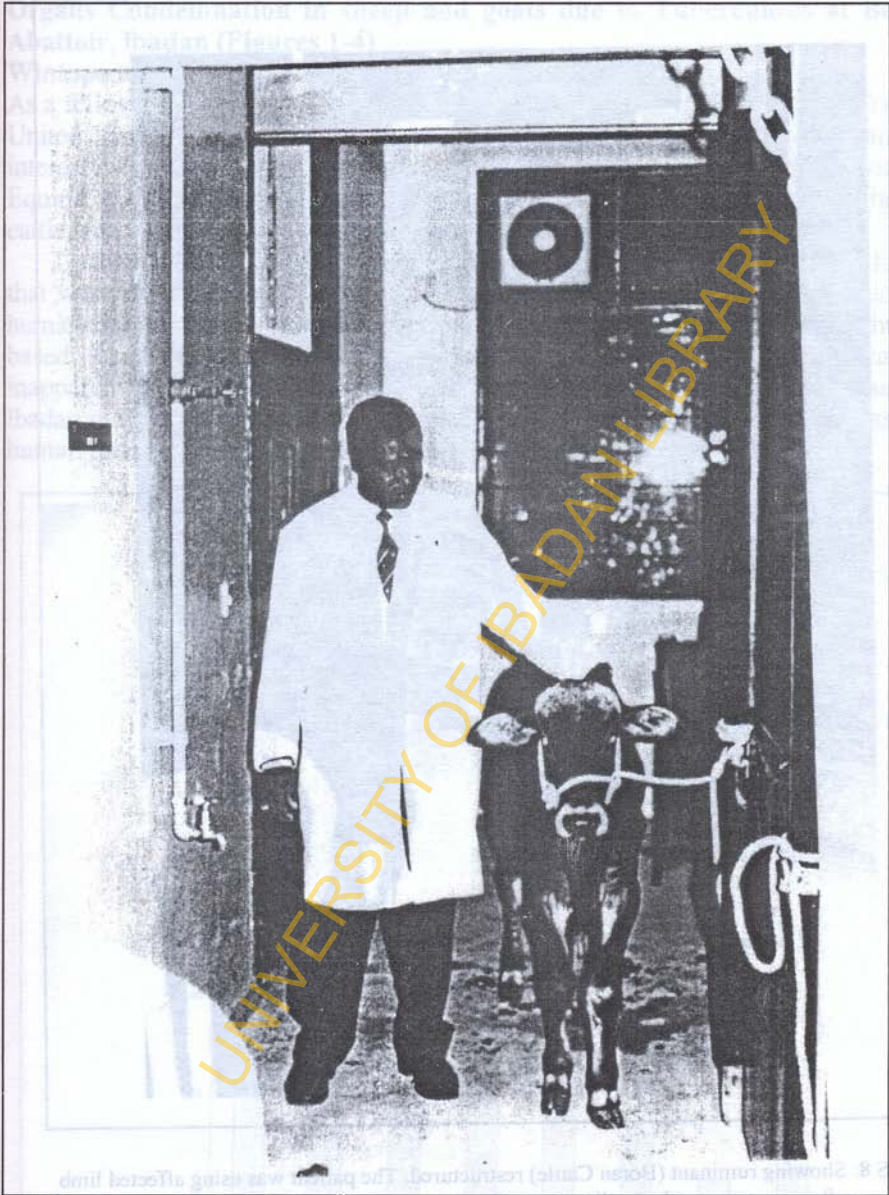


Plate RS 7: Showing the surgeon (Inaugural Lecturer) and the patient after corrective surgery.



Plate RS 8: Showing ruminant (Boran Cattle) restructured. The patient was using affected limb after corrective orthopaedic surgery.

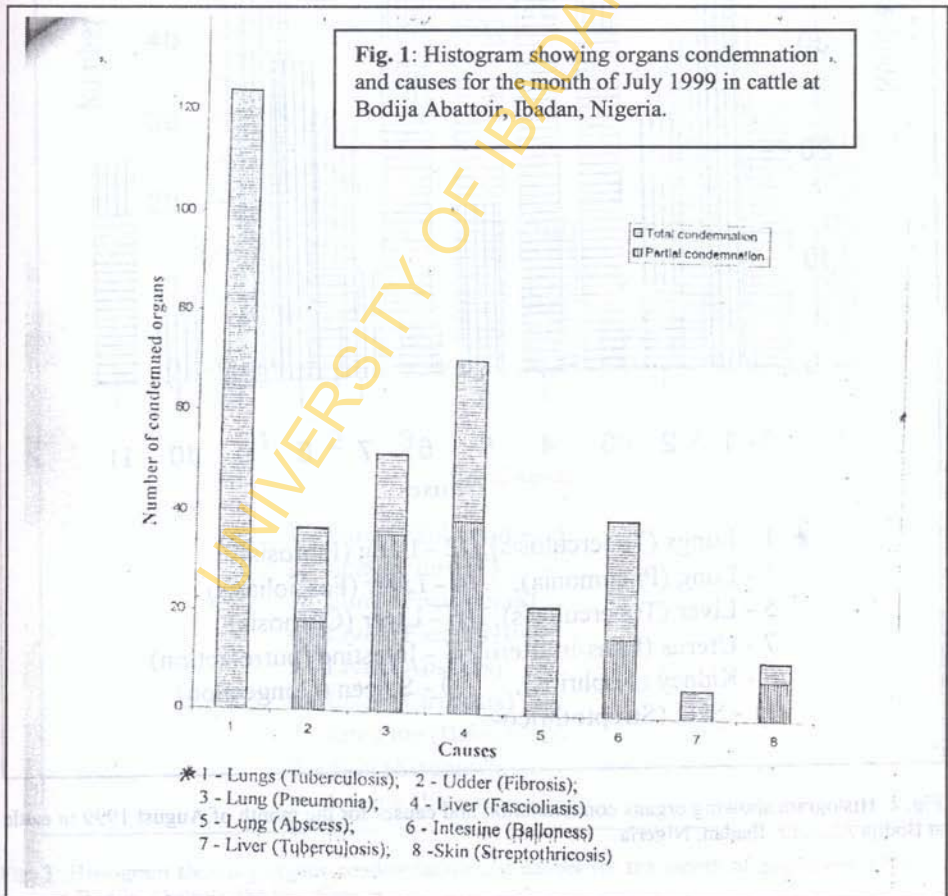
Ruminant Tuberculosis Studies

Organs Condemnation in sheep and goats due to Tuberculosis at Bodija, Abattoir, Ibadan (Figures 1-4)

Wintope and Oladosu (1998)

As a fellow of the Royal Institute of Public Health and Hygiene (FRIPHH) of the United Kingdom, food safety and related public Health issues are of paramount interest as part of my problem solving veterinary clinical research and services to Equine and Ruminant livestock. This was with particular reference to horses, cattle, sheep and goats.

To this end, I initiated further updating of data in 1998 to appraise the factors that were complimentary to the apparent upsurge in the number of encountered human clinical tuberculosis observed in Ibadan at that time. This thought was based on the hypothesis and proposition that possibly the level of clinical and inapparent Tuberculosis infection in the beef consumed from slaughter houses at Ibadan may be significantly responsible for the apparent increase in the cases of human tuberculosis of the time as shown in Figures 1-4.



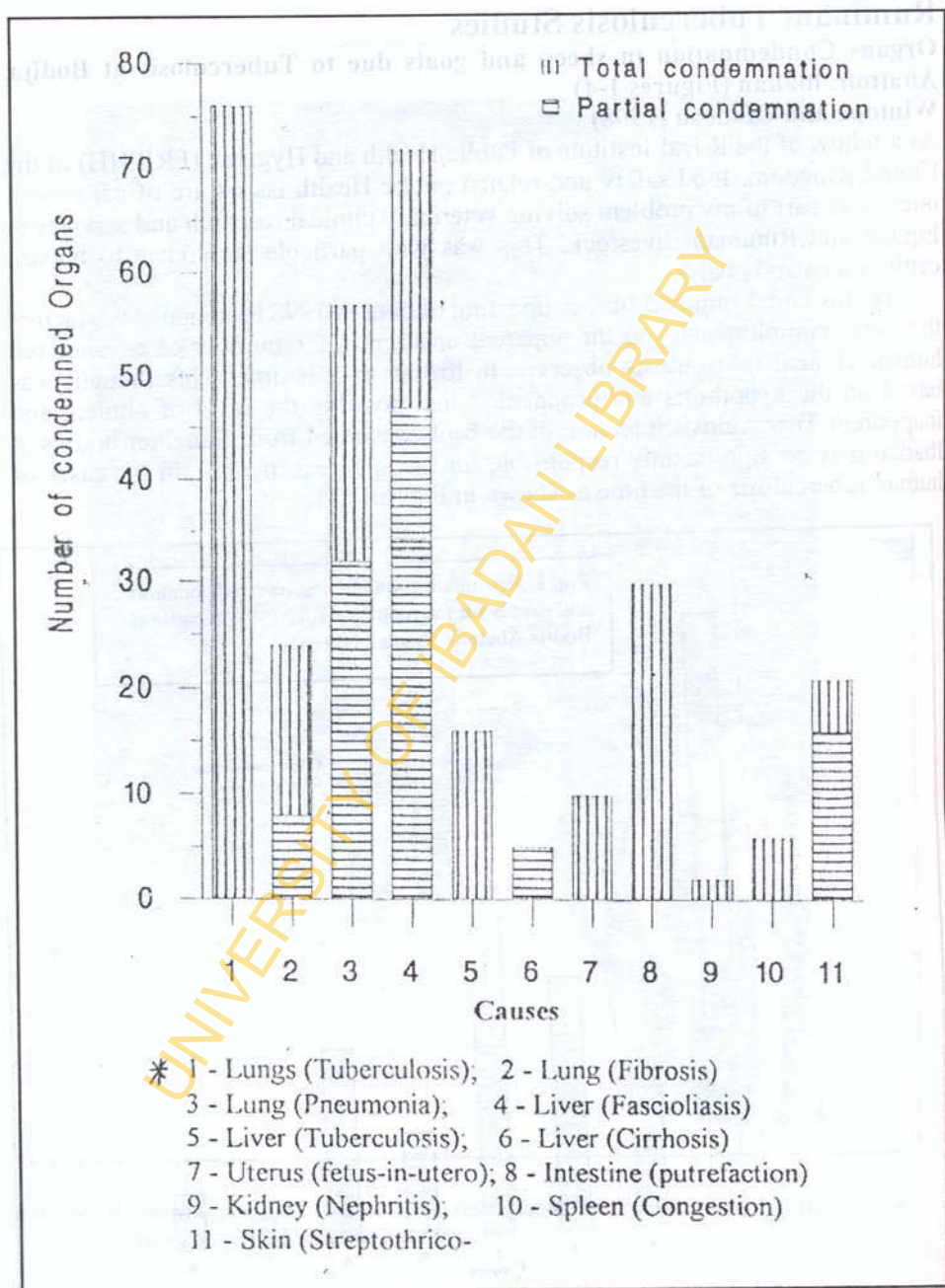


Fig. 2: Histogram showing organs condemnation and causes for the month of August 1999 in cattle at Bodija Abattoir, Ibadan, Nigeria.

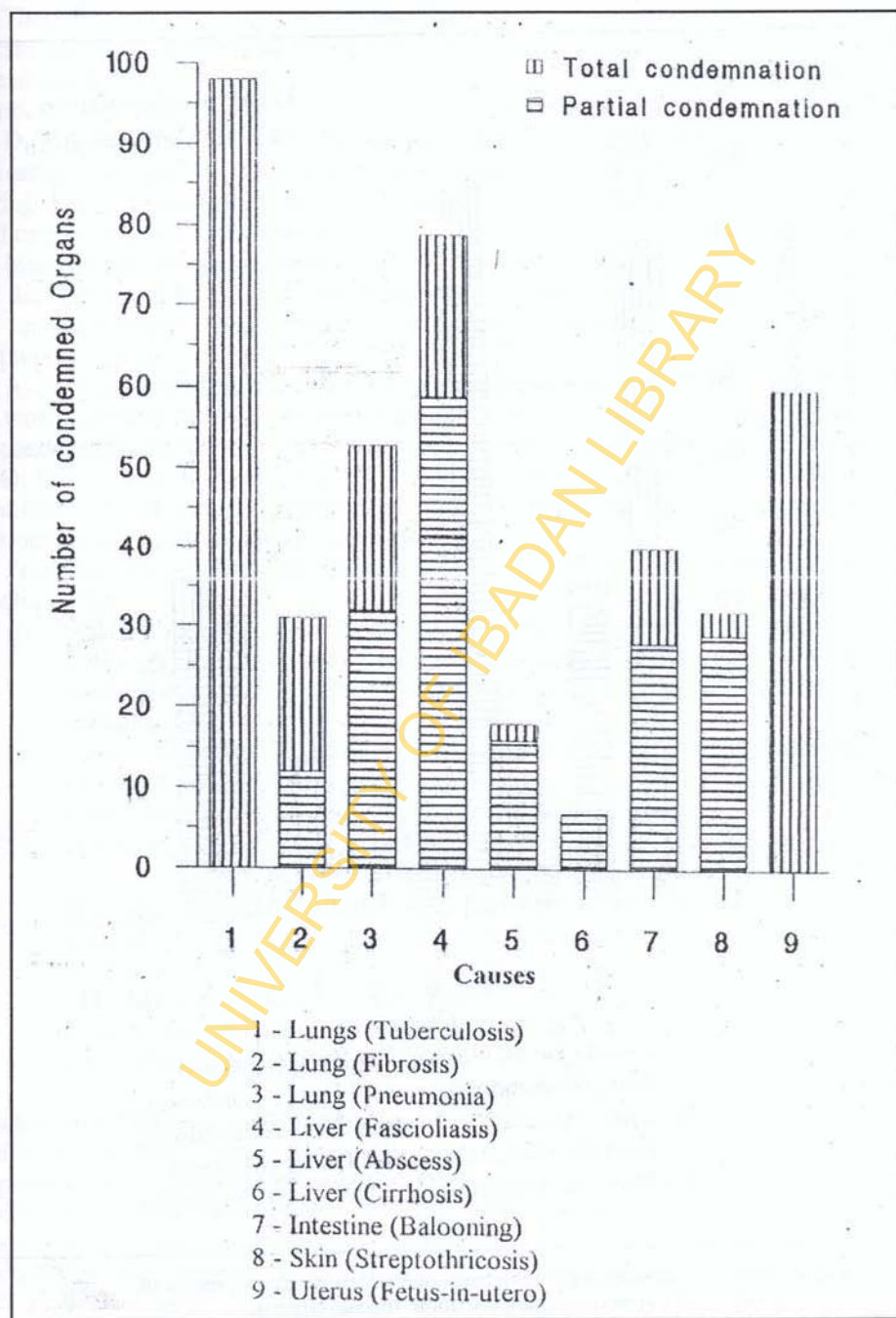


Fig. 3: Histogram showing organs condemnation and causes for the month of September 1998 in cattle at Bodija Abattoir, Ibadan, Nigeria

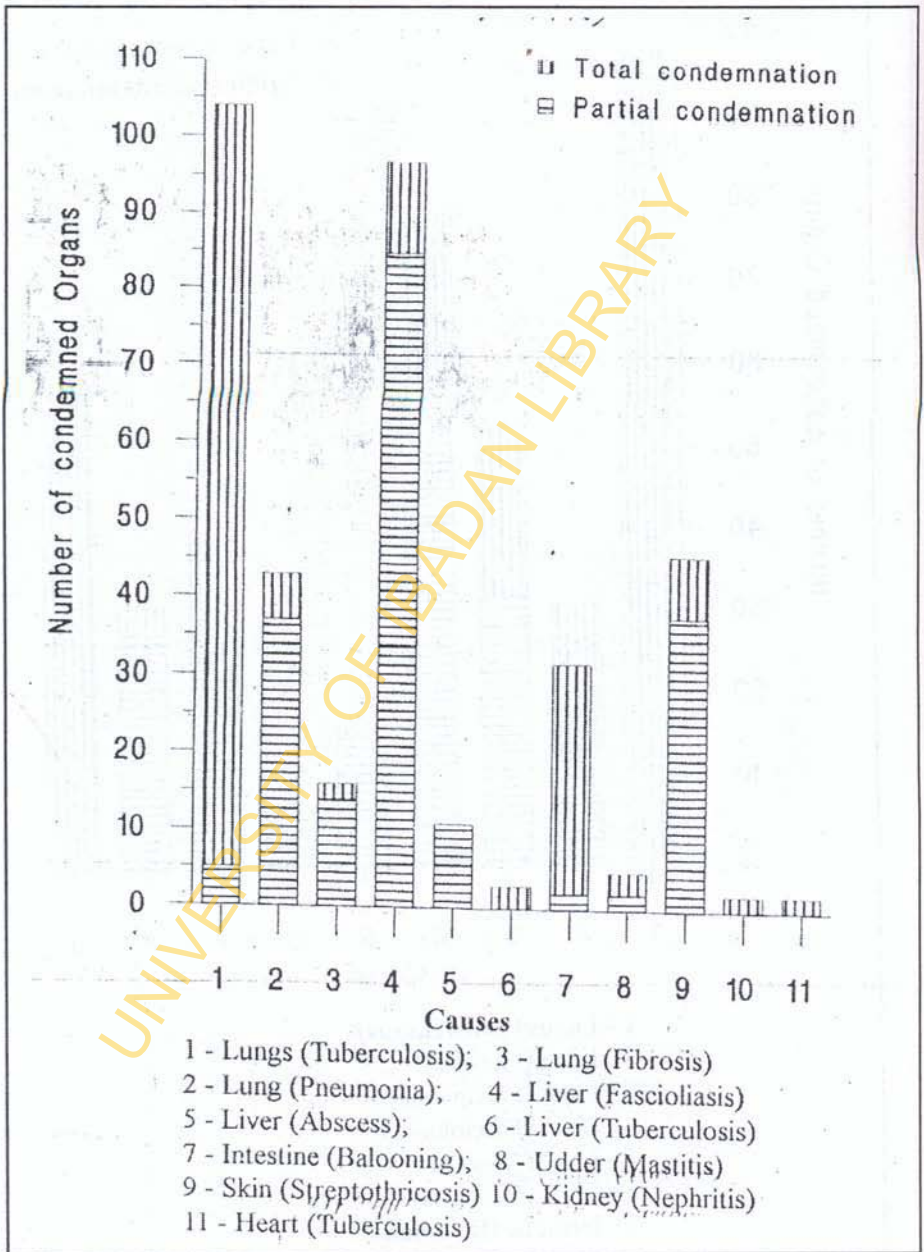


Fig. 4: Histogram showing organs condemnation and causes for the month of October 1999 in cattle at Bodija Abattoir, Ibadan, Nigeria.

Therefore, for the purpose of establishing the prevalence and causes of carcass and organ condemnation of slaughtered cattle in the urban city of Ibadan, an extensive abattoir survey was carried out over a period of 4 months - July to October, 1998 at the Bodija Municipal Abattoir, Oyo State.

During the period, 26,458 slaughtered cattle were involved in the carcass evaluation. Routine inspections were also carried out before and after slaughter. During ante-mortem inspection, 1152 cattle were held as suspect for partial and total carcass/organ condemnation.

Mastitis was the most common (27.95%) followed by emaciation (22.92%) and diarrhoea (9.12%). Other less common ante-mortem conditions responsible for carcass/-organ condemnation included lameness, dehydration and streptothricosis.

At postmortem inspection, 1,462 organs were condemned. Tuberculosis was the most common cause of organs condemnation accounting for about 50% (of all condemnations). Of this percentage, tuberculosis of the lungs accounted for 80%; followed by fascioliasis (25%), and pneumonia (18.2%). Other significant conditions which caused partial and total carcass/organ condemnation were ballooning, and multiple abscesses (Figs. 1-4).

From the above observations, and the analysis of the data obtained, it was concluded that:

- (i) Mastitis which accounted for 27.95%, emaciation, 22.92% and diarrhoea, 9.12% of ante-mortem condemnation at the Bodija abattoir continued to be of great public health hazard in the consumption of beef in Ibadan.
- (ii) Tuberculosis which caused 50%, fascioliasis, 25% and pneumonia, 18.2% of postmortem organs condemnation at the Bodija abattoir, is of tremendous public health concern resulting in an upsurge in the number of human clinical cases of tuberculosis. These were predominantly seen in adult, women and children. From our observations of the results obtained, it could be concluded that restructured veterinary clinical practice, by timely and thorough meat inspection, when carried out by well trained veterinarians, would enhance safe meat consumption. This will improve health of the public due to prevention of clinical tuberculosis and other zootomic diseases which would have otherwise, been rampant among the populace.

Odebiyi and Oladosu (1999): Sheep and goats organ condemnation data

Similarly, the study was carried out to detect the various clinical conditions responsible for carcass and organs condemnation in sheep and goats at the Municipal Abattoir, Bodija, Ibadan. The work was carried out between the months of July and October, 1998. During this period, 5,600 sheep and 4,300 goats which were slaughtered at the abattoir were examined. In sheep, 907 and 494 cases of total and partial organ condemnations, respectively were encountered. In goats, 596 and 359 cases of total and partial organ condemnations, respectively were encountered (Figs. 1 - 2).

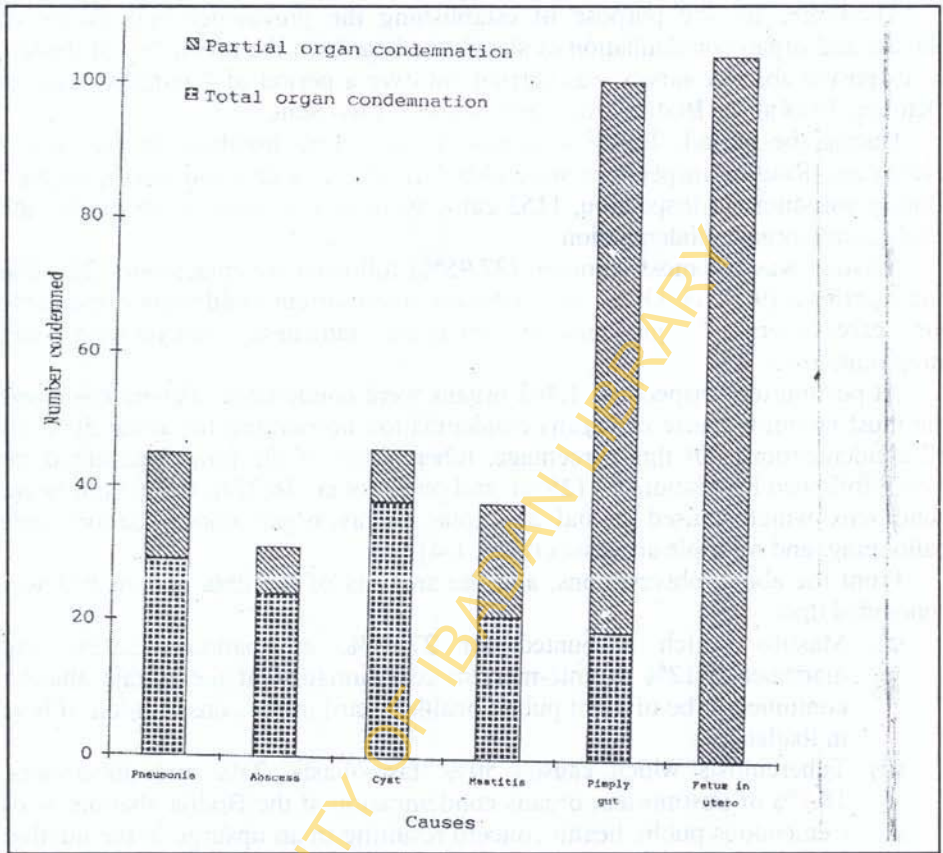


Fig. 1: Histogram showing number of organ condemnation and causes for the month of July, 1999 in goats at Bodija Abatoir, Ibadan Nigeria.

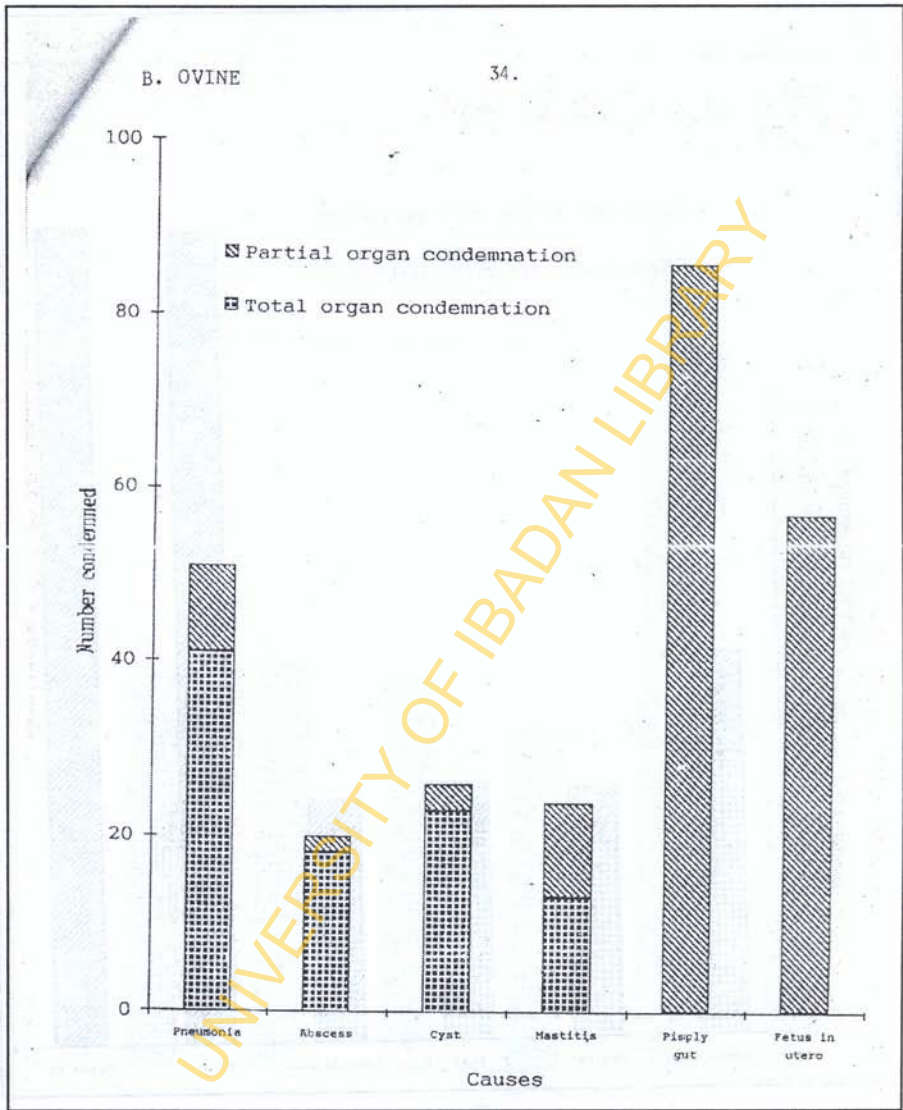


Fig. 2: Histogram showing number of organ condemnation and causes for the month of July, 1999 in sheep at Bodija Abattoir, Ibadan, Nigeria

The various conditions encountered at the time of this work included: oesophagostomiasis which accounted for 25 (2.1%) of all cases in sheep and 30(3.2%) in goats; pneumonia, 38.2% and 28.3% in sheep and goats, respectively. Mastitis, 37.5% and 36.2% in sheep and goats, respectively;

abscess, 17.1% and 19.8% in sheep and goats, respectively and cysts, 11.5% and 12.7% in sheep and goats respectively (Figs. 3 – 7).

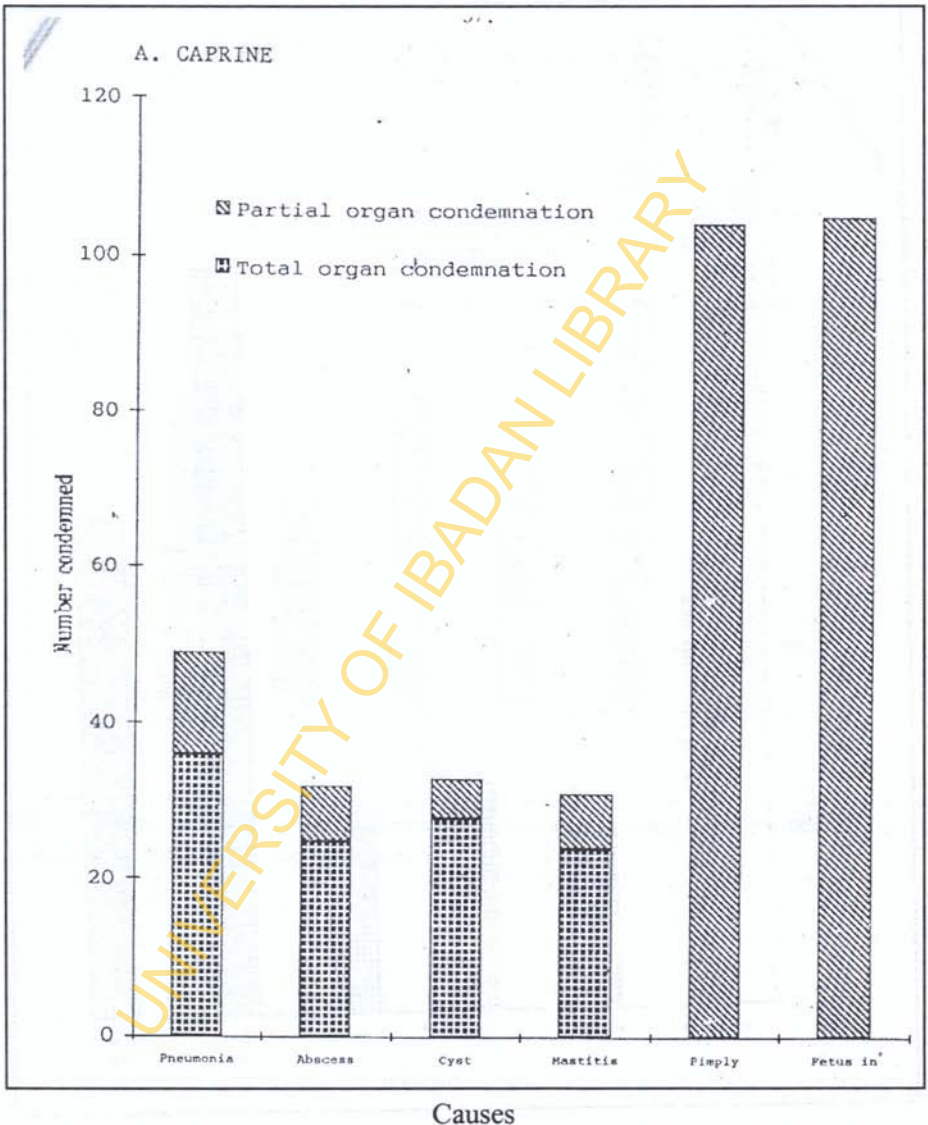


Fig. 3: Histogram showing number of organ condemnation and causes for the month of August, 1999 in goats, and Bodija Abattoir, Ibadan, Nigeria.

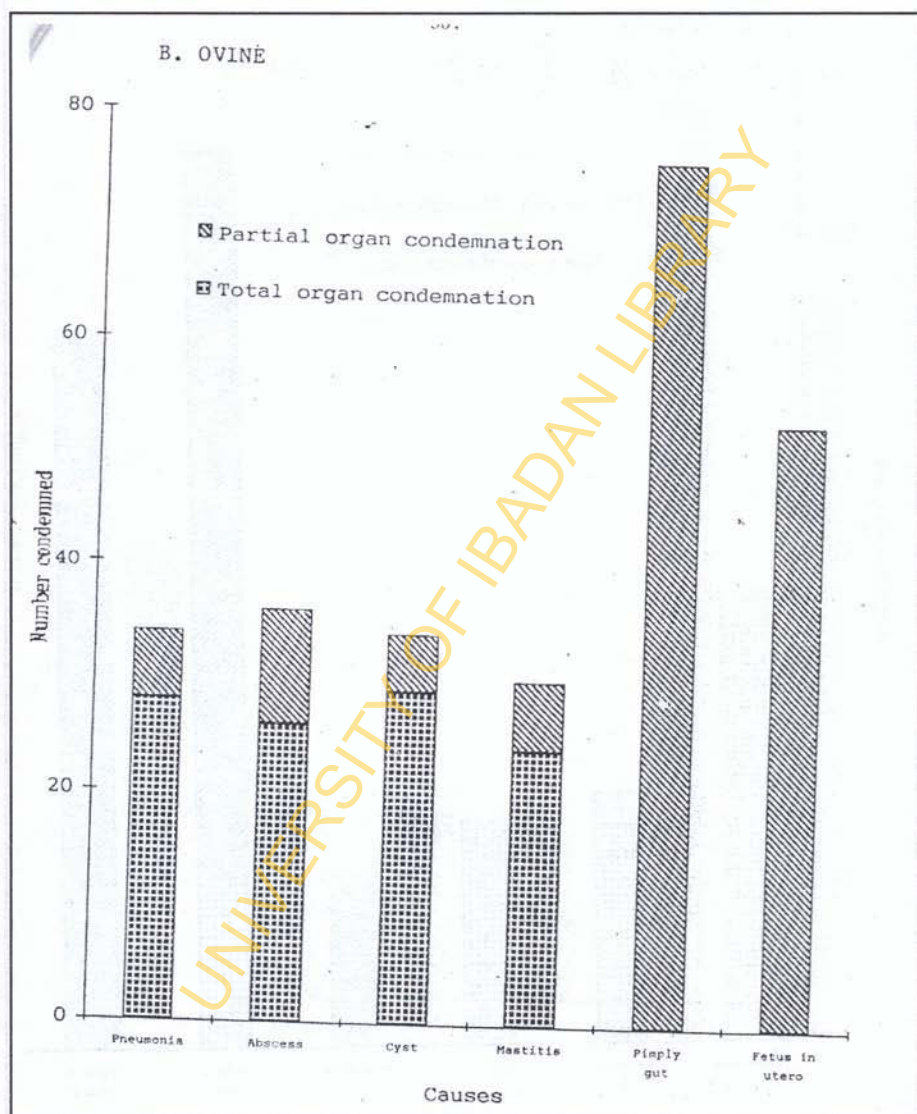


Fig. 4: Histogram showing number of organ condemnation and causes for the month of August, 1999 in sheep at Bodija Abattoir, Ibadan, Nigeria.

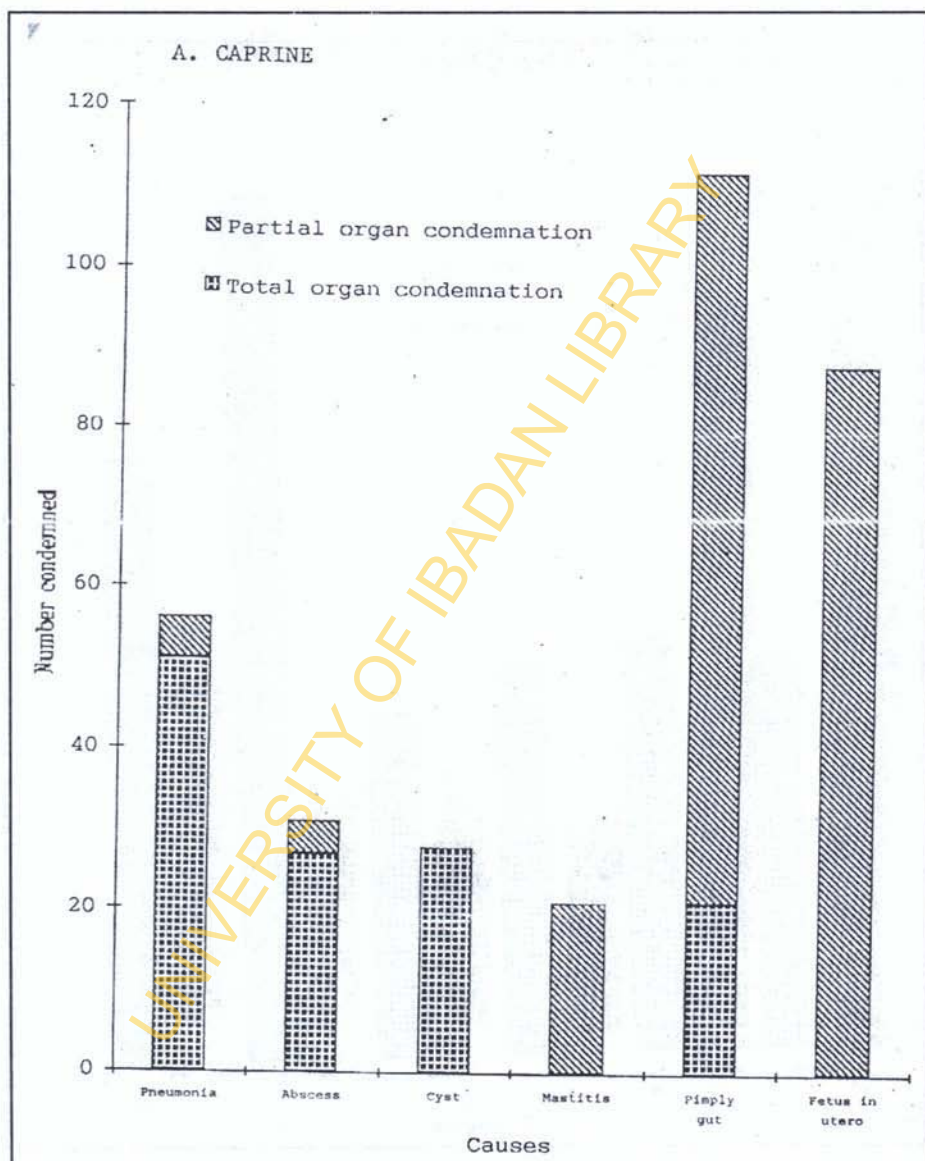


Fig. 5: Histogram showing number of organ condemnation and cause for the month of September, 1999 in goats at Bodija Abattoir, Ibadan, Nigeria.

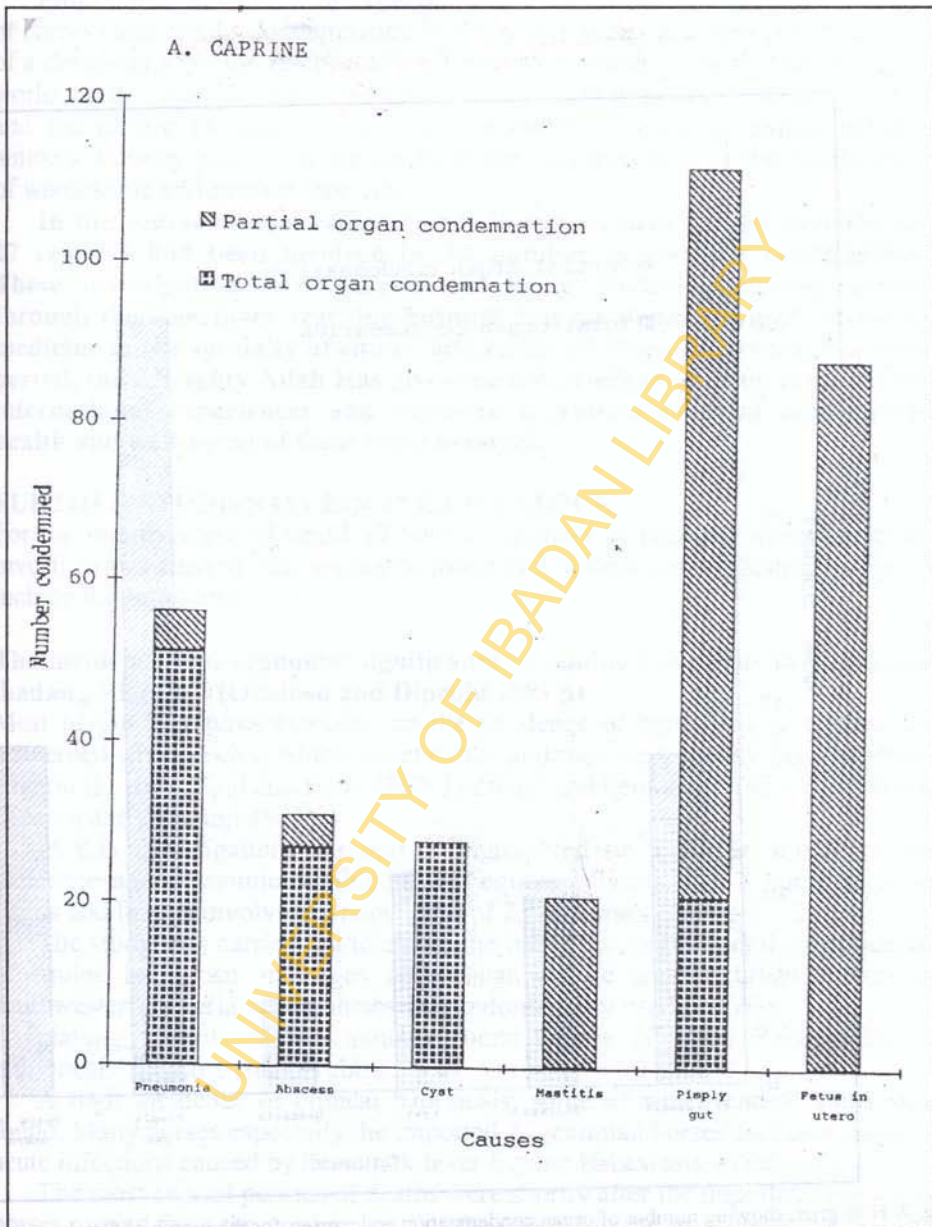


Fig. 6: Histogram showing number of organ condemnation and causes for the month of October 1999 in goats at Bodija Abattoir, Ibadan, Nigeria

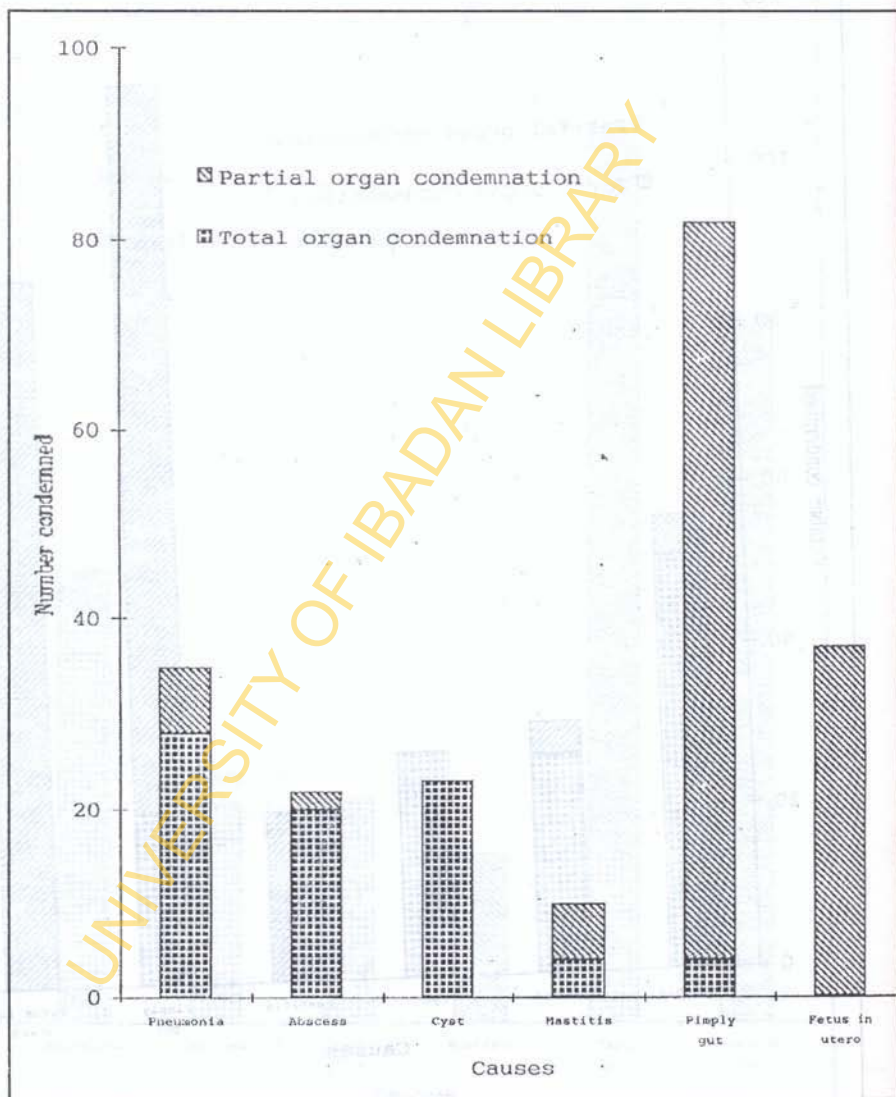


Fig. 7: Histogram showing number of organ condemnation and causes, for the month of October, 1999 in sheep at Bodija Abattoir, Ibadan, Nigeria.

From the point of view of Zoonosis, this work unraveled the common causes of carcass and organs condemnation in sheep and goats, in a typical African City of a developing Nation relative to what obtains in the developed countries of the world. With these findings, attempts could be made to improve the prophylactic and therapeutic measures against most zootomic disease conditions in these animals, thereby improving the health of the populace through the consumption of wholesome and disease-free meat.

In the course of my academic and clinical services pursuit over the last 27 years, I had been involved in the number of research investigations. These investigation were carried out while rendering clinical services through the veterinary teaching hospital and my department of veterinary medicine in the speciality of equine and ruminant livestock. Within the same period, the Almighty Allah Has given me the privilege of using my local and international experiences and exposure to restructure and improve the health and well-being of these large livestock.

FURTHER STUDIES ON EQUINE LIVESTOCK

For the improvement of health of horses a number of problem solving research investigations carried out, mainly to assist and sustain polo industry in Nigeria include the following.

The incidence and economic significance of equine babesiosis in Lagos and Ibadan,, Nigeria. (Oladosu and Dipeolu 1981 a)

Most of the literatures available on the incidence of babesiosis in Nigeria are concerned with species, which infect cattle, and they were mostly from Northern Nigeria (Folkers, Kuil and Perie 1967; Leeftland and Ilemobade 1977; Akinboade, Dipeolu and Adetunji 1981).

In this investigation, a report is highlighted on a 5-year survey of the incidence and economic significance of equine babesiosis in 8 horse herds in Lagos and Ibadan involving a population of 2,627 horses (Tables 1 – 2).

The study was carried out to assess the incidence and economic significance of equine babesiosis in Lagos and Ibadan. These are the urban centres in southwestern Nigeria where horses are predominantly used for polo playing, patrols of the mounted units of the Nigerian Police and for individuals' pleasure rides (Tables 3 – 4).

A high incidence of clinical babesiosis, some of which ended fatally was found. Many horses especially the imported Argentinian horses died as a result of acute infections caused by horse tick fever Equine Babesiosis – (Table 4).

The most critical periods of deaths were shortly after the importation or when horses moved from the northern part of the country to the two areas covered. The field clinical data from the areas investigated showed that more and more horses were died as a result of this same disease. Stress of polo playing and those arising from other inter-current diseases were found to be the major predisposing factors. The incidence of the disease was highest during the rainy season when the population of the tick vectors of the disease was highest (Table 4).

Our investigation also showed that an average of 10 Argentinian horses were dying annually in Lagos and Ibadan alone. These horses were the ones popularly used for polo playing in view of their size and body conformations.

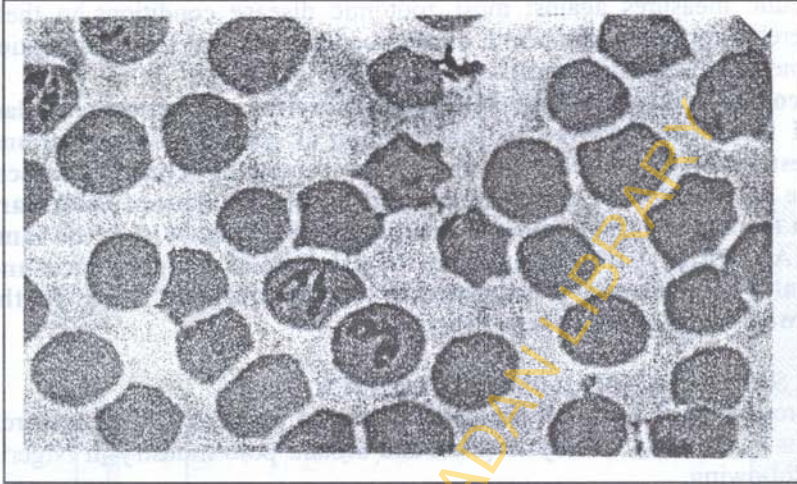


Plate 1: Blood Parasites of Horses *Babesia caballi* within the red blood cells

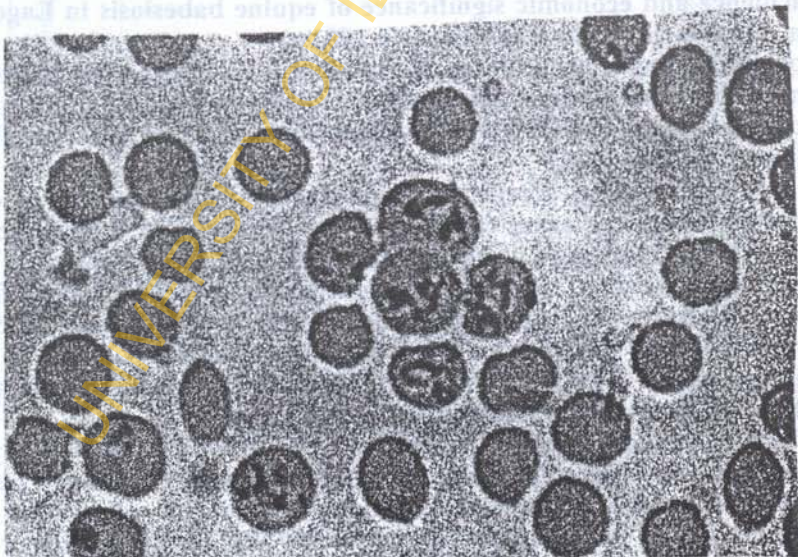


Plate 2: Showing blood parasite of horses *Babesia equi* at different stages of multiplication with the stained red blood cells

Considering the fact that each of the 10 imported Argentinian horses that died annually cost between N800,000 and N2.5m, the financial loss suffered by polo enthusiasts due to Equine babesiosis alone becomes colossal. Between N8m.

and N25m were thus lost annually from the country's foreign exchange reserve as a result of deaths of horses caused by this disease in Lagos and Ibadan alone (Table 3).

The clinico-pathological features and containment of equine babesiosis in Nigeria. (Oladosu and Dipeolu 1981b)

In Nigeria, reports on the clinico-pathological aspects of *Babesia* infections of equines are not widely documented. Nevertheless, several field clinical experiences (Olotu 1978; Adejumbi 1979; Idris Alhaji 1981, and Dipeolu and Oduye 1976) showed the disease to be highly endemic and highly pathogenic in the country. This investigation attempts to put on record the major clinico-pathological features of the disease in Nigeria in relation to the various strategies that could be used for the control of the problem (Table 1).

In our three-year clinico-pathological investigations on equine babesiosis in major horse areas of Nigeria, (Oladosu and Dipeolu 1981b) temperature elevation, anorexia, ecchymosis of the third eyelids, depression, thirst, lacrimation, incoordination, rapid pulse, dyspnoea, rapid respiration, injected mucous membranes were recorded. Turbulent colic and tetanic spasms of the locomotory muscles, and "blood stained" tears were the fairly constant clinical manifestations of acute cases. There were also, icterus of the mucous membranes, sluggishness, severe weight loss, swelling of the supraorbital areas, severe anaemia, reddish brown urine, oedema of the limbs and lower abdomen. Weak and irregular pulse and dehydration, blanched mucous membranes were some of the signs observed in chronic infections.

Necropsy findings were generalised haemorrhage, watery blood with prolonged clotting time, icterus of all tissues, excessive serous fluid in the pleural, pericardial and peritoneal cavities, subcutaneous oedema and oedema of the lungs, hepatomegaly, splenomegaly, pale and swollen kidneys. Most fatal cases were characterised by coronary and epicardial haemorrhages, petechiae and ecchymoses along most vessels of the heart, enlarged and oedematous lungs with subpleural deposits of yellow-coloured fluid or gelatinous materials. Others manifested congested blood vessels of the abdominal viscera, petechiae and ecchymoses of the serosal surface and serious enteritis. The predominant parasitologic findings included the presence of organisms morphologically typical of *B. equi* and *B. caballi* within the erythrocytes. The histopathologic observations were degenerative changes of the liver with increased amount of haematogenous pigments, congestion and haemosiderosis of the spleen, pulmonary oedema, generalised depletion of the lymphoid germinal centres and cerebral oedema.

Results

Among the 1564 horses investigated in the 3-year period (1977 - 1979), 506 (32.4%) manifested clinico-pathological features of equine babesiosis. Of the 506 babesiosis cases, 67 (13.2%) were fatal (Table 1) out of which 43 (67.2%) cases were confirmed to have died of *B. equi* infections, 12 (17.9%) of *B. caballi*, and 10 (14.9%) mixed infections.

Table 1: Clinico-pathological Features and Containment of Equine Babesiosis
(a) Summary of horses investigated and analysis (1977-1979)

Locations	Total surveyed	Number with clinical babesiosis	Number of deaths	Mortality rate (%)	<i>B. equi</i> Deaths	<i>B. caballi</i> deaths	Mixed deaths
Lagos	1024	312	49	15.7	34(69.4)	9(18.4)	6(12.2)
Ibadan	540	194	18	9.3	11(6.1)	3(16.7)	4(22.2)
Total	1564	506	67	13.2	45(67.2)	12(17.9)	10(14.9)

() Figures in parenthesis are in %

(b) Equine babesiosis incidence and infection rates with *B. equi* and *B. caballi* and both at Ibadan and Lagos, Nigeria (1976-1980)

Origin and Years	Total Examined	Total Babesiosis Cases		<i>B. equi</i> Cases		<i>B. caballi</i> Cases		Mixed Cases	
		No.	%	No.	%	No.	%	No.	%
Ibadan*									
1976	173	63	36.4	42	66.7	18	28.6	3	4.8
1977	181	54	29.8	28	51.9	21	39.6	5	9.3
1978	188	72	38.3	48	66.7	18	25.0	6	8.3
1979	171	68	39.8	38	55.9	23	33.8	7	10.3
1980	193	82	42.5	55	67.1	21	25.6	6	7.3
Total	906	339	37.4	211	62.2	101	29.8	27	8.0

Table 1(b) (Contd.)

Origin and Years	Total Examined	Total Babesiosis Cases		<i>B. equi</i> Cases		<i>B. caballi</i> Cases		Mixed Cases	
		No.	%	No.	%	No.	%	No.	%
Lagos**									
1976	317	98	30.9	70	71.4	22	22.4	6	6.1
1977	342	102	29.8	64	62.7	31	30.4	7	6.9
1978	331	93	28.1	74	79.6	10	10.8	9	9.7
1979	352	117	33.2	82	70.1	31	26.5	4	3.4
1980	379	121	31.9	75	62.0	39	32.2	7	5.8
Total	1721	531	30.9	365	68.7	133	25.1	33Q	6.2

*includes cases at Ibadan Polo Club, Ibadan saddle club, Ibadan race course stables and Ibadan mounted units of the Nigerian Police stables

**includes cases at Lagos Polo Club, Ikeja saddle club, Obalende and Ikeja mounted units of the Nigerian Police stables.

Table 2: A 5-year equine babesiosis incidence and rates of infection with *B. equi*, *B. caballi* and mixed infections at Ibadan and Lagos, Nigeria (1976-1980)

	Total Examined	Total Clinical Babesiosis Cases		<i>B. Equi</i> Cases		<i>B. caballi</i> Cases		Mixed Cases	
		No.	%	No.	%	No.	%	No.	%
Ibadan	906	339	37.4	211	62.2	101	29.8	27	8.0
Lagos	1721	531	30.9	365	68.7	133	25.1	33	6.2
Grand Total	2,627	970	36.9	576	59.4	234	24.1	69	7.1

Table 3: A 5-year incidence, morbidity and mortality rates of equine babesiosis in Lagos and Ibadan (1976-1980)

Clinical Parameters	1976	1977	1978	1979	1980
Total horses examined	490	523	519	523	572
Total babesiosis cases	161	156	165	185	203
Morbidity rates (%)	32.9	29.8	31.8	35.4	35.5
Deaths due to babesiosis	19	23	17	27	31
Death as % of babesiosis cases	11.8	14.7	10.3	14.6	15.3
Mortality (%)	3.9	4.4	3.3	5.2	5.4

Table 4: Seasonal distribution of equine babesiosis cases in Lagos and Ibadan, Nigeria (1976-1980)

Seasons		1976	1977	1978	1979	1980
Rainy season (April-Sept)	No.	120	98	125	112	139
	%	74.5	62.8	75.8	60.5	68.5
Dry season (Oct-March)	No.	41	58	40	73	64
	%	25.5	37.2	24.2	39.5	31.5
Total		161	156	165	185	203

Clinical illness and demonstrable parasitaemia (Plates 1 and 2) caused by *Babesia* infection lasted a few days to a few weeks. Clinically recovered horses were found to often join the ranks of infected, asymptomatic horses that become carriers of *Babesia* organisms. When horses were stressed with Polo tournament, this asymptomatic status was exacerbated into clinical illness.

Generally, the *Babesia* infected horses were dull, listless, jaundiced and inappetent with elevated rectal temperatures and heart rate. In acute cases staggering gait, abdominal pain mimicking acute abdominal disease (violent colic and Gastrointestinal tract disturbances), paleness and petechiation of the conjunctival, buccal and vulval membranes, marked jugular pulsations, dyspnoea and discoloured urine were conspicuously featured.

Fever and anaemia were consistent findings in both *B. caballi* and *B. equi* infections. Rectal temperatures range from 39.5 - 41.8°C. *B. equi* infection often result in intermittent fevers whereas the fever of *B. caballi* infections was more constant. Affected horses become depressed with laboured respiration but often continue to eat. Gait may be unsteady and head were often held down with neck forwardly distended. Hypereamia of mucous membranes, ecchymosis of the third eyelid, constipation, colic and ventral oedema were common signs. As the disease progressed, anaemia become more severe, icterus develops along with signs of dehydration. Sometimes constipation often progress into diarrhoea. Haemoglobinuria were common in horses with *B. equi* infections but was rare in horses with *B. caballi*. Concurrent pneumonia was a common diagnosis in natural *B. caballi* infections. Only after a thorough physical examination could primary disease be rightly diagnosed.

Clinical and haematological features of stress induced babesiosis in *Babesia equi* infected indigenous horses (Oladosu and Olufemi 1988)

Introduction

Some studies on the haematological parameters of local horses in Nigeria and those horses that were plagued with naturally occurring equine babesiosis (Oladosu and Dipeolu, 1981 a, b) had been previously reported. However, the clinical features and problems of stress induced relapses of babesiosis in premune Polo horses appear to have been ignored.

In this investigation involving 123 local polo horses, an appraisal of the clinical and haematological features of stress induced relapses of babesiosis in *B. equi* and *B. caballi* premune indigenous Polo horses, is reported.

The horses

The stressed indigenous horses were brought from different polo clubs to Ibadan and were exposed to long distance transportation stress, heat stress (due to over exposure to hot weather). They were kept in temporary stables during the tournament periods with lack of sufficient drinking water and gastrointestinal parasitism.

The Results

Actively stressed *B. equi* infected premuned indigenous polo horses, manifested severe clinical syndromes characterised by partial anorexia, hyperthermia, lethargy, extreme weakness, marked dehydration, ecchymotic third eyelid, pale mucous membranes, sternal recumbency and coma. Some horses showed complete anorexia, obvious colicky symptoms, watery blood, and haemoglobinuria. The haematologic changes in the affected horses included highly significantly ($P < 0.01$) low packed cell volume, reduced haemoglobin concentration, depleted red blood cell counts and highly significantly ($P < 0.01$) depleted neutrophils and lymphocytes.

Tables I and 2 show the effect of the multivariate stress factors on the haematology of 14 of the 123 visiting local polo horses from Kano, Kaduna, Sokoto, Zaria and Lagos. The haematological parameters (i.e. PVC, HB, RBC and WBC) of these horses, evaluated six (6) days after the onset of the week long national polo tournament at Ibadan showed highly significant differences ($P < 0.01$) between the means of one hundred and nine ($N = 109$) *Babesia* negative horses compared with the means of fourteen ($N = 14$) horses, which showed stress induced relapses of *B. equi* infections (Table 1).

While the mean packed cell volume (PVC %) of the 109 *Babesia* negative horses was 34.66, that of the 14 *Babesia* positive horses was highly significantly ($P < 0.01$) reduced to 19.86 due to *B. equi* parasitaemia. Similarly, the mean red blood cell (RBC) value dropped significantly ($P < 0.01$) from $6.72 \times 10^6/\text{mm}^3$ for the $N = 109$ *Babesia* negative to $3.73 \times 10^6/\text{mm}^3$ for the $N = 14$ *Babesia* positive horses. Faecal examination of the horses from the *Babesia* Positive (BP) and the *Babesia* Negative (BN) groups showed evidence of gastrointestinal parasites, identified as strongyles, ascarids, pinworms, stomach worms, tapeworms and

bots. A highly statistically significant ($P < 0.01$) reduction also occurred in the haemoglobin concentrations (HB); and the White Blood Cell (WBC) counts of these horses. (Table 1). The mean differential leucocyte counts were selectively affected (Table 1). There were highly significant ($P < 0.01$) reduction in the mean lymphocyte values of the BN and the BP horses (Table 2). The mean Basophilic cells were also significantly ($P < 0.01$) reduced.

The observed haematologic alterations on these indigenous horses are more glaringly shown with the histogram in Figure 1 for PVC, Hb, RBC and WBC values and Fig. 2 for the differential leucocyte parameters.

The neutrophils and the monocytes were not significantly ($P < 0.05$) affected (Table 2).

Haematological Parameters of Argentinian Polo Horses with Acute Babesiosis (Oladosu and Olufemi 1990)

Introduction

When an animal is exposed to unfavourable conditions such as: poor nutrition, poor management, physical exertion, excessive stress and concurrent diseases, its equilibrium is disturbed and the level of immunity is lowered (Courier, 1972). In Nigeria, Argentinian horses which are popularly used for Polo sports are frequently exposed to immense physical strain and exhaustion due to the recycling polo tournaments. Such horses quite often manifest clinical disease from haemoparasites which may be present at sub-clinical levels.

In this investigation the point prevalence of *Babesia* infection in 40 Argentinian Polo horses which had been under stress during a week-long polo tournament is reported, including the observation of the haematological parameters in the infected and non-infected polo horses.

Results

In the study of 40 stressed Argentinian horses, during the Ibadan annual Polo Tournament, 27 (67.5%) developed *Babesia* parasitaemia. The development of babesiosis in the horses was associated with stress of the Polo games. Babesiosis in the horses was characterised by significant ($P < 0.01$) decreases in PVC, Hb. and RBC, values. The leucocytes were variously affected and only the segmented neutrophils and lymphocytes were very highly significantly ($P < 0.01$) reduced. Equine practitioners therefore should be aware that stress can produce clinical diseases in horses thus allowing the clinical expression of a concomitant sub-clinical infection.

Tables 1, 2, 3 and 4 show the mean haematological parameters of *Babesia* infected and non-infected Argentinian Polo horses from among the 40-visiting animals. The number of horses with subclinical *Babesia* parasitaemia showing recrudescence before, during and after the polo tournament are indicated in the same tables.

Table 1: Mean Haemogram of Babesia-Infected and Non-Infected Argentinian Polo Horses Before, During and after Tournament

Tournament Day	Before Polo Tournament			During Polo Tournament			After Polo Tournament	
	-2	-1	-0	2	4	6	8	9
<i>Babesia</i> Infected	(2)	(2)	(3)	(8)	(15)	(27)	(7)	(2)
RBC (xl0 ⁶ /mm ³)	5.62 ±0.82	5.44 ±1.22	5.14 ±0.72	5.42 ±0.91	4.33 ±1.32	4.08 ±0.78	4.22 ±1.14	4.43 ±0.82
PCV%	30.42 ±1.24	29.64 ±0.82	26.48 ±2.22	23.48 ±0.96	22.55 ±0.75	20.48 ±4.77	23.65 ±0.94	24.72 ±1.04
Hb. (gm/dl) WBC xl(Pm/m ³)	7.24 ±0.66 5.92 ±0.16	6.98 ±1.02 5.98 ±C.84	6.92 ±0.44 5.88 ±0.44	5.88 ±1.12 5.66 ±0.87	6.82 ±0.66 5.44 ±b.72	5.93 ±1.67 4.51 ±1.25	5.84 ±0.72 4.63 ±0.40	5.91 ±0.62 4.02 ±1.22
Non-Infected RBC (xl0 ⁶ /mirf)	(38) 7.06 ±0.91	(38) 7.95 ±0.51	(37) 7.62 ±1.24	(32) 6.92 ±1.84	(25) 6.48 ±2.31	(13) 7.44 ±2.42	(13) 7.68 ±0.61	(38) 7.87 ±0.55
PCV (%)	33.44 ±1.32	32.62 ±0.88	33.12 ±1.42	34.12 ±0.84	33.22 ±1.85	32.82 ±3.45	33.82 ±0.94	32.62 ±1.72
Hb. (gm/dl.)	10.75 ±0.44	11.30 ±0.68	11.22 ±0.21	10.88 ±0.42	10.92 ±1.12	10.80 ±0.62	11.48 ±1.24	11.52 ±0.41
WBC (xKPA ³ m ³)	7.48 ±0.16	7.12 ±0.74	6.82 ±0.14	7.46 ±0.62	6.48 ±0.22	8.05 ±2.86	8.02 ±0.44	7.32 ±0.64

= Figure in parentheses indicate the number of infected and non-infected Argentinian Polo horses

= Day of Berenil (R) treatment. ± = Standard Deviation.

Table 2: Mean Leukogram (\pm SD) of Argentinian Polo Horses with Acute

	Before Polo				During Polo		After Polo	
	Tournament				Tournament		Tournament	
Tournament Day*	-2	-1	-0	2	4	6	8	9
<i>Babesia</i> Infected	(2)	(2)	(3)	(8)	(15)	(27)	(7)	(2)
S/Neutro	42.35	43.14	43.22	41.82	41.31	39.89	39.92	38.48
%	± 5.26	± 4.34	± 3.14	± 6.25	± 5.88	± 6.94	± 6.26	± 5.13
Lympho.	26.52	27.34	26.27	21.48	20.56	19.93	18.48	19.36
%	± 6.41	± 5.04	± 4.42	± 4.32	± 5.22	± 3.57	± 4.32	± 5.12
Eosino.	1.22	1.43	1.46	1.49	1.31	1.41	1.38	1.02
%	± 0.86	± 1.03	± 0.13	± 1.12	± 0.87	± 1.82	± 0.72	± 0.88
Mono.	2.32	1.64	2.14	1.92	2.04	1.59	1.48	2.12
%	± 0.92	± 0.88	± 0.72	± 1.21	± 0.77	± 1.31	± 1.02	± 0.47
Baso	0.33	0.52	0.48	0.48	0.55	0.15	0.42	0.27
%	± 0.12	± 0.22	± 0.11	± 0.32	± 0.18	± 0.36	± 0.17	± 0.15
Non-Infected	(38)	(38)	(37)	(32)	(25)	(13)	(33)	(38)
S/Neutro.	58.43	57.52	57.62	57.72	56.45	58.54	57.62	56.82
%	± 6.82	± 6.12	± 5.23	± 6.33	± 8.42	± 7.38	± 7.38	± 8.44
Lympho.	27.42	26.22	27.41	26.48	25.88	27.92	27.43	26.22
%	± 7.89	± 7.18	± 5.62	± 8.87	± 9.22	± 8.14	± 7.88	± 6.87
Eosino.	1.04	1.67	1.47	1.84	1.21	1.15	1.03	1.64
%	± 1.14	± 1.12	± 1.02	± 1.12	± 0.86	± 1.41	± 1.24	± 1.32
Mono.	2.66	1.58	1.92	2.85	1.26	2.62	2.41	2.22
%	± 1.03	± 1.18	± 0.88	± 1.22	± 0.72	± 1.45	± 1.26	± 1.34
Baso	0.26	0.46	0.44	0.51	0.42	0.23	0.28	0.12
%	± 0.47	± 0.13	± 0.21	± 0.34	± 0.22	± 0.59	± 0.25	± 0.15

* = Figure in parentheses indicate the number of infected and non-infected Argentinian Polo horses

** = Day of Berenil (R) treatment \pm = Standard Deviation

Two (5%) of the forty (40) Argentinian horses showed relapsed *Babesia* parasitaemia with clinical symptoms of acute babesiosis two days before the onset of polo tournament, following their arrival at Ibadan. On days 2, 4 and 6 however, the number of horses with acute babesiosis rose to 8 and 15 respectively. At this time, all horses were treated with Berenil® at a dose of 3.5mg/kg body weight for two consecutive days in the early hours of the mornings. On days 8 and 9 post-treatment the number of horses with *Babesia* parasitaemia dropped to 7 and 2 respectively. The parasitaemia in most horses at this stage were lower. No mortality was recorded among the *Babesia* positive Argentinian horses although parasitaemia were high in some of the positive cases before and during the polo tournament.

Table 3: Haematological Parameters in Argentinian Polo Horses with Acute Babesiosis

Haemic Values	Comparative Sources Horses Groups	n	x	S.D.	S.E.	F-Value Prob F.	
PCV (%)	B. equi Negatives	13	32.82	3.45	0.96	8.39...	0.0001
	vs B. equi Positives	27	20.48	4.77	0.91		
HB (gn. 100ml)	B. equi Negatives (BN)	13	10.80	1.24	0.34	0.29...	0.0001
	vs B. equi Positives (BP)	27	5.93	1.67	0.32		
RBC ($\times 10^6/\text{mm}^3$)	B. equi Negatives (BN)	13	7.44	2.42	0.67	5.22...	0.001
	vs B. equi Positives (BP)	27	4.51	1.25	0.24		
WBC ($\times 10^3/\text{mm}^3$)	B. equi Negatives (BN)	13	8.05	2.86	0.79	5.22...	0.0004
	vs B. equi Positives (BP)	27	4.51	1.25	0.24		

N = Total Horse Examined

X = Mean

S.D. = Standard Deviation

S.E. = Standard Error of Mean

..... = Highly Statistically Significant ($P < 0.0001$)

n = No. for each category of Argentinian horses

Table 4: Leukocyte Differential Counts in Argentinian Polo Horses with Acute Babesiosis

<i>Haematologic Parameters</i>	<i>Comparative Sources (horses Groups)</i>	<i>n</i>	<i>x</i>	<i>S.D.</i>	<i>S.E.</i>	<i>F-Values</i>	<i>ProbF</i>
S/Neuro.	B. equi Negative	13	58.54	±1.38	±2.05	7.63***	0.0001
%	vs B. equi Positive	27	39.89	±6.94	±1.33		
Lympho.	B. equi Negative	13	27.92	±8.14	±2.26	5.19***	0.0004
%	vs B. equi Positive	27	19.93	±3.57	±0.69		
Eosino.	B. equi Negative	13	1.15	±1.41	±0.39	1.69-	0.3445
%	vs B. equi Positive	27	1.41	±1.82	±0.35		
Mono.	B. equi Negative	13	2.61	±1.45	±0.40	1.22-	0.6428
%	vs B. equi Positive	27	1.59	±1.31	±0.25		
Baso.	B. equi Negative	13	0.23	±0.59	±0.16	2.74*	0.0306
%	vs B. equi Positive	27	0.15	±0.36	±0.07		

- N = Total No. of horses examined
 X = Means of haemic values
 S.D. = Standard Deviation
 S.E. = Standard Error
 ns = Not significant ($P > .05$).
 . = Statistically significant ($P < 0.05$)
 ... = Highly significant ($P < .0001$)
 n = No. in each category of horses.

NIGERIA'S POVERTY SITUATION

How much poverty one finds in Nigeria will depend on one's definition of poverty, especially since so much controversy surrounds the whole question as to what constitutes poverty. So, I must precede my assessment of the poverty situation in Nigeria with some conceptual clarifications.

Poverty Concepts

The most widely used approach for defining poverty and for identifying the poor is the poverty-line approach. By this approach, a certain level of income is identified as the minimum income, which an individual or an ordinary household

in the given society requires, daily or monthly, for their most basic or most essential needs. Anyone in the given society, whose income falls below that minimum, is then identified below the poverty-line.

For example, the World Development Report 2000/2001 gives the percentage of the population falling below the US\$1.0/day poverty-line as 18.5 as at 1998, for China, and 70.2 for Nigeria.

Indeed, the poverty-line approach makes a lot of sense. For example:

- (i) It is true that poverty is, primarily, economic even though its manifestations are, essentially, cultural, since they refer to the totality of the living conditions and life-style of the poor.
- (ii) The poor in any society are differentiated from the non-poor by their economic disabilities and by living conditions and life-styles, which are largely determined by those disabilities.
- (iii) Thus, income-poverty is central to the whole poverty experience at individual and household levels and the poverty-line could, therefore, be a useful predictor of many of the cultural, life-style and attitudinal attributes commonly associated with poverty.

Having said that, however, I must qualify this endorsement of the poverty-line methodology in three ways, namely:

- i. The notorious problem of income measurement in Nigeria poses a serious limitation to the suitability and application of the approach in this setting and justifies serious reservations concerning summary evaluations based on it.
- ii. In view of the limitations of personal/household income data obtainable in most developing countries, including Nigeria, it is hazardous to rely on such data alone in assessing the poverty situation in such countries.

(Indeed, in such countries, the poverty-line approach must always be used in combination with a more independent observation and assessment of certain concrete aspects of the actual living conditions and life-style of the populations. For example, housing conditions and environment; child-rearing practices and capacities (nutrition, clothing, education); morbidity patterns; healthcare culture and health-seeking behaviour; economic adjustment behaviour, spiritual life.

- iii. Indeed, the prevalence of poverty in a society can be established through a careful assessment of the actual living conditions of the people, whether or not such an assessment ends up in any single index of poverty.

(This is to say that neither an assessment based on the poverty-line methodology nor the construction of a sophisticated single index of poverty is a necessary condition for tackling the poverty problem).

There is one conceptual issue on which I must comment in order to complete this clarification. The issue concerns relativist notions of poverty, notions, which

suggest that poverty is a relative thing. Let me quickly consider four examples of the relativist notion:

(i) Poverty as Inequality

According to this notion, poverty simply means that some people have less resources than others, which is natural (all fingers are not equal).

Of course, poverty refers too much more than inequality; it refers to a life-situation characterized by want, frustration, human suffering and disgrace.

Poverty must be seen as a social problem in its own right, even if inequality is one of its major causes.

(ii) Poverty as a function of prevailing standard of living

According to this notion, persons defined as poor in one society may have a standard of living, which would place them among the non-poor in some other less affluent society.

This is very true. But it only means that one must be careful in making international or even inter-temporal comparisons. It does not mean that the poor in the more affluent society are not poor, since the relevant reference point and yardstick in their case is the higher standard of living prevailing in their own country.

(iii) Poverty as an elastic concept

According to this notion, 'the poor', as identified in most cases are not homogeneous categories, in terms of their levels of poverty.

This observation is true but even those who are less poor among the poor are poor, nevertheless, as long as their life-situation and living conditions manifest the income problem and other disabilities associated with poverty. But then, it should be possible to differentiate meaningfully, between 'the poor' and 'the very poor' or the desperately poor, so that the latter can receive more urgent attention than the former, especially, relief measures.

(iv) Poverty as subjective feeling

According to this notion, a person is only as poor as he/she feels; that is, poverty is all in the mind.

This is, perhaps, the most pernicious of relativist notions, especially when one considers its possible implications for policy: that we can 'solve' the poverty problem by doing everything to make the poor 'feel' and 'believe' that they are not poor; by conditioning their mind to see the objective state of poverty in which they live as something else.

Thus, we find that these relativist notions are, in general, plausible, at least in the sense that they do not assert anything that is false. However, we also find that they add little, if anything at all, to our understanding of the poverty phenomenon.

Unfortunately, relativist motions also have a tendency to trivialise poverty and divert attention away from the concrete social problem that poverty is,;

indeed to encourage the illusion that poverty is something that is neither here nor there, and not a definite problem to which society must find a solution.

How much Poverty

From whichever angle one views the situation, one finds that there is a lot of poverty in Nigeria and that Nigeria's poverty problem is quite serious. I will illustrate the point with respect to the following four (4) aspects of the poverty situation:

- i. Aggregate national poverty;
- ii. Income-poverty at household/individual level;
- iii. Poverty-driven social problems (The social costs of poverty).

Aggregate National Poverty

We need not belabour the point that Nigeria is now one of the poorest nations on earth, when poverty is measured in terms of Gross National Product (GNP), per capita. According to the World Development Report 2000/2001, Nigeria's GNP/Capita (1999) was US\$310.00, which put the country in the 179th position among the 206 countries surveyed and ranked in the exercise.

What this depressing per-capita-income statistic (US\$310/year) means is that the average Nigerian had an income of much less than one US dollar per day during 1999. But the situation on the ground was much worse than that, since most Nigerians in fact had incomes that were below the average, and this shows that we must pay even more attention to the prevailing structure of income distribution.

On that point, Nigeria also had a bad reputation, since most of the nation's income (and wealth) is, in fact, in the hands of the privilege few. In that pernicious group of the few who practically own the rest of us are a few successful entrepreneurs in productive, manufacturing, construction, commercial and service activities, a large number of retired military officers, many serving military officers, some retired and some serving police officers, many retired and many incumbent top bureaucrats (permanent secretaries, directors-general, directors, etc), both the retired and the incumbent board members and top executives of the oil companies, the major companies in the private sector, professional politicians, the various categories of 'contractors' whose "business" activities, oil and drive the wheels of corruption at all levels of public administration, etc.

The activities, insensitive greed and callousness of all these people have created the structure of wealth-distribution and income-distribution which now exists in Nigeria and which is not only inegalitarian but also inequitable, even by capitalist standards. Of course, such activities and their cumulative outcome have also been facilitated by a macro-policy environment in which the control of inequalities in interpersonal incomes was not considered an important objective.

Writing in 1981, Diejomaoh and Anusionwu noted: "... a very substantial increase in personal income inequalities in the Nigerian economy from 1960-

1979, and currently the levels of inequalities are quite high by the standard of developing countries and about twice the level in developed countries”.

As one would expect, given the continuous insensitivity of government in Nigeria to the inequality problem, the situation has remained quite bad. The Gini Index (of income concentration) in Nigeria (as at 1996/97) has been estimated at 50.6. In comparison, the Gini Index for Ghana (1997) was 32.7 for Cote d'Ivoire (1995) was 36.7, for the United States of America (1997) was 40.8, for France (1995) was 32.7 and for each of Belgium (1992), Denmark (1992), Japan (1993), Norway (1995) and Sweden (1992), about 25.0.

In terms of how much of the national income is concentrated in the hands of the top 10 per cent of the population, the situation is roughly as follows: Nigeria, 1997, 40.8%; Ghana, 1997, 26.1%; Cote d'Ivoire, 1995, 28.8%; United States of America, 1997 30.5; France, 1995 25.1%; Belgium, 1992, 20.2%; Denmark, 1992 20.5%; Japan, 1993 21.7%; Norway, 1995, 21.8%; and Sweden, 1992, 20.1%. (Source: World Development Report 2000/2001.)

Nigeria's Poverty Statistics

The statistics on poverty in Nigeria is appalling. Poverty has been on the increasing trend. The standard of living and the quality of life of most Nigerians today are worse than they were at Independence. In particular, the last 15 years has witnessed a steady decline in living standard. Nigeria remains the only low-income country in OPEC. The standard of living in Nigeria is lower than the average for low-income countries and slightly higher for the sub-Sahara Africa. Today, Over 72 per cent survive on less than US\$2.00 per day. US\$1

Alongside the deep poverty is the problem of income inequality. About 10 per cent of the population controls over 40 per cent of nation's income. These grim statistics imply that only the upper 10 per cent of the population live above poverty. The middle-class that is so critical to any country's development has disappeared. The incidence of poverty in the country falls hardest on farmers, the rural and old people, women, children, the informal sector operators, the disabled, the unemployed and under-employed. The worsening state of poverty in Nigeria is a threat to national security, political security as well as constraint to economic growth. Poverty has been linked with the increasing scourging of HIV/AIDS and social problems such as prostitution, child labour, diverse and religious intolerance. Poverty is a serious problem for both the poor and non-poor alike. The army of unemployed and poor youths in the country today is a threat to security of lives and property.

Although, the poverty problem predates the present civilian government, the fact is that little has been done to relieve Nigerians from the scourge of the problem. Situations in the country have degenerated to that level that people have not much room for choice. It is either they are waiting for the inevitable slow death through hunger or they take the risk of living for one more day by engaging in whatever criminal or risky activities they find.

The corruption, incompetence and unaccountability of past regimes, both civilians and military, have been the causal factors for poverty. The manner with which politicians flaunt their ill-gotten wealth is obscene. The amount of

stealing going on at all levels of government today and the huge allocation that political office holders award to themselves as salaries, allowances and perquisites of office given the extensiveness and depth of poverty in the land are, to say the least, provocative, a reflection of insensitivity to the massive poverty in the land and a threat to the democratic stability of the country.

Unless the poverty issue is effectively tackled, the groundswell of opposition and resentments that will develop would provide a breeding ground for the enemies of democracy. The cynicism and hopelessness that are creeping over the national polity and that are so evident in the faces of many Nigerians in recent times are an indictment of the current political process. Therefore, addressing the deep poverty and inequality in the land is the only guarantee for the sustenance of the present democratic experiment.

Therefore, taking a decisive step against the growth of poverty is the only way for democracy and development to thrive.

Refocusing Governments Poverty Alleviation Scheme

To solve the poverty question, a reorientation of government policies to focus on improving the welfare of the youth, the aged and the weak in the society, boost the supply of social and economic infrastructure and show a greater fiscal commitment to human capital development. First, the easy money culture, which penalizes those who are hardworking, should be discouraged. Second, political offices should not be seen as avenues for accumulation of wealth but for service to the nation. Poverty alleviation also requires effective partnership among major stakeholders, the government, the private sector, non-profit organization, international donors and the civil society.

Nationwide Agro-Livestock Pilot Farm Project

The Federal Government of Nigeria proposed 109 Pilot Farm Centres nationwide as part of government's Special Programme on Food Security (SPFS) and Poverty Alleviation. This is a right step in the right direction and a welcome development in the implementation of measures against Poverty.

The farm pilot projects are designed to be established by and supervised on behalf of the Federal Government by the Projects Coordinating Unit (PCU) of the Federal Ministry of Agriculture and Rural Development. This proposal as disclosed by the Ministry at the opening address of the 14th Annual Southwest Zonal Workshop on Research Extension Farmers Input Linkage System (REFILS) at the IAR&T, Ibadan on Tuesday February 20, 2001.

Military Rulership and Poverty Perpetration

The agony of the majority of the Nigerians is a direct indictment of the greed and cruelty of the ruling class. The rulers at the Federal, State and local government levels must strive earnestly to find urgent and enduring solutions to the general insecurity of life and property, hunger, homeless and unemployment. The governed should also imbibe the spirit of industry, forgiveness, cooperation and magnanimity. Nigerians in academics and research institutes should in particular

design programmes that will effectively eradicate the menace of poverty and food insecurity in all its ramifications.

Poverty Alleviation with Prayer and Determination

Furthermore, giving lip service to poverty eradication will not solve the problem. It demands reaching a state of mind where you believe that poverty is not, yours and you are able to act and feel like that in your day to day activities. You must know that **Allah is God of Abundance**. He has plenty to give and if He gives you abundantly, this does not reduce His bounteous blessing at all. He said in the Holy Quran:

"To him belong the keys of the heavens and the earth. He enlarges the provision for whomsoever He pleases and straitens it for whomsoever He pleases. Surely He knows all things fully well." Quran 42 vs 12.

With the proper knowledge and spiritual prayer you will ask God and you shall surely receive abundantly. Pray over your problems, throw it in the hands of God and believe you shall receive. God said:

"... I answer the prayer of supplicant when he prays to Me..."
Quran 2 vs 186

Have a clear focus on life attainment and make honest demand for riches: Never believe that hardwork alone can bring riches. It is not true. Riches come in response to definite demands and not by chance or luck. You must know what you want in life and work towards that goal. Be honest in your business, profession, trade or vocation and believe that you will surely succeed. Then you will make it at last.

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COMPOSITIONAL CHARACTER: VERITABLE TOOL IN THE APPRAISAL OF GEOMATERIALS

A. A. Elueze
Department of Geology

Introduction

Description and Constitution of Geomaterials

For effective commencement of this scientific expedition from the obvious to the normally unseen, it is appropriate to appreciate that **geomaterials** are naturally occurring substances or matter of the earth, and essentially include rocks, and their derivatives, notably regoliths and sediments. The geological cycle (Fig. 1) provides a schematic illustration of the paths of transformation of these materials. Specifically, rocks which are products of magmatism, sedimentation and metamorphism, are invariably converted into regoliths and sediments by superficial processes.

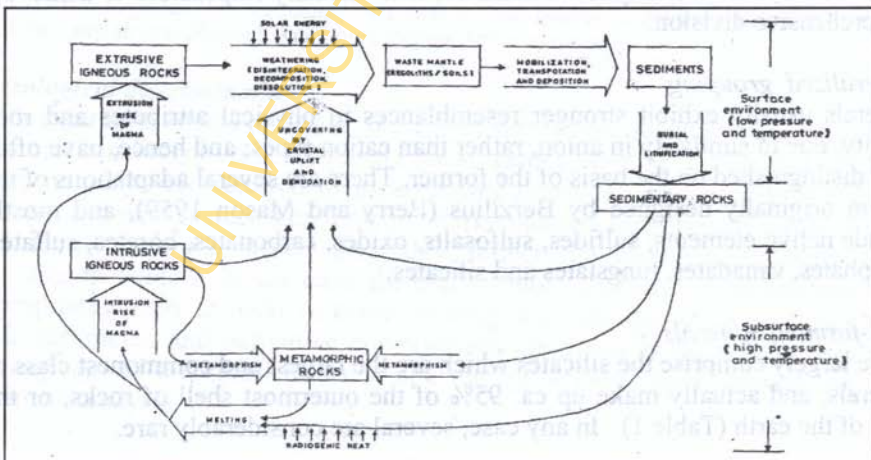


Fig. 1: The geological cycle – transformation paths of geomaterials (modified after Strahler, 1981)

A **rock** is commonly regarded as an aggregate of one or more minerals. The texture is invariably determined by the variations in size, shape, habit and aggregation nature of the constituent grains or crystals. Regoliths and sediments are generally composed of loose grains of minerals and rock fragments. On the other hand, a **mineral** is mostly considered to be a naturally existing substance, usually inorganic, and with a definite chemical constitution and an ordered atomic arrangement.

Consequently, the compositional attributes of geomaterials are normally defined from the mineralogical or geological (the obvious) and the elemental or chemical (the usually unseen) perspectives. In essence, mineralogical and chemical compositions are inherent qualities of any substance.

Compositional Indices and Variations In Geomaterials Characterization and Distinction Of Minerals

Features of minerals

Firstly, it is pertinent to remark that there is hardly any precise definition of a mineral, which is generally acceptable. For instance, there are disagreements on the form of occurrence, since some also rate natural fluids like water and hydrocarbons as minerals. Besides, from the genetic viewpoint, several minerals have synthesized equivalents, while some, particularly the fossil fuels are essentially of organic origin. Again, minerals generally lack fixed chemical compositions, arising from differences in the extent of substitution. However, the variations are commonly within definite limits. On the other hand, due to environmental factors, they seldom assume regular crystal forms, to reflect their ordered atomic arrangements.

Classification of minerals

Several schemes have been proposed for the separation of minerals. Over 2,500 species have been described and identified, especially through recent advances in mineral analytical techniques. Therefore, it is virtually impossible to achieve a comprehensive division.

Generalized grouping

Minerals usually exhibit stronger resemblances in physical attributes and rock affinity, due to similarity in anion, rather than cation types; and hence, have often been distinguished on the basis of the former. There are several adaptations of the system originally designed by Berzilius (Berry and Mason 1959), and mostly include native elements, sulfides, sulfosalts, oxides, carbonates, borates, sulfates, phosphates, vanadates, tungstates and silicates.

Rock-forming minerals

These largely comprise the silicates which are the largest and commonest class of minerals, and actually make up ca. 95% of the outermost shell of rocks, or the crust of the earth (Table 1). In any case, several are considerably rare.

Table 1: Common Rock-forming Minerals (Silicates)

Name	Chemical formula	Crystal system
Silica Group*		
Quartz varieties	SiO ₂	Trigonal
Feldspar Group*		
Orthoclase	K AlSi ₃ O ₈	Monoclinic
Albite	Na Al Si ₃ O ₈	Triclinic
Anorthite	Ca Al ₂ Si ₂ O ₈	Triclinic
Feldspathoid Group*		
Leucite	K Al Si ₂ O ₆	Isometric
Nepheline	Na Al SiO ₄	Hexagonal
Mica Group		
Muscovite*	K Al ₂ (Al Si ₃ O ₁₀) (OH) ₂	Monoclinic
Lepidolite *	KLi ₂ Al Si ₄ O ₁₀ (OH) ₂	Monoclinic
Biotite**	K (Mg, Fe) ₃ (AlSi ₃ O ₁₀)(OH) ₂	Monoclinic
Amphibole Group**		
Anthophyllite series	(Mg, Fe) ₇ Si ₈ O ₂₂ (OH) ₂	Orthorhombic
Tremolite-Actinolite series	(Ca ₂) (Mg, Fe) ₅ Si ₈ O ₂₂ (OH) ₂	Monoclinic
Hornblende series	NaCa ₂ (Mg, Fe, Al) ₅ (Si, Al) ₈ O ₂₂ (OH) ₂	Monoclinic
Pyroxene Group**		
Enstatite-Hypersthene series	(Mg, Fe) SiO ₃	Orthorhombic
Diopside-Hedenbergite series	Ca (Mg, Fe) Si ₂ O ₆	Monoclinic
Augite	Ca (Mg, Fe, Al) (Al, Si) ₂ O ₆	Monoclinic
Olivine series**	(Mg, Fe) ₂ SiO ₄	Orthorhombic

*Felsic - rich in silicon (Si), aluminium (Al), sodium (Na), potassium (K) and calcium (Ca)

**Mafic - rich in iron (Fe) and magnesium (Mg) or ferromagnesian

Petrological discrimination

With regards to rocks, minerals present in substantial quantities, are classed as essential constituents, and are mostly the silicates (Table 1). Those that occur in small amounts, are referred to as accessory minerals, and are mainly oxides, sulfides and phosphates. The light and dark-coloured are generally termed felsic and mafic minerals, which invariably reflect the chemical distinctions as specified in Table 1. In any case, the qualifications leucocratic and melanocratic appropriately refer to rocks of corresponding tone, and hence mineralogy. For a rock, the modal and normative compositions are given as the weight percents, respectively of the actual minerals and the hypothetical ones derived from its chemical analysis.

Economic categorization

The grouping of minerals has similarly been based on the modes of utilization; for example, as outlined in Table 2. An ore mineral is that from which one or

more valuable metals can be profitably extracted. Gangues are usually the waste constituents found with ore minerals in deposits. Industrial or non-metallic minerals are those consumed as raw materials in construction, processing and production. They have different functional uses, notably as abrasives, absorbents, aggregates, ceramics, chemicals, cosmetics, fertilizers, fillers, filters, fluxes, gems, insulators, lubricants, refractories and stones. Ore and industrial minerals are collectively termed economic minerals. Energy resources include substances which are utilized as fuels or harnessed to generate power.

Table 2: Economic classification of minerals

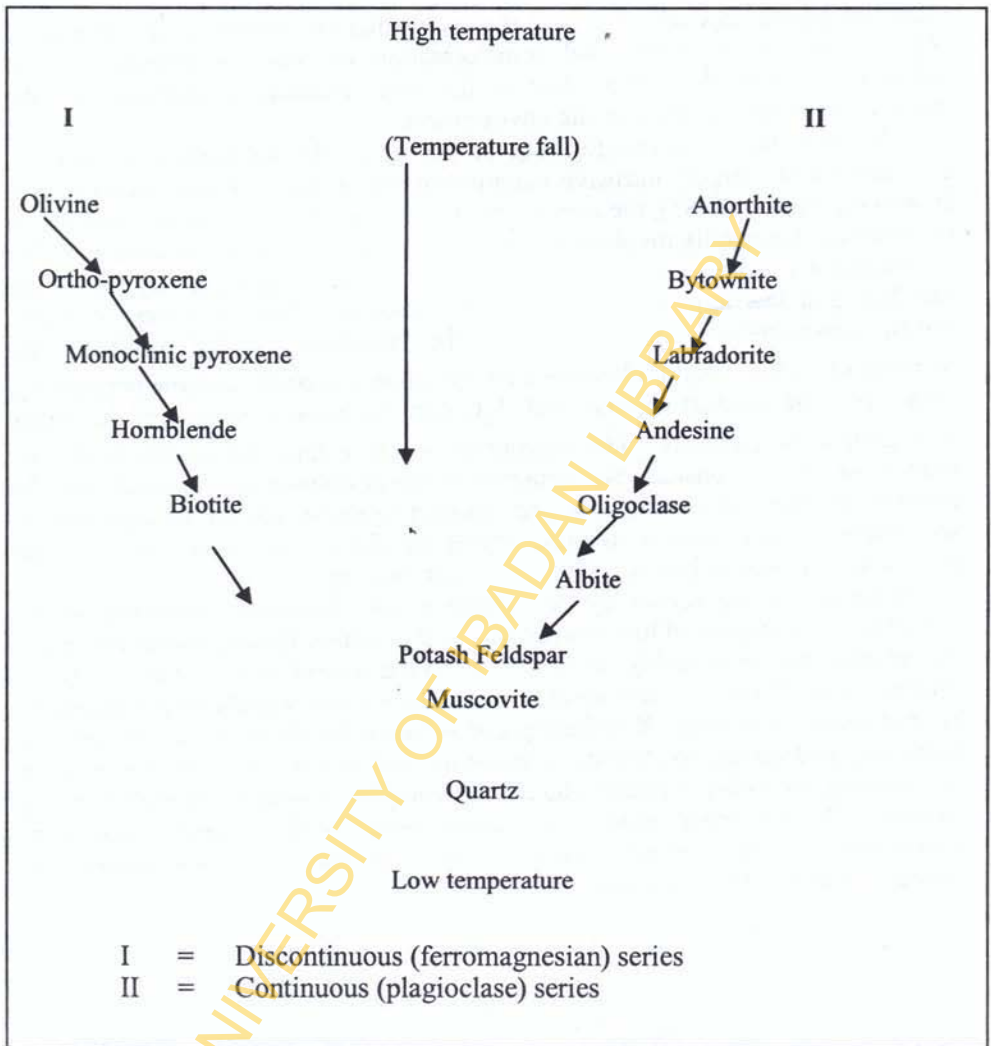
	Class	Uses	Mineral composition
1.	Ore Minerals		
	Precious metals	Ornamental, Iron and steel alloy	Gold (Au), Silver (Ag) Platinum (Pt)
	Non-ferrous	Ore of copper, ornamental Ore of copper, ornamental Ore of lead, accumulator Ore of zinc, galvanizing Ore of tin, canning, steel Ore of manganese, steel Ore of nickel, steel alloy Ore of titanium, steel alloy	Cuprite (Cu_2O) Chalcopyrite (CuFeS_2) Galena (PbS) Sphalerite (ZnS) Cassiterite (SnO_2) Pyrolusite (MnO_2) Pentlandite (NiS) Rutile (TiO_2)
	Ferrous	Iron and steel Iron and steel Iron and steel Iron and steel	Magnetite (Fe_3O_4) Haematite (Fe_2O_3) Goethite ($\text{Fe}_2\text{O}_3, \text{H}_2\text{O}$) Siderite (FeCO_2)
2.	Industrial minerals		
		Electronics Chemicals Chemicals Insulators Refractories Gemstones Abrasives	Mica, selenite, silica (SiO_2) Phosphorite, barytes Flourspar (CaF_2) Asbestos, magnesite Sillimanite, graphite Diamond, garnets, beryls Silica sands
3.	Energy Resources		
		Nuclear/radioactive Minerals Fossil fuels	Uraninite (UO_2) Thorite (Th SiO_4) Thorianite ($\text{ThO}_2 \text{ U}_3\text{O}_8$) Coal, petroleum and natural gas

Formation of Minerals

From the geological cycle (Fig.1), it is obvious that minerals originate during the activities of the evolution and transformation of rocks. Consequently, the formation of minerals is dependent on the bulk chemical composition and the physical conditions of the specific environment.

The two major mineral-forming processes of the subsurface or primary environment are largely intrusive magmatism and metamorphism. According to Bowen (Krauskopf 1985), the crystallization of minerals from magma with fall in temperature, essentially involves two main paths of reaction, as depicted in Table 3. Magma is a molten mass usually composed mainly of O, Si, Al, K, Na, Ca, Fe and Mg, and low amounts of most other elements. Also, it always contains fluids, substantially H_2O and CO_2 . The reactions usually result in the partitioning of these major elements into the mineral crystals, and the preferential retention in the residual volatile- and H_2O -rich fractions, of several of the minor or incompatible elements. Metamorphism largely entails the transformation of solid rocks, due to considerable variations in the physico-chemical conditions. In essence, the mineral assemblages are changed to those that are in equilibrium, and likewise may assume textural styles or fabrics as determined by the prevailing interplay of heat, pressure and fluids activity.

Processes in the secondary environment, are commonly characterized by atmospheric conditions of low temperature and pressure. Hence, primary silicates are unstable, and presumably decay at rates in the reserve orders of the Bowen's reaction series (Table 3). Inter-element relations are also significantly influenced by environmental setting. Weathering and sedimentary reactions mostly involve hydration, hydrolysis, oxidation, carbonation and dissolution. However, their mechanisms are rather intricate, due to the complex structures of rock-forming minerals. On the other hand, some constituents such as oxides and low-temperature silicates virtually withstand decomposition, and are retained as resistates in the residues and soils.

Table 3: The Bowen's Reaction Series

Nature and Classification of Elements

Elements are the ultimate constituents of minerals, as they are substances which normally cannot be split into simple or smaller components. However, the periodic table which is essentially a structural categorization of the about 100 known ones, cannot fully account for their behaviours, due to the complexities of geological environments. Consequently, the geochemical discrimination of elements based on parameters that are also related to their natural distribution, have been found more tenable in investigating geomaterials.

Abundance character of elements

In terms of the natural occurrences, elements can be said to have preferences for different minerals, some of which are relatively rare, but are sometimes concentrated in deposits. The most abundant elements are ultimately the main components of magmas and the common silicate minerals (Table 1). Besides, some less common metals like Cr, Ni, V, Ti and Mn are often found as substitutes for related elements in the silicates.

Consequently, from mean concentrations in crustal rocks, elements may be distinguished as major (%), minor ($1/10\%$), trace (ppm) and rare (ppb).

Geochemical classification of elements

On the basis of geochemical associations or affinities, elements can be grouped as shown in Table 4. Similarly, they may be broadly separated into petrogenic and metallogenic classes. The former largely tallies with the lithophile group (Table 4), which constitute the bulk of rock-forming minerals, and are again the major elements and their common substitutes. Metallogenic elements like Cu, Pb and Zn are those found in ore minerals, particularly sulfides and sulfosalts, in which they commonly make-up relatively high percentages, and are readily extractable. These are invariably the chalcophile members (Table 4).

Table 4: Goldschmidt's 1954 Geochemical Classification of the Elements

Siderophile	Chalcophile	Lithophile	Atmophile
Fe Co Ni	Cu Ag (Au)*	Li Na K Rb Cs	H N (C) (O)
Ru Rh Pd	Zn Cd Hg	Be Mg Ca Sr Ba	(F) (Cl) (Br) (I)
Re Os Ir Pt Au	Ga In Tl	B Al Sc Y REE++	Inert gases
Mo Ge Sn C P	(Ge) (Sn) Pb	(C) Si Ti Zr Hf Th	
(Pb) (As) (W)	As Sb Bi	(P)V NbTa	
	S Se Te	O Cr W U	
	(Fe) (Mo) (Re)	(Fe) Mn	
		F Cl Br I	
		(H) (T) (Ga) (Ge) (N)	

Source: Krauskopf, 1985

+ Parentheses around a symbol indicate that the element belongs primarily in another group, but has some characteristics that relate it to this group. For example, gold is dominantly siderophile, but (Au) appears in the chalcophile group because gold is often found in sulfide veins.

++ REE = rare-earth elements.

Development and Experience in the Compositional Disciplines

Historical Perspectives

Understanding the nature and distribution of geomaterials significantly demonstrates the intimate linkage between geology and chemistry. The ranking

between these subjects, essentially corresponds to that of a mineral and an element, which may be comparable to that of a chicken and an egg. In any case, historical records largely indicate that the isolation and study of elements emanated substantially from attempts to exploit and understand the character of minerals and geomaterials. The earliest known techniques mostly involved smelting. Therefore, the practice of chemistry can be regarded to have commenced much later than geology, whose records actually date back to prehistory. For instance, one of the earliest documentation on minerals (Berry and Mason 1959) was by Theophrastus (ca. 372-282BC). Also, as shown in Table 5, elements were generally discovered much later in human history. Even the earliest known, namely gold, silver, copper, tin, lead, iron, mercury, antimony, carbon and sulfur are essentially those minerals in the native or elemental form. It is also remarkable that the first 6 metals are those mentioned in the Bible.

Similarly in Nigeria, projects on geomaterials are amongst the earliest indigenous trades (Elueze and Onuoha 1995). Perhaps, it would be interesting to know if there are native names for the following minerals and elements. The former are kaolinite, galena, halite, lignite and trona, while the latter comprise silicon, aluminum, lead, sodium and oxygen. The expected responses may be variable; however, there is seemingly no name in one's mother tongue for any of the elements, especially if oxygen is not confused for air or breeze. As for the minerals, the names "nzu", "otangele", "nnu", "ako" and "akanwu" could be applicable.

The practice of geology has likewise maintained invaluable relationships with some applied disciplines, including mining/mining engineering, petroleum engineering, metallurgy, mineral processing and materials science. These close professional connections were clearly recognized by the pioneer Nigerian earth scientists, with the founding of the Nigerian Mining, Geological and Metallurgical Society in 1961, currently the Nigerian Mining and Geosciences Society (NMGS).

Introductory Exposure

The study of chemistry commenced at the secondary level, in St Pius Grammar School (SPGS), Onitsha-Ugbo, and was continued in the 2-years advanced level (A/L) course of the part-time programme in Methodist Boys' High School, Lagos. The absolute drive and visionary stance of the Principal, Chief J.I. Izah (B.A., London), a pre-eminent 1950 alumnus of the University of Ibadan, and the exceptional dedication of other staff members ensured that the SPGS training, notably in the sciences, was excellent.

It is particularly noteworthy that in inorganic chemistry, even at the A/L course, mentions were made of the substances from which metallic elements can be obtained. However, the fact that these are minerals, and constituents of rocks, some of which occur in Nigeria, was then virtually unimportant.

Training and Skill Acquisition

With the A/L qualification in mathematics, physics and chemistry, the admission in 1971, was into the 3-year degree programme of the Department of Geology, University of Ibadan. In the first year, all the 3 one-series 100-level courses of inorganic, organic and physical chemistry were taken. Of the 3 corresponding 200-level courses, those in inorganic and physical chemistry, were offered in the second year.

As regards geology, the first year was expectedly the initiation to the subject, and the 3 years afforded the progressive exposure to the theoretical and practical aspects of relevant courses. It was quite challenging to study the unique suite comprising charnockites, syenites and pegmatites around Osunredo, as the final year research project. Besides, the recognition (with A.A. Akinyemi, one's project partner) of the unusual rock composed dominantly of intergrown quartz and tourmaline crystals, was equally symbolic, though was then classified as tourmalized quartzite (Elueze, 1974).

Research Activities

In terms of scholarship, the Department under the dynamic headship of Professor M.O. Oyawoye, FAS, FNMGS, OON, had by 1975, when I returned as a postgraduate student, acquired a formidable complement of research facilities, support personnel and experts, and been internationally designated a centre of academic excellence. It enjoyed linkage relationships with institutions in Holland, France, Germany, the United Kingdom, British Columbia, Japan, the USA and several African countries. The Department had also designed major research projects, especially in the exploration and evaluation of mineral occurrences of national significance, and particularly under the supervision of Professor M.A. Olade, FNMGS, an exceedingly versatile scholar and motivator.

My initial work entailed stream sediments geochemical survey, and studies of the compositional and genetic characteristics of the rocks, in relation to elucidating the nature and distribution of the Ilesha gold mineralization. Having highlighted the intriguing geodynamic significance of the association of mafic, ultramafic and metasedimentary rocks in the Ilesha area or schist belt, research interest was subsequently extended to other similar belts. Further, the recognition of various compositional trends with economic implications, afforded the expansion in work extent and locations.

Apart from the facilities in Ibadan, opportunities were afforded through different awards, notably by the German Academic Exchange Service (DAAD), Bonn, the Federal Ministry of Science and Technology and the UNESCO, for the execution of specialized research studies, particularly in the Universities of Munich and Braunschweig, Germany and the Ecole des Mines, Paris, France. Sample analyses were likewise undertaken in other institutions in Nigeria and abroad, especially by my research students.

Applications and Implications of Compositional Data

Concepts, Objectives and Scope of Work

The fundamental essence of any geological research is the provision of data and/or information that contribute to elucidating the nature and value of geomaterials, and hence understanding the evolution of the earth. In similar light, the focus of one's research is basically the utilization of compositional characterization as means of achieving this ultimate goal.

Efforts have largely been directed into ascertaining the petrogenetic and geotectonic nature of basement rocks, exploration and evaluation of mineral resources and assessment of water quality and environmental dispersion patterns. Compositional data and indices have likewise been applied extensively in geochronology, geotechnical site investigations, medical and health surveys, geobotanical and geobiological indexing, agrogeological/agronomical characterization and petroleum exploration and production.

Table 5: Abundances and discovery years of some common elements

Elements	Symbol	Crustal abundance (ppm)	Discovery year
Aluminium	Al	81000	1825
Antimony	Sb	1	BC
Arsenic	As	5	1649
Barium	Ba	250	1808
Beryllium	Be	6	1797
Boron	B	3	1808
Cadmium	Cd	0.15	1817
Calcium	Ca	36300	1808
Carbon	C	320	BC
Chlorine	Cl	314	1774
Cobalt	Co	23	1742
Copper	Cu	70	BC
Fluorine	F	900	1771
Gallium	Ga	15	1875
Gold	Au	0.005	BC
Hydrogen	H	1300	1765
Iron	Fe	50000	BC
Lead	Pb	16	BC
Magnesium	Mg	20000	1755
Manganese	Mn	1000	1774
Mercury	Hg	0.5	BC
Molybdenum	Mo	15	1782
Nickel	Ni	80	1751
Nitrogen	N	46.3	1772
Oxygen	O	466000	1772
Phosphorus	P	1180	1669
Platinum	Pt	0.005	1735

Potassium	K	25900	1807
Rubidium	Rb	310	1861
Silicon	Si	277200	1823
Silver	Ag	0.10	BC
Sodium	Na	28300	1807
Strontium	Sr	300	1787
Sulphur	S	520	BC
Tin	Sn	40	BC
Titanium	Ti	4400	1791
Vanadium	V	150	1830
Zinc	Zn	132	<1400

Source: Dineley, *et al.* 1976.

The execution of each project was generally designed as to duly incorporate the main components of field geology involving mapping, examination and collection of representative samples, and laboratory activities which included appropriate analytical procedures and techniques.

Petrogenetic and Geotectonic Characterization of Basement Rocks

Outline geology of the precambrian basement complex of Nigeria

Igneous and metamorphic rocks essentially constitute the Precambrian basement complex of Nigeria (Fig. 2). Though the assemblages have been variedly classified, they may be broadly subdivided into the ancient gneiss-migmatite complex, the schist belts and the Pan-African (ca. 0.6 Ga) intrusive series or the Older Granites plus minor rocks.

Radiometric ages obtained from the ancient migmatitic gneisses, are notably between ca. 2.8 and 2.0 Ga (Rahaman, 1988). Older dates (≥ 3.0 Ga) have more recently been derived from some (Dada *et al.* 1998).

The schist belts occur prominently within the western half of the country (Fig. 3), though a few have more recently been highlighted in the central and southeastern parts (Elueze 2000).

They generally show distinctive petrological, structural and metallogenetic features, and are mostly regarded to be Proterozoic age (≥ 0.6 -2.5 Ga). Notwithstanding the lack of agreement on the geographic delimitation, geological nomenclature, geochronological characterization and geodynamic setting, the schist belts are composed dominantly of metasediments, particularly pelitic schists and quartzites. The secondary lithologies are often variedly distributed, and include banded iron formations, marble bodies, amphibolites and meta-ultramafites.

The Pan-African intrusive suite comprises mainly granites and granodiorites, with subordinate pegmatites and aplites. Minor, presumably affiliated rocks include charnockites, syenites and bauchites (Olarewaju, 1999), plus extrusive and hypabyssal bodies, notably dolerite dikes believed to belong to the terminal stage of the Pan-African event (ca. 0.45Ga). One of the greatest challenges in the study of this obviously intricate basement, has been to decipher and reconcile the modes of origin or petrogenetic affinities and petrotectonic settings of the different units.

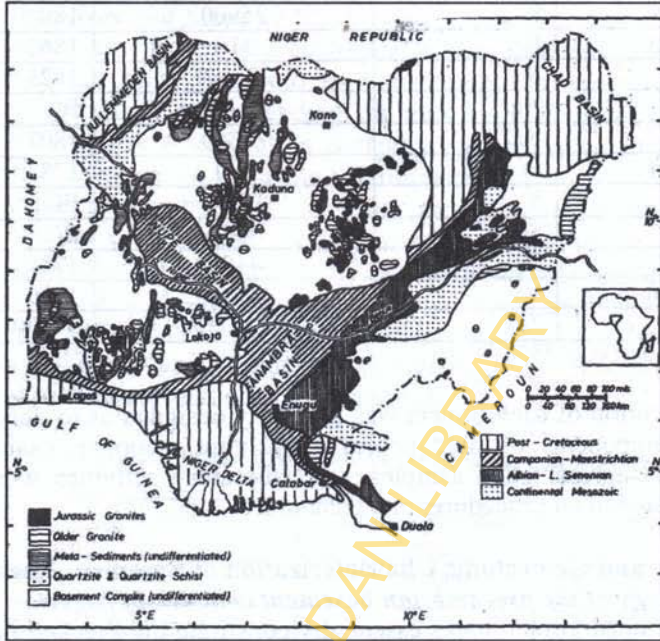


Fig. 2: Generalized geological map of Nigeria (Geological Survey of Nigeria, GSN).

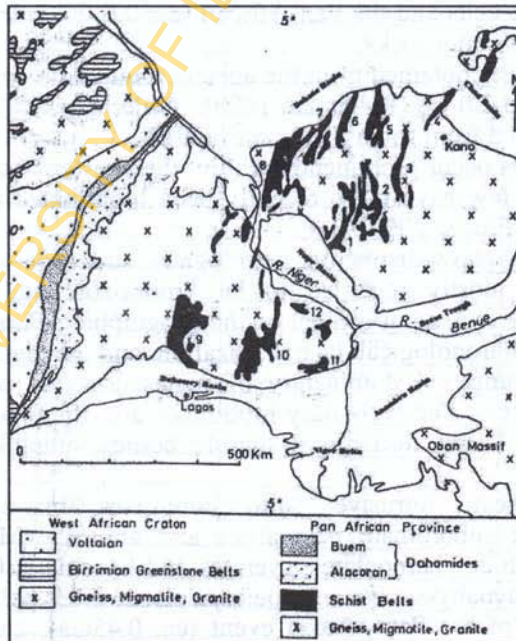


Fig. 3: Location of the schist belts in the Nigerian sector of the Pan-African Province (after Turner, 1983) (unsymboled – Phanerozoic depositional sites)

Petrochemistry in petrogenetic and geodynamic studies

As already implied, chemical results and indices provide the best clues to the nature of the precursors of rocks, especially basic/ultrabasic types such as amphibolites and meta-ultramafites, which are more restricted in compositions, compared to siliceous migmatitic, metasedimentary and granitic units. Besides, petrochemical variations when related to geological environments, are significantly dependable in ascertaining the regimes of crustal evolution (Elueze 1980; Shoji and Kaneda 1980).

Migmatitic gneisses

As shown by Elueze (1982a), rocks of the gneiss-migmatite complex largely display chemical variations indicative of having been derived from heterogeneous progenitors, which may have been partly volcanogenic. Some likewise exhibit traits believed to be signatures of the Pan-African remobilization (Oyawoye 1972), notably the enhancements in K_2O , Ba and Rb (Elueze 1982b).

The overall crustal character is further subtly portrayed in the innovative $CaO-P_2O_5$ plot (Fig. 4) and the Zr content (ca. 300ppm), which invariably correspond to the presence and significance of apatite and zircon, that are merely minor constituents. On the other hand, the tectonized or cataclastic varieties developed along fault zones, are substantially differentiated in petrographic and compositional properties. (Elueze 1982a).

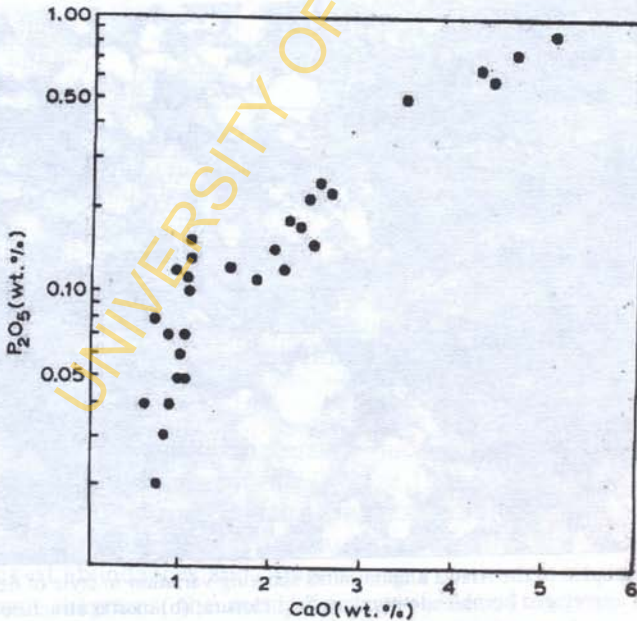


Fig. 4: $CaO - P_2O_5$ variation diagram for the Ilesha granite gneiss (Elueze, 1982b)

Amphibolites and meta-ultramafites

The amphibolites are also variable in textural and mineralogical characteristics (Fig. 5), while the meta-ultramafites are mostly various talc-bearing rocks (Elueze 1981c, 1982c). Some of the latter may be composed dominantly of any or more of other minerals, with insignificant talc abundance (Wright and Ogezi 1977; Elueze 1982c).

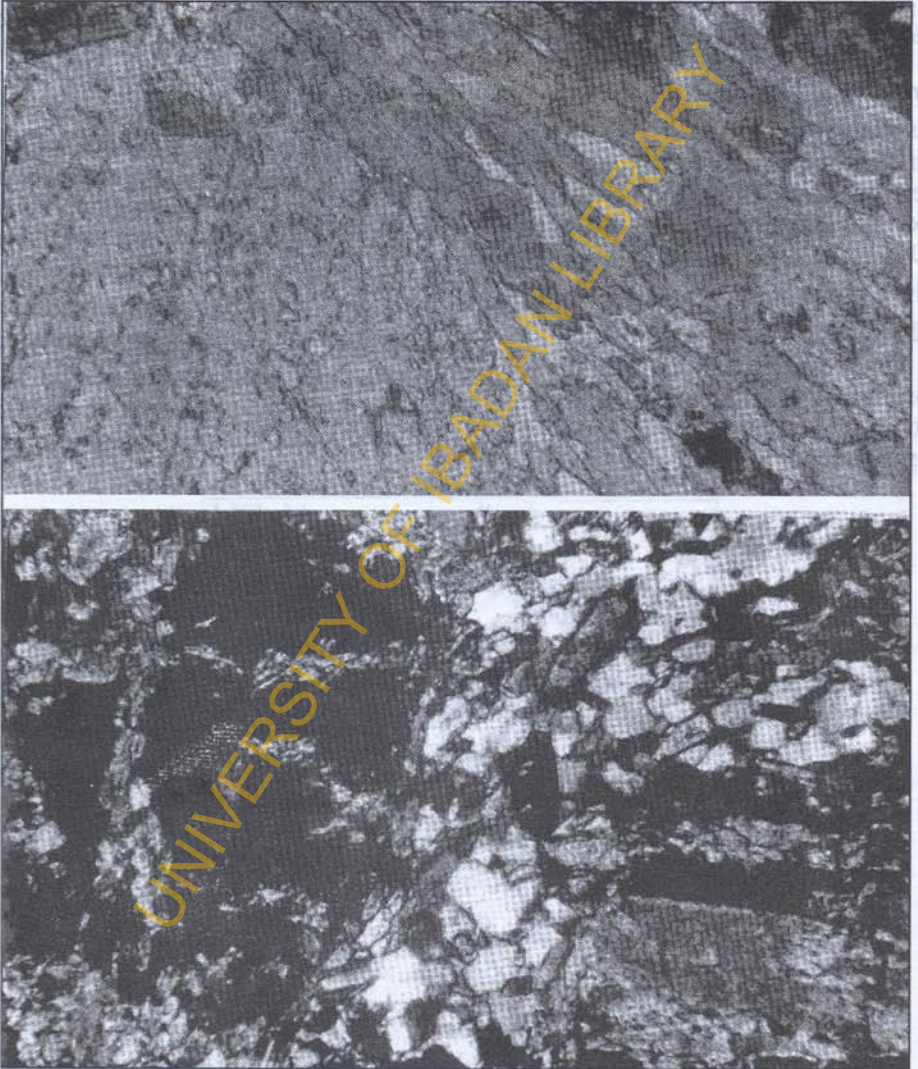


Fig. 5: Photomicrographs of the Alawa amphibolites showing variation in style of deformation (a) plicated fabric with aggregated hornblende in micro-fold closure; (b) mortar structure with abraded and fractured aggregates in granulated matrix)

Geochemical studies have shown that these rocks are commonly of igneous parentage (Elueze and Olade 1980). The amphibolites are largely derivatives of tholeiitic basalts, as particularly depicted on discriminant plots (e.g. Fig. 6), employing relatively immobile minor and trace elements Ti, Ga, Y and Ni (Elueze 1993a; Elueze and Okunlola 1998). However, the petrographic subgroups are distinctive in certain petrochemical indices and trends. These variations, especially in the cases of upgrading in K, Rb, and Ba values, presumably are imprints of crustal inputs, and tend to constrain the geotectonic setting, as being essentially intracontinental (Olade and Elueze 1979).

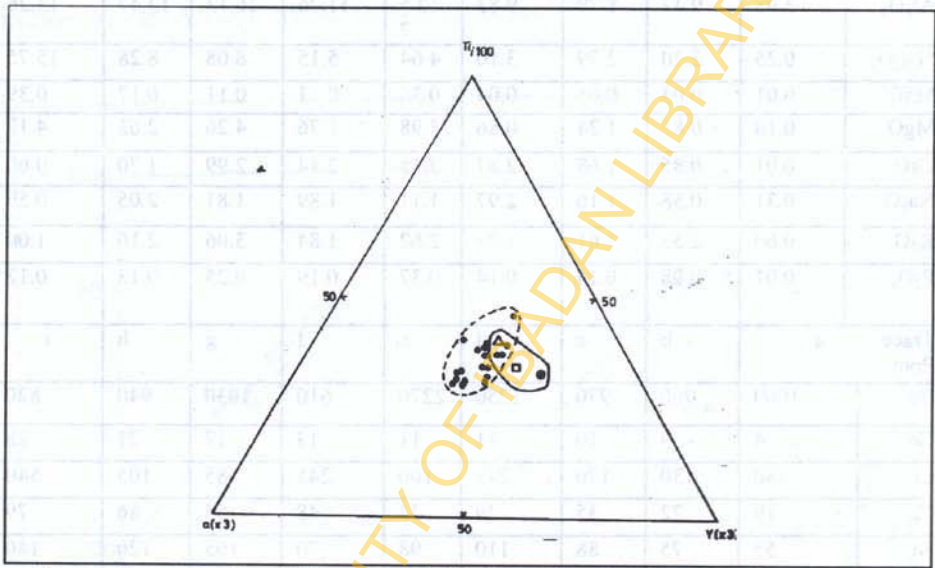


Fig 6: Characterization of Alawa amphibolites on a Tiv – Ga – Y ternary plot for basaltic suites (Elueze, 1985).

As for the meta-ultramafites, major and trace element abundances, and petrochemical patterns suggest they are mainly similar to ultramafic magmatic rocks (Elueze 1982c). Cr and Ni are substantially high, and the latter generally correlates positively with MgO content (Elueze 1982c).

Metasedimentary rocks

The pelitic schists or metapelites are mainly micaceous units, with essential and minor proportions of other constituents (Elueze 1981a; Rahaman 1988). Quartz is dominant in the quartzites which also pass into schistose varieties with increasing contents of aligned flakes of muscovite/sericite.

On the basis of abundances and ratios of major and trace elements (Table 6), and discriminant diagrams, the metapelites are believed to have been derived from protoliths of shale to greywacke affinity (Elueze 1981a; Elueze and Okunlola 2001a). As for the marbles, Elueze and Okunlola (2001a) have incorporated stable isotope geochemical indices, in constraining the geotectonic

setting of the Okene-Lokoja area as being rift-like, which amplifies the assertions on the schist belts (Elueze 1985; Okonkwo and Winchester 2000).

Table 6: Average contents of major and trace elements of meta-sedimentary rocks

Major %	a	B	c	D	e	f	g	h	i
SiO ₂	95.12	81.16	80.72	75.19	69.10	72.97	61.41	66.35	60.67
TiO ₂	0.09	0.36	0.58	0.51	0.77	0.81	0.94	1.15	1.84
Al ₂ O ₃	3.98	9.47	8.79	9.83	12.57	11.76	16.13	13.47	13.26
*Fe ₂ O ₃	0.25	2.20	2.79	3.10	4.64	5.15	8.08	8.28	15.75
MnO	0.01	0.03	0.05	0.04	0.36	0.11	0.11	0.17	0.39
MgO	0.10	0.85	1.24	0.86	3.98	1.76	4.26	2.63	4.17
CaO	0.01	0.85	1.68	2.87	3.55	2.44	2.99	1.70	0.60
Na ₂ O	0.31	0.58	1.16	2.97	1.11	1.89	1.81	2.05	0.59
K ₂ O	0.60	2.53	1.61	1.75	2.62	1.84	3.06	2.16	1.00
P ₂ O ₅	0.01	0.08	0.14	0.14	0.37	0.19	0.25	0.13	0.12
Trace Ppm	a	b	c	d	e	f	g	h	i
Ba	1060	960	970	1250	2270	610	1030	940	820
Co	4	9	10	11	11	13	17	21	28
Cr	180	130	170	245	100	245	185	105	540
Cu	19	22	35	29	33	48	55	86	79
Ni	55	75	88	110	98	70	105	120	140
Rb	35	78	67	96	145	105	99	120	42
Sr	29	82	160	105	205	160	195	90	37
V	5	25	38	35	100	65	145	195	250
Zn	5	26	27	4	5	39	43	29	7
Zr	390	340	420	245	210	235	150	185	115
K/Rb	137	259	192	146	144	140	247	170	190
Rb/Sr	1.21	0.95	0.42	0.91	0.71	0.66	0.51	1.22	1.14
Sr/Ba	0.03	0.09	0.16	0.08	0.09	0.26	0.19	0.10	0.05

- (a) Quartzites/quartz schists (4 samples)
 (b) Quartz-sericite schists (5 samples)
 (c) Quartz-muscovite (chorite) schists (8 samples)
 (d) Quartz-muscovite biotite-feldspar schists (3 samples)
 (e) Quartz-plagioclase-biotite-garnet schists (8 samples)
 (f) Quartz-plagioclase-biotite-garnet schists (5 samples)
 (g) Biotite-plagioclase-garnet schists (10 samples)
 (h) Biotite-garnet-staurolite schists (5 samples)
 (i) Mafic schists (5 samples)

* Total Fe as Fe₂O₃ Source Elueze, 1981a

Granites and pegmatites

Petrographic types of the intrusives include porphyritic, even-textured and muscovite-biotite or 2-mica granites (Elueze 1987, 1993b).

Petrochemical data and patterns generally indicate that the even-textured is considerably basic in nature, whereas the porphyritic bodies evolved from relatively less fractionated magmas, compared to the 2-mica variety which consolidated from water-rich melt, possibly of sedimentary affiliation. Pegmatites, such as the body adjacent to the 2-mica granite in Ilesha area (Elueze, 1987), developed from silica and volatile – richer fractions. In any case, the Rb-Sr diagram (Fig. 7) suggests that the rocks were emplaced within a fairly thickened Pan-African crustal setting (Elueze, 1987).

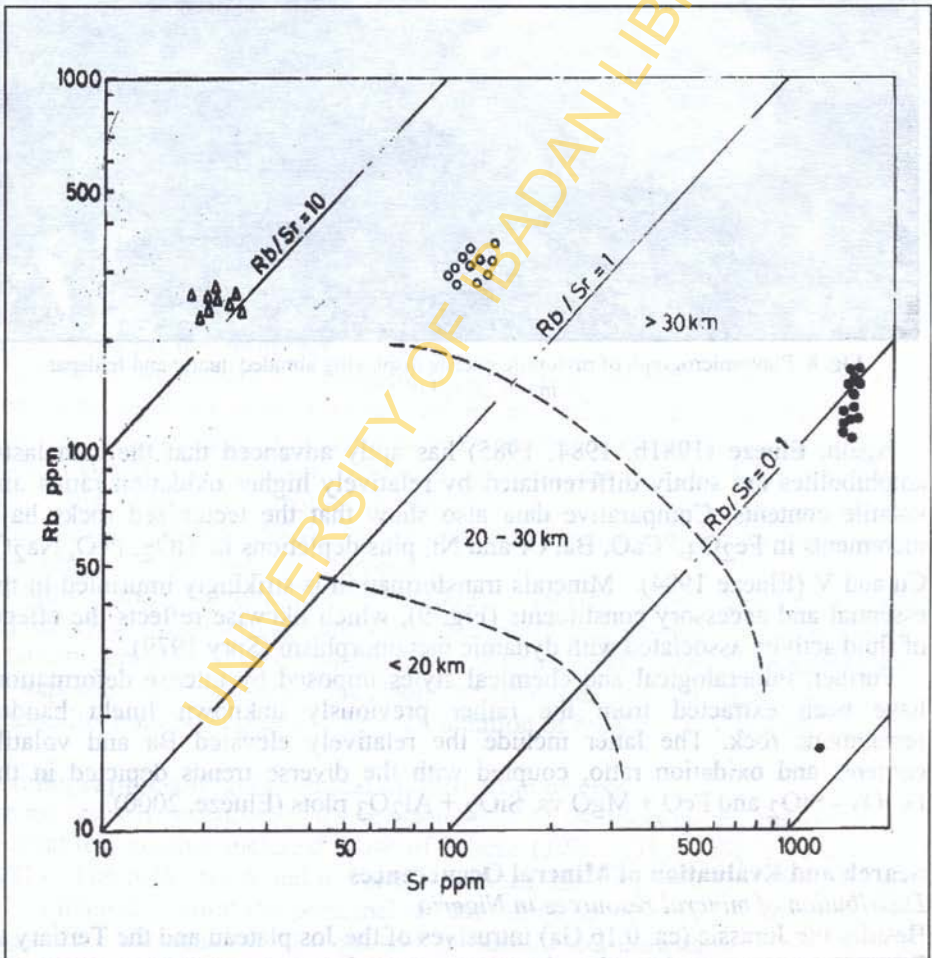


Fig. 7: Granite rocks in the Rb against Sr crustal thickness grid of Condie (1976).

Cataclasites and mylonites

The mylonitic and cataclastic gneisses notably exhibit distinctive deformational features and transposive fabrics (Fig. 8). Compared to the undeformed units, they are usually characterized by enrichments in TiO_2 , Fe_2O_3 , and considerable Ba and Zr contents (Elueze 1982a, 1982b).



Fig. 8: Photomicrograph of mylonitic gneiss displaying abraded quartz and feldspar in pulverized matrix.

Again, Elueze (1981b, 1984, 1985) has aptly advanced that the cataclastic amphibolites are subtly differentiated by relatively higher oxidation ratios and volatile contents. Comparative data also show that the tectonized rocks have increments in Fe_2O_3 , CaO , Ba, Cr and Ni, plus depletions in TiO_2 , FeO , Na_2O , Cu and V (Elueze 1984). Minerals transformation is strikingly imprinted in the essential and accessory constituents (Fig. 9), which likewise reflects the effects of fluid activity associated with dynamic metamorphism (Spry 1979).

Further, mineralogical and chemical styles imposed by intense deformation, have been extracted from the rather previously unknown Imelu banded ferruginous rock. The latter include the relatively elevated Ba and volatile contents and oxidation ratio, coupled with the diverse trends depicted in the $\text{Fe}_2\text{O}_3 - \text{SiO}_2$ and $\text{FeO} + \text{MgO}$ vs. $\text{SiO}_2 + \text{Al}_2\text{O}_3$ plots (Elueze, 2000).

Search and Evaluation of Mineral Occurrences

Distribution of mineral resources in Nigeria

Besides the Jurassic (ca. 0.16 Ga) intrusives of the Jos plateau and the Tertiary to Recent igneous rocks, the basement complex accommodates important Phanerozoic (<ca.0.4 Ga) sedimentary basins (Figs. 2 and 3). Therefore, the

geology of Nigeria is characterized by widely variable lithological and structural features, and hence several mineral occurrences (Elueze 1993c). The latter include ore minerals, industrial and energy resources and even water sources.



Fig. 9: Photomicrograph of polished section of the Tegina cataclastic amphibolite showing abraded amphibole lenticules, ore of white chalcopyrite rimmed by shells of oxidation products tapering along lamination.

Exploration for ore minerals

In search of ore minerals, dispersion patterns in geomaterials, have commonly been found workable tools (Hawkes and Webb 1962). Elueze and Olade (1985) have particularly applied the factor scores map for the element association P-Fe-As-Au extracted from stream sediments geochemical data, in defining a target area. This also on geological grounds, has the highest potentials for mineralization (Elueze 1986), and subsequently became a major location for the development of the Ilesha gold project.

Elueze and Kehinde-Phillips (1993a, 1993b) have further utilized mineralogical characteristics and chemical trends in assessing the ore prospects of lateritic profiles (cf Schellmann, 1989; Elueze, 1994). They have shown that the saprolite horizons over the Ibodi amphibolite and the Itan-Osan meta-ultramafite, hold good promise for accumulation of Ni, Co, Cr, V and Mn ores.

Metallographic and geochemical investigation of ores

The earliest investigation of the ore potentials of the metabasites and the meta-ultramafites, notably included those of Elueze (1980, 1981c, 1982d) and Bafor (1981). The rocks are found to contain sulfides, mostly pyrrhotite, chalcopyrite, and pentlandite; while the principal oxides comprise ilmenite, pyrophanite and magnetite. Chromite is also present in some meta-ultramafites. Though the mineralization is largely dispersed, the overall metallographic character is consistent with the petrogenetic affinity of the rocks (Elueze 1981c).

Iron ores are found within the Precambrian domain and some Phanerozoic sedimentary basins. Majority of the Precambrian ores bear magnetite and hematite in varying proportions and paragenetic relations (Elueze 1999). The iron (Fe_2O_3) concentrations or grades are considerably different (Table 7). In any case, the Kakun ore contains mainly magnetite, ferromagnesians and plagioclase (Elueze and Okolo 1990; Annor and Mucke 1991). Therefore, the high Fe_2O_3 (ca. 46%) does not connote an equivalent tenor (ore mineral content), considering the significance of Fe-rich silicates in the ore type. On the other hand, the enriched Agbaja ironstone (Table 7) is dominantly oolitic (Fig. 10), and mostly contain goethite, hematite, kaolinite and phosphates (Elueze 1999). However, the relatively elevated P_2O_5 concentration (ca. 2.4%) is deleterious in steel production, hence rather diminishes the commercial worth of this most extensive deposit in Nigeria. The principal P-phase has been identified as goyazite-crandallite (Abimbola *et al.* 1999).

Table 7: Average abundances (%) of major elements of some iron ore bodies

	Itakpe	Tajimi	Kakun	Agbaja
SiO_2	59.27	64.50	35.59	29.08
TiO_2	0.03	0.01	0.55	0.11
Al_2O_3	0.33	0.30	7.91	5.72
Fe_2O_3 (t)	39.20	34.77	45.76	62.63
MnO	0.02	0.01	0.10	0.03
MgO	0.04	0.02	2.11	0.19
CaO	0.29	0.05	7.51	0.05
Na_2O	0.02	0.03	0.34	0.01
K_2O	0.01	0.02	0.01	0.01
P_2O_5	0.38	0.15	0.42	2.38
C	0.03	0.02	0.03	0.19
S	0.07	0.07	0.10	0.07

Source: Elueze, 1999

Economic potentials of industrial minerals

The talc-bearing bodies mainly display physical attributes which largely reflect compositional characteristics, and are consumable in several industries, as appraised by Elueze and Akin-Ojo (1993). However, treatment of the samples is necessary, especially the elimination of Fe-rich constituents, to achieve the specifications for each application. The utility of blending and bleaching has also been recommended for the processing of some (Elueze and Ogunniyi 1985; Elueze and Awonaiya 1989). In addition, Elueze and Dosumu (1987) have shown that the magnesite-rich variety, with beneficiation, can yield adequate raw materials for making refractory and sored cement.

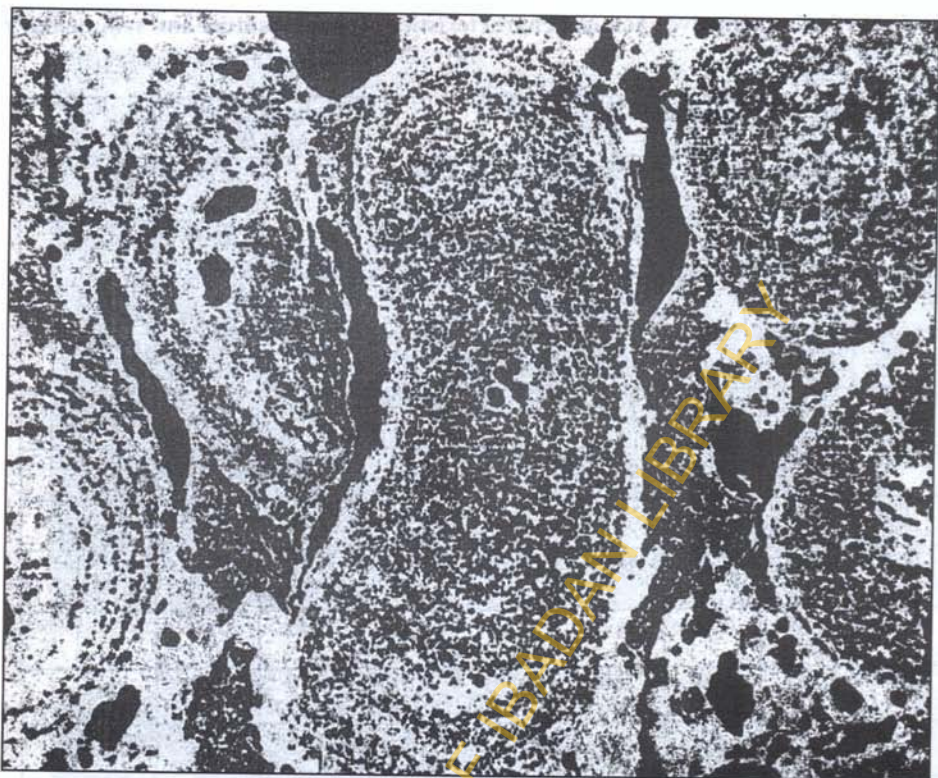


Fig. 10: Photomicrography of Agbaja ironstone in transmitted light, showing different shapes of goethitic ooids

As for the gypsum bodies in the Sokoto basin, Elueze *et al.* (1997) have asserted that the CaO-rich samples like those of Ewekoro, hold better promise for chalk and pharmaceutical production, while all the varieties are adequate for utilization in portland cement and fertilizer manufacture. Screening and bleaching are appropriate for processing.

Various investigations (Elueze *et al.* 1994; Elueze and Bolarinwa 1995, 2001; Elueze *et al.* 1999) show that most of the clay occurrences are essentially kaolinitic, though the residual types commonly have higher mineralogical inhomogeneity. The sedimentary bodies are mostly finer and more plastic, hence of higher commercial values (Table 8). On the whole, the samples, with appropriate processing, particularly screening, are exploitable as ingredients for fillers, extenders, paints, fertilizers, pesticides and coatings. They likewise are suitable raw materials for ceramics, bricks, refractories and structural wares. Elueze (1993c) had advanced that these readily won deposits have attractive prospects to support organized artisanal projects in sun and simple oven-dried bricks (Fig. 11). Incidentally, a very recent television news coverage highlighted the thriving status of such undertakings.

Table 8: Comparative chemical characteristics of some residual and sedimentary clays

Oxide	Residual clays					Sedimentary clays	
	RAB	ISAN	IJERO	K	IM	SAB	SITU
SiO ₂	60.00	55.49	60.70	56.00	54.12	52.50	70.60
TiO ₂	0.78	-	-	-	-	0.91	-
Al ₂ O ₃	18.21	18.63	17.75	23.29	21.11	28.73	15.03
Fe ₂ O ₃	7.58	9.67	6.04	2.55	8.92	3.31	1.93
(i) MnO	0.06	0.04	0.03	0.01	0.06	1.45	-
MgO	0.59	1.25	1.22	0.01	0.10	0.41	0.14
CaO	0.80	0.77	0.83	0.03	0.38	0.28	0.62
Na ₂ O	0.94	0.46	0.23	0.94	0.77	0.33	0.07
K ₂ O	1.55	1.84	1.40	1.13	0.16	0.40	0.35
P ₂ O ₃	0.31	-	-	1.15	0.61	0.38	-
H ₂ O ⁺	8.70	10.18	10.71	12.13	9.83	11.12	9.05
H ₂ O	-	-	-	2.47	2.67	-	-
Total	99.52	98.33	98.91	99.71	98.73	99.62	97.79

- RAB - Residual clay of Abeokuta area
 ISAM - Residual clay of Isan-Ekiti
 IJERO - Residual clay of Ijero-Ekiti
 K - Residual clay of Kitibi-Ayedade. Iwo district
 IM - Residual clay of Imope, Ijebu district
 SAB - Sedimentary clay of Abeokuta area
 SITU - Sedimentary clay of Itu area, S.E. Nigeria

Source: Elueze, 1995

Elueze and Okunlola (2001b) have also shown that the Burum dolomitic and Jakura calcitic marble bodies meet the specifications for use as steel fluxes, fillers and extenders, and in production of glass, hypochlorites, road bases, ornamental stones and lime-based chemicals. Only the Jakura is consumable in calcium carbide and ordinary portland cement (OPC) manufacture. Besides, agronomic characterization supports their usefulness as soil acidity ameliorants.



Fig. 11: Exploitation of lateritic clay for simple sun-dried bricks in building of low-cost accommodation

The crystalline igneous and metamorphic rocks of the basement complex, often collectively called 'granites', are commonly being quarried indiscriminately, without adequate precaution for conservation and environmental protection. Even the laminated quartzites are being exploited as natural building slabs (Fig. 12). In any case, Elueze (1995) has commercially characterized the rocks, based on compositional and physical properties (Table 9). It is particularly interesting, as the "nero icheku" products are derived from charnockitic rocks. Elueze (1988, 1995) has also recognized the requirements and options for viable investments in decorative and ornamental stones. However, it is striking that in the recent discourse on "resource control", a new forum named

“Granite-rich States” of Nigeria emerged, presumably from political, rather than geological considerations.



Fig. 12: Potential projects in high grade geomaterials (a and b artisanal working of laminated quartzite for building slabs; c – varieties of polished products of different basement rocks).

Table 9: Commercial characterization of crystalline rocks for ornamental stones

Rock types	Potential commercial products	Application and functional uses
Gneisses and migmatites tiles	multicolour, diadema, nylandia, african juparans, and others	Interior and exterior decorations, orienta, vibro verde, spriana.
Quartzites and schists	oakley schiefer, favang, verde	Interior and exterior, tiles.
	Fundrels, verde vermion, schiefer brands etc.	
Amphibolites and mafic schists	verde shades, nero tones	Interior and exterior, monumentals
Marbles and calc gneisses	bianco brands,, zebirino, maharani and so on	Interior and exterior, monumentals. pupilt and altar slabs
Granites, granodiorites and diorites	grigio, star flash, serizzo, verde lights, nero tijuca	Interior and exterior, tiles, stone items
Syenitic and charnockitic rocks	nero "icheku", verde coloured, tijuca	Interior and exterior, monumentals, counter, altar tops etc.
Gabbros, dolerites and lamprophyres	nero oriental, verde, nero assoluto, grunporphyr	Monumentals, tiles, stone items and decoratives

Source: (Elueze, 1995)

Compositional determinations have likewise been invaluable components of most of the major consultancy projects executed in the Department. These include the investigation of the Ibese limestone and clay deposits for OPC-type manufacture; the Ifon ceramic clay project; the evaluation of the Ubo marble, and the appraisal of brick clay bodies in Ire-Ekiti. Several other projects also entailed the compositional evaluation of geomaterials, such as granites for quarrying and crushing, rocks and soils in engineering foundations and pavements, and minerals for gems (Olade *et al.* 1981; Elueze *et al.* 1990).

Water Quality and Environmental Assessments

Further, in the appraisal of the nature and value of water sources, compositional results and indices have been found to be decisive (Levin 1981; World Health Organization WHO, 1984). Even the relevant physical properties like taste, colour and smell depend largely on the dissolved and suspended constituents. Therefore, evaluation of the usability should entail isolating appropriate treatment measures, especially for the readily polluted, but much easily available and accessible surface supplies.

On the other hand, anthropogenic activities especially industrialization, directly or indirectly lead to myriads of environmental hazards ranging from noise to toxic waste pollution. Notably, heavy metals contamination of waters, soils and plants can subsequently be acquired by man, through the food chain (Holum 1977).

Hydrochemical characterization

Elueze *et al.* (2001a) have demonstrated that sodium and bicarbonate ions predominate as the solute components of the slightly acidic surface water samples from southeastern Nigeria (Fig. 13). Surface and groundwater sources around Ibokun in the southwestern part, were however found to be weakly alkaline, but also with low sodium hazard, and essentially meet the WHO standards for domestic, agricultural and industrial uses requiring notably filtration and disinfection (Elueze *et al.* 2001b).

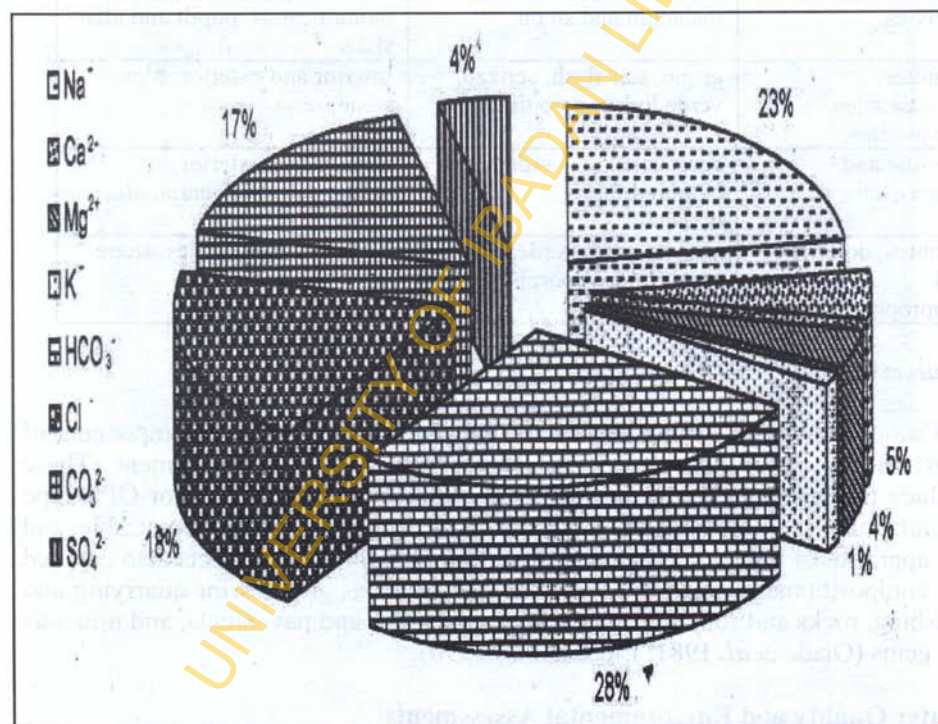


Fig. 13: Relative illustration of the dissolved constituents of the waters from southeastern Nigeria.

Geoenvironmental evaluation

As shown by Elueze *et al.* (1997), the products of the corrosion of reprographic machines in Lagos, particularly portray the inputs from the steel appliances, their exhaust emissions, the processing pigments and the local hydro-system. Elueze *et al.* (2001c) have likewise illustrated that organic matter and Fe₂O₃ contents have

positive controls on Pb, Zn, Cu and Cd absorption capacities of soils and sediments around the Ibadan Exide Battery Factory. The overall compositional patterns in water bodies, soils and sediments, largely imply the dispersion and deposition of heavy metals laden wind-borne dusts from the plant chimneys, plus direct discharge into the ecosystem.

Conclusions

Previewing Observation

Several pertinent issues have emanated from, or been highlighted in the conception, execution, outcomes and effects of the different assignments. Some are considered to merit further elaboration, specifically with respect to recognizing the remedies to the problems inherent in the research on geomaterials, prescribing options for optimizing the development and exploitation of the geo-resources, and then extending and reconciling the necessary aspects to the human perspectives.

Derivatives from the Major Areas of Contribution

Water supply and environmental monitoring

In the rural areas where industrialization levels are still relatively low, water sources commonly meet the compositional qualities of domestic supplies demanding minor treatments. On the other hand, human activities have been found to influence the compositional variations of water, soils and sediments. Therefore, there is need for continuous environmental checks, including geomaterials-based project sites which readily emit wastes and pollutants (Elueze 1989).

Precambrian crustal evolution in Nigeria

There are still disagreements as to the regimes of crustal formation in Nigeria. However, the riftogenic model, particularly for the schist belts (Olade and Elueze 1979; Turner 1983; Elueze 1985; Elueze 1992; Elueze and Okunlola 2001) is rated most dependable in accommodating their compositional variations, petrogenetic affinities and petrotectonic styles. Undoubtedly, enlargement of the relevant data-base would afford more acceptable geodynamic model (Ajibade and Wright 1989; Elueze 1992, 2000). For example, isotope variations and abundance ratios plus radiometric data are still relatively scanty for the Precambrian suites of Nigeria.

In any case, the compositional recognition of the cataclastic and mylonitic units, along some major fault zones, is particularly remarkable. Such dislocations are probably linked to the tremors experienced around Ibadan, in 1984 and 2000 (Elueze 1990, 2001). It is pertinent to add that in place where the crust is relatively thin and subjected to high heat flow (hot spotism), major fractures could provide channelways for eruption of magmas to the surface, or create volcanos. Volcanic activities are often catastrophic, as experienced lately around Goma in the Congo Democratic Republic. However, the extent of crustal thickness (Fig. 10) and stability do not suggest proneness to extreme seismicity in Nigeria. Nevertheless, as emphasized by Elueze (2001), the National

Technical Committee on Earthquake Phenomena (NTCEP) should urgently establish the long proposed monitoring seismograph network with a station allocated to this University. It is also necessary to evaluate and remedy major slopes, whose failures could propel destructive earthflows and mudflows which are at times confused as volcanic eruptions, like the case in Isan-Ekiti (Elueze and Olorunniwo 1997).

Geomaterials wealth of Nigeria

Mineral resources, notably gold, iron ores, clays, talc, magnesite, gypsum, marble, limestones, gemstones and rock stones have been shown to occur in Nigeria. Despite their enormous demand (Table 10), not much concerted effort is made in evolving appropriate strategies of harnessing, and hence monetizing these valuable geomaterials. In any case, the prevailing unfavourable socio-economic situation clearly echoes the necessity of adopting appropriate strategies, especially on the industrial minerals, which likewise have high export potentials (Elueze 1998).

Table 10: NIMAMOP preliminary market assessment of economic minerals in Nigeria

Commodity	Annual demand (tonnes)	Local value	International value
		(Naira/tonne)	(US\$/tonne)
Barytes	100,000 - 225,000	16,000	39-80
Gypsum	150,000 - 300,000	6,000	9-18
Kaolin	150,000	3,000	55-92
Bentonite	60,000 - 80,000	5,000	30-40
Feldspar	60,000 - 100,000	2,400	N/A
Diatomite	-	N/A	250-500
Talc	50,000 - 100,000	9,000	50-250
Rutile	60,000 - 80,000	N/A	85-700
Phosphates	200,000 - 300,000	4,400	25-24
Salt	300,000 - 500,000	N/A	6-37
Soda ash	50,000 - 60,000	7,000	105-115
Glass sand	180,000 - 2000,000	N/A	N/A
Iron ore	300,000	3,000	30-50

Source: Elueze 1998

Firstly, there is need to isolate the prevailing limitations to the effective operation of the economic minerals sector in Nigeria. These notably include the following.

- Substantial reliance on imported mineral raw materials, derivatives and products plus operational machines; consequently draining the meagre foreign exchange reserves.
- Haphazard execution of exploitation activities, without due consideration of the environment, vividly depicted by the unwholesome mining of gemstones and precious metals in many parts of Nigeria. The ills are likewise seriously sociological, as the areas are commonly transformed into enclaves of immense lawlessness.
- Inadequacy of financial facilities for the minerals industry, which commonly has long gestation period and high risk factor.
- Instability of the socio-political conditions, and the prevailing economic recession.

Elueze (1998) has also prescribed some priority actions required in addressing and resolving the prevailing constraints. Though, there are also overlaps, some are outlined below.

- Ensuring that the relevant government establishments are well funded and encouraged, notably the GSN and the Mines Department, for efficient and effective execution of mapping and evaluation programmes, and their outputs being readily accessible to all stakeholders.
- Providing for easy access to the required financial, management and technical facilities of the minerals industry, through the establishment and functioning of appropriate institutions.
- Recognizing and organizing artisanal miners including the illegal ones, into cooperative bodies in which the landowners and local authorities are “shareholders”, for proper operational monitoring and control, and governments being involved in buying and marketing of such winnings.
- Streamlining and easing of the procedures of the regulatory aspects of the minerals industry. Besides, ensuring that the roles of the three tiers of government are appropriately reconciled, such that artisanal to small-scale projects in geomaterials, are under the exclusive administration of state and local governments, thereby allowing for the regulation of unofficial workings. Their localized markets and job opportunities would significantly boost the economies of these levels of government, and reduce the dependence on the declining “zero” federal allocations. Similarly, making the Council of Nigeria Mining Engineers and Geoscientists (COMEG) to be fully operational, to enforce professional ethics, and ultimately guaranteeing improved performance of the minerals sector.
- Adopting allocation formula, whereby revenues from minerals-based projects are duly made beneficial to all stakeholders; namely, the investors, landowners, local authorities and state and federal governments.
- On the whole, the processes and requirements of optimizing the benefits of the exploitation of geomaterials would demand positive efforts, ethics and commitment of all stakeholders.

Problems and Remedies in Curricula and Research

The prevailing conditions, particularly with regards to facilities and personnel, are generally deplorable in the Department of Geology. While some recommendations have been advanced in addressing the prevailing lapses, it is considered desirable to further enumerate some, suggest remedies, and then outline the current and future thrusts in research.

Limitations and shortcomings

Most of the inhibiting factors are definitely not peculiar to the University of Ibadan Geology Department, and have also been highlighted by Elueze and Onuoha (1995). Some notable ones are itemized below.

- Inadequacy in field and industrial exposures, and logistics.
- Prevalence of non-available or non-functioning and obsolete laboratory facilities, instruments, machines, items of equipment and workshops.
- Insufficient funding, low motivation and morale and poor provisions for staff development and specialized skills acquisition.

Recommendations and priorities

Obviously, for improvement and enhancement in performance and productivity, there is need to make some expedient suggestions.

- Efforts should be made to ensure proper collaboration with related Departments, and then the industry and relevant establishments.
- The provision of working facilities is of priority, though there should be availability of competent operational and maintenance personnel, and avoidance of undue duplication and under-utilization, within the context of the University.
- The priority national projects of the envisaged revitalized GSN should include integrated geochemical and subsurface mapping; in which it must mobilize and utilize available expertise in the academia. The expected outputs should comprise data bank on compositional characterization of rocks, minerals, soils, waters, air and vegetation, plus information on noise, seismicity and radioactivity levels.
- The Departments of Geology and Chemistry should urgently establish the postgraduate programme in environmental geochemistry. Similarly, in cooperation with the Department of Geography, concerted effort should be made to develop the expertise, facilities and training in geological information system (GIS).
- External resources generation should be vigorously pursued by the University, to ensure adequate augmentation, since underfunding is presumably a worldwide phenomenon. Incidentally, most of the earlier research projects and facilities were funded through external grants obtained by Professor Oyawoye, while Professor Olade notably utilized consultancy projects and revenues for acquiring and sustaining items and activities.

During one's tenure of headship, significant support was achieved, particularly through former students, including the donation of items, prizes, substantial funds and two field Jeeps (Fig. 14). It is however imperative that the financing by government, should be realistic and regular.



Fig. 14: The field jeeps donated by NAOC, being "launched" by members of staff.

Current and Future Research Inclinations

The contributions outlined in this treatise, have generally served as worthwhile references, and the earlier ones were particularly stimulants to other researchers on the reality of compositional characterization, in evaluating geomaterials in Nigeria. However, it is of pertinence that the relevant investigations largely entailed analyses of whole samples. Therefore, the current and future lines of research considerably integrate determinations in the realms of mineral chemistry, stable isotopes and organic geochemistry. In particular, these thrusts are substantially incorporated in the works of Bolarinwa (2001), Okunlola (2001) and Nton (2001).

Compositional Characterization of Geomaterials: Implications for Humanity

In conformity with the posture of launching from the visible, the hidden theme of this discourse is on the bearings of compositional qualification to humans.

These aspects are obviously only realizable at the arrival station, being not the essence which belongs to the starting block.

A sizable proportion of humanity inhabit Nigeria which is part of the earth's landmass. The foundation or basement of the country is shown to be composed of Precambrian rocks that also accommodate various younger suites. The assemblages are widely variable in compositional nature, and hence have different genetic affinities, geotectonic significance and economic values. Similarly, the inhabitants of the country show disparities in origin, inclinations and endowments. Otherwise, the collective strength relates positively to the extent of diversity.

On the other hand, the prevailing crustal situation, except for some minor shocks, has favoured much tranquility and accommodation, between and among the rocks and their components. It is therefore imperative that Nigerians must sincerely accept that no meaningful peace and growth, least of all, the optimal exploitation of the geomaterials can be achieved in conditions of ethnic bigotry, religious antagonism, violence, corruption, cultism and other negative tendencies. Again, no two crystals of a mineral, or whole-specimens of the same rock are found to have identical compositions. As a matter of fact, not even the assumed mono-elemental mineral or native metal that has a fixed composition. It is also unnatural to find a single-plant colony, since even in a plantation, there are bound to be weeds or parasites in the botanical population. Further, there is no single-tongued settlement, in which all the indigenes can be proved to belong to the same stock or lineage. Besides, each individual is at least an offspring of two different and normally distinctive persons. Consequently, inhomogeneity in composition, is an inherent attribute of all physical and biological entities.

On the other hand, it has been demonstrated that the minor and trace components, which are comparable to human minorities, have significant roles in appraising the nature of geomaterials. Environmental factors are known to exert influences in the cycle of geomaterials, and invariably also on humans. Hence, Nigerian kids exposed to the same situation, do definitely have comparable traits, and their categorization should be based on locations of birth and/or abode, rather than that of the ancestry. The reconstruction of the latter, like for geomaterials, could be problematic, especially after considerable span or intensity of transformation. In addition, the semblances of minerals have been shown to be related to the similarities in anions, which for example are silicates, hydrated oxides and sulfides, respectively in magmatic, surface and reducing environments. Invariably, the metallic or positive cations, otherwise the male components get united with the available negative anions or the female partners, in proportions determined by their oxidation states or charges. It is hence not surprising that men whose wives are compatible, readily relate closely.

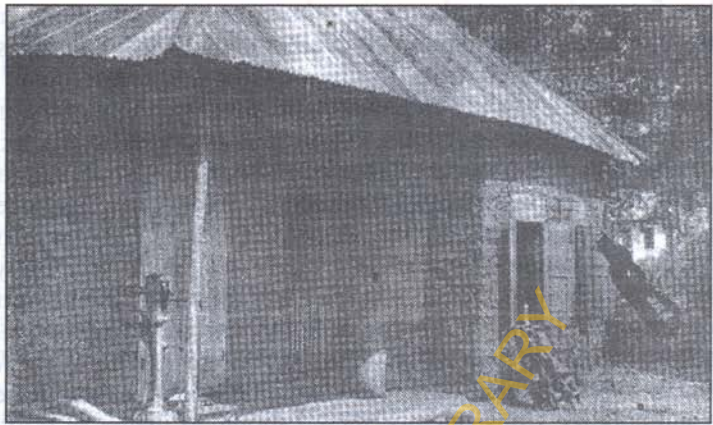
In essence, for this country, and particularly the University, the acceptance of the diverse ethnic composition is the only realistic and honest option. Else, there would be the destruction of fairness, merit and excellence, with the breeding of mediocrity, subservience, sycophancy, indiscipline and blackmailing. Therefore, conscious and appropriate measures have to be in place, to forestall the thriving

of undue favouritism and abuses in admissions, examinations, appointments, promotions, selections, elections, and even in the informal situations.

It is likewise explicit from this presentation, that thorough grounding in geology and chemistry, is pre-requisite to the understanding of the transformation and inter-relations of geomaterials. Correspondingly, adequate exposure to the tenets of citizenship and morality, is *sine qua non*, for proper appreciation of the development and norms of human societies. Nowadays, the need for formal training in positive orientation and values, has largely been taken for granted. The prevailing situation of immense religiousness, with seemingly low upright inclinations, is rather worrisome. At one's early stages, moral instructions were major components of the upbringing at home, and in the primary and secondary schools. In particular, the SPGS (Piusian) motto (*Virtus Sola Nobilitat*) and culture duly stressed that only virtuous values and attitudes readily secure success and nobility. Consequently, the UI should as matter of priority, introduce an entry year compulsory course in citizenship and behavioural science. Similarly, all categories of staff should benefit from training in work ethics, management and social norms. The University should take the lead, in conformity with the pace-setting philosophy of its State of location.

A major component of the work of the "compositionist", which has considerable human angle, is field geology. For one, the cumulative temporal and spatial coverages are exceedingly substantial. There were countless opportunities for very close and informal interactions with persons that can be appropriately labelled as the "grassroots". The experiences have also been very memorable; mostly unbiased and devoid of ethnic, political or religious prejudice. It is delightful to highlight the continued link with the Osuntedo people (fig. 15), since the first visit in 1974, and the 1975 conferment of the title of "Omo Owa of Ijeshaland" by the host family in Ilesha. Some candid scenes are likewise worth recollecting, like also in 1974, of the boy Sule, Ile Asati, Ogbagba, who had meticulously whispered "*baba mi ti ko o*" to communicate the absence of his mother that had been separated from the fondly father, and the donkey riding Mallam Yahaya at Alawa, who in his undisguised goodwill, was very emphatic in the parting statement of "*aboki na, tsa-uni wan cham bayi dechaw sam-sam*", to forestall contact with a presumed unsafe rock hill.

In general, the sociological dividends of geologists investigating the compositional nature of geomaterials, are unquantifiable. Therefore, such experts have complete and unpolluted understanding of the people, their environments and the exploitable resources, and are best suited to head all programmes on rural development, job creation and poverty alleviation. Actually, their comprehensive knowledge of the human and physical aspects of the country, distinctively qualify them to all positions of trust and responsibility.



a



b



c

Fig. 15: Scenes at Osuntedo village (a) the cocoa store field accommodation and (b) close interaction with the host's child in 1974 (c) re-union posture with hosts in 1992).

Synthesis of Research Philosophy, Approach and Conviction

This exercise has largely enunciated contributions to the knowledge on the compositional nature of geomaterials. Despite the alternative views obtainable in some cases, the prevalent style has been the scrutiny, recognition and consideration of even the subtle components of the compositional variations and indices. This posture can be said to have been cultivated early in one's development. Hence, the unusual rock encountered at the initiation stage, was from the obvious compositional qualities, excitedly tagged tourmalinized quartzite. Of course, it is part of the mineralized pegmatites currently attracting enormous commercial, rather than scientific interest. In essence, the fundamental research attitude has been to generate, process and interpret compositional data, through scientific reasoning, coupled with sound judgement, and thereby upholding the vision of this citadel of excellence, the University of Ibadan (*Recte Sapere Fons*)

Altogether, efforts have been made to adorn the fact that compositional characterization is a realistic and dependable instrument in understanding natural things. Further, all physical and life entities are no exception to what may be referred to as the "principle of natural heterogeneity". Consequently, it is conclusively convincing that there is no degree or form of religious or ethnic cleansing or genocide which can effectively confer homogeneity to any nation, and such acts are not only crimes to humanity, but gross violation of the ordinance of God.

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How then does this translate to "the Journey from the stomach to the womb" which hormones also produces such hormones is Gastrin

23

LEAVING CERTAINTY FOR UNCERTAINTY: FROM THE STOMACH TO THE WOMB

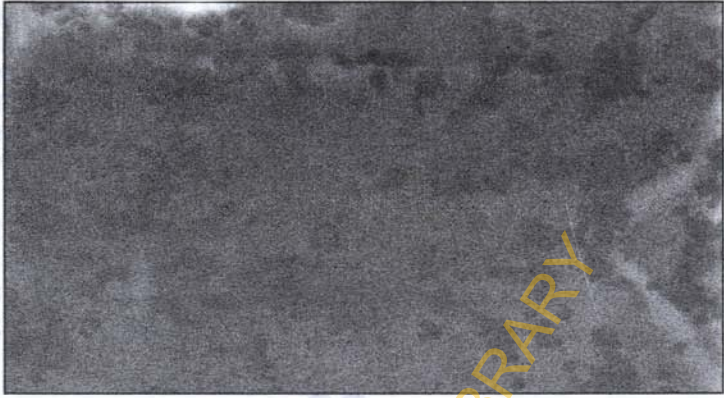
Adeyombo F. Bolarinwa
Department of Physiology

Introduction

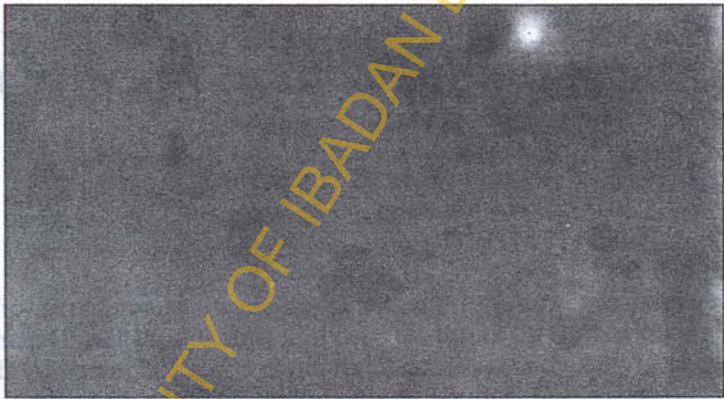
My journey into the world of the Sciences began when I was offered the University Scholarship to enroll as a Ph.D student in the Department of Physiology. In my last year as an undergraduate I was fascinated by the stories my mentor, Professor B.O. Amure, used to tell us about the discovery, extraction and purification of Gastrin. I therefore decided to do some studies on Gastrin, one of the hormones in the stomach.

Earlier research has shown that the acid gastric responses of the male rats do not vary appreciably from one animal to the other; while in the female, significantly varying responses have become obvious. These differences in the responses of the male and female rats are influenced by the estrous cycle of the female animals. This cycle is of very short duration. The existence of a typical estrous cycle in the guinea pig and the associated changes in vaginal cytology were first reported by Stockard and Papanicolaou in 1917. Shortly thereafter, similar phenomena were reported in the rat and the mouse. The estrous cycle is similar to the menstrual cycle in humans. It lasts for 4-5 days and is made up of the pro-estrous, diestrous and the estrous, which is the period generally known as "coming on heat". Unlike what occurs in humans, the estrous phase, which is similar to ovulation phase in humans, is the only time at which the female animal is receptive to the male (Fig. 1 a-c). The level of circulating estrogen also varies with the estrous cycle. Thus Presl *et al.* (1969) reported that the level of circulating estrogen is highest during pro-estrous and lowest during di-estrous.

A



B



C



Fig. 1: Estrous Cycle: (A) Pros-estrus (B) Estrous (C) Diestrus

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How then does this translate to "the journey from the stomach to the womb"? The stomach is the major seat of power for the processing of food, which eventually becomes the fuel for energy production. It also produces hormones, which are vital to the well-being of the animal. One of such hormones is Gastrin (fig 2).

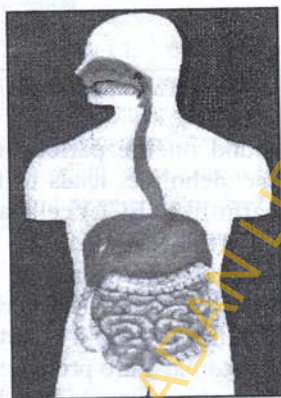


Fig. 2. The Stomach

Gastrin is a major physiological regulator of gastric acid secretion. It also has an important trophic influence on the gastric mucosa. Gastrin is synthesized in the G cells, which are located in the gastric pits, primarily in the antrum of the stomach, and it binds receptors found predominantly on the parietal and enterochromaffin-like cells.

Structure of Gastrin and Gastrin Receptor

Gastrin is a linear peptide that is synthesized as a preprohormone and is post-translationally cleaved to form a family of peptides with identical carboxytermini. The predominantly circulating form is Gastrin - 34 ("big Gastrin") but full biologic activity is present in the smallest peptide (Gastrin-14 or mini Gastrin). Further, full bioactivity is preserved in the five C-terminal amino acids of Gastrin, which is known as Pentagastrin. Importantly, five C-terminal amino acids of Gastrin and Cholecystikinin, another gastrointestinal hormone, are identical which explains their overlapping biological effects (Fig. 3). The Gastrin receptor is also one of the receptors that bind Cholecystikinin and is known as the CCK-B receptor.

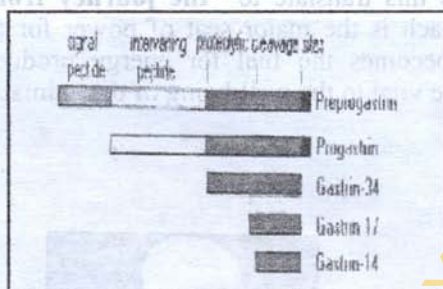


Fig. 3. The Structure of Gastrin

Gastrin receptors are found on the parietal cells. The binding of gastrin, along with histamine and acetylcholine, leads to fully stimulated acid secretion by those cells. Enterochromaffin-like (ECL) cells also bear gastrin receptors, and recent evidence indicates that this cell may be the most important target of gastrin with regard to regulating acid secretion. Stimulation of ECL cells by gastrin leads to histamine release, and histamine binding to H_2 receptors on parietal cells is necessary for full-blown acid secretion.

The epithelial cells of the stomach are protected by two agents and tend to be damaged by two agents. Protective agents are layers of mucus and alkaline secretions containing bicarbonate. The damaging agents are acid and pepsins of the stomach. Peptic ulcer results from deficiency of either one or both of the protective factors. It may also result if one or both of the damaging factors become excessively powerful.

A peptic ulcer disease is a worldwide problem, affecting about 1 in 10 people. Similarly, *Helicobacter pylori*, the now undisputed culprit in most cases of peptic ulcer disease, is found virtually everywhere in man on our planet. Although the organism causes problems in only a minority of those who carry it, it is linked with a number of serious consequences. In developing nations four of five persons are infected by age 20 years (Graham *et al.* 1991 and Brewer *et al.* (1997). According to Graham *et al.* 1991, Malaty and Graham (1994), twice as many Black and Hispanic people are infected as White people. This difference is not racial but reflects socioeconomic and educational factors especially socioeconomic status during childhood. Another major risk associated with *H. pylori* infection is gastric cancer.

Let us pause here and look at some common beliefs on ulcer. Contrary to popular beliefs, there is limited evidence to show that a person's occupation or socioeconomic status causes ulcer. However incidence of duodenal ulcer in men is about twice that in women, while the occurrence of gastric ulcer is about equal in both sexes. Although ulcer can occur at any age, it is rare among children and only slightly more common in teenagers. Duodenal ulcer usually first appears in people during their twenties or thirties, while gastric ulcer is more likely to develop among people who are in their forties or older. Although a variety of

popular beliefs have associated numerous factors with peptic ulcer, only a few have been found to play a role in causing the disease.

Heredity is a factor in the incidence of peptic ulcer disease. The risk of developing an ulcer is increased threefold if any blood relation has had ulcer. Similarly gastric ulcer is more likely to occur in a person whose parents or siblings have had it. Other factors may include:

- *Smoking.* A considerable amount of scientific evidence has shown that cigarette smoking not only doubles a person's chance of developing an ulcer, but it also tends to slow the healing process of an existing ulcer. In addition, recent research findings indicate that smoking is an important factor in causing ulcer recurrence. People who stop smoking have a lower rate of recurrent ulcers regardless of what medication they may take. In fact, recent research has shown that the chances of an ulcer healing and staying healed are better if a patient quits smoking and takes no medication than if the patient continues to smoke and receives drug treatment.
- *Aspirin.* Persons who use aspirin regularly over long periods of time, such as some arthritis patients, have an increased chance of developing gastric ulcer. Researchers have found that aspirin and similar drugs inhibit the stomach's production of a substance called prostaglandin which protects the lining of the stomach from injury by a wide variety of chemical agents, including the stomach's own acid secretions.
- *Caffeine.* Coffee, tea, cola drinks, and other foods that contain caffeine can stimulate acid secretion in the digestive tract and, in turn, may aggravate the pain of an existing ulcer. However, the role of caffeine products in contributing to the development of ulcer is unknown. The level of acid secretion induced by decaffeinated coffee is the same as with regular coffee. Therefore, substances other than caffeine are apparently present in coffee that stimulates gastric activity.
- *Diet.* No convincing evidence shows that certain diets cause ulcer or that certain diets can heal ulcer and keep them healed. A diet may help to relieve the pain or indigestion of an existing ulcer, but it will not prevent an ulcer from forming.
- *Alcohol.* One of the most popular myths about peptic ulcers is that people who drink alcohol are more likely to develop ulcer disease. The truth is that even those people who are moderate to heavy users of alcohol do not have an increased chance of developing ulcer. Although alcohol was often thought to be a stimulant of stomach acid secretion, numerous studies have failed to establish such a relationship between acid secretion and concentrated alcoholic drinks. This however is not a vote for alcohol.

Although stress may aggravate the pain or indigestion associated with ulcer, scientists have not yet been able to determine whether stress is an important factor in causing ulcer. Stress is difficult to measure, because people react

differently to similar circumstances. A situation that may cause stress in one person may have no effect on someone else.

So far, there is no convincing proof that people who have high pressure jobs or who experience a great deal of tension in their lives are more likely to develop ulcers. However, some ulcer patients may be less able to tolerate large amounts of stress or tension. Regardless of the level of effect that stress may have on a patient's ulcer, it is a good idea for the patient and his physician to work together to identify and then try to reduce or remove stressful factors in the patient's life. .

Doll in 1952 established that duodenal ulcer prevalence was higher in males than in females. A marked increase in gastric hospitalizations for women over 65 years old has however been reported (Jurata *et al.* 1985). This could be due to the fact that the risk of developing ulcer disease increases with age (Bonnievie 1980) and as women appear to now live longer than ever, more women can expect to develop ulcer in their lifetime (National Health Interview survey conducted by the National Center for Health Statistics 1978). On the other hand it has been suggested that the female sex hormones confer some protection against peptic ulceration (Crean, 1963). Earlier researchers have shown that pregnancy affects the gastric acid secretory response in different species. Diminished secretions of pepsin and hydrochloric acid occur during pregnancy in women (Murray, Erskine and Fielding 1957) in the rat (Lozzio, Gagliardi and others 1961) although in the experimental dog, no consistent changes in gastric acid secretion were found (McCarthy, Evans and Dragestedt 1954). These have led many workers to seek a relationship between female sex hormones, chorionic gonadotrophins and gastric acid secretion.

It was therefore in a bid to unravel this jigsaw puzzle that I embarked on the studies on the gastric acid secretion, estrous cycle, pregnancy and parturition. In 1975, we studied the pattern of gastrin content of the rat mucosa during the estrous cycle using the modified method of Gregory and Tracy (1964) and reported as follows:

The female rats in di-estrous showed a remarkably high gastrin concentration in the mucosa, which significantly exceeded the concentration in the estrous and pro-estrous. We then concluded that estrous cycle appears to exert an inhibitory effect on secretion in the female rat stomach (Amure and Bolarinwa 1975) (Fig 4).

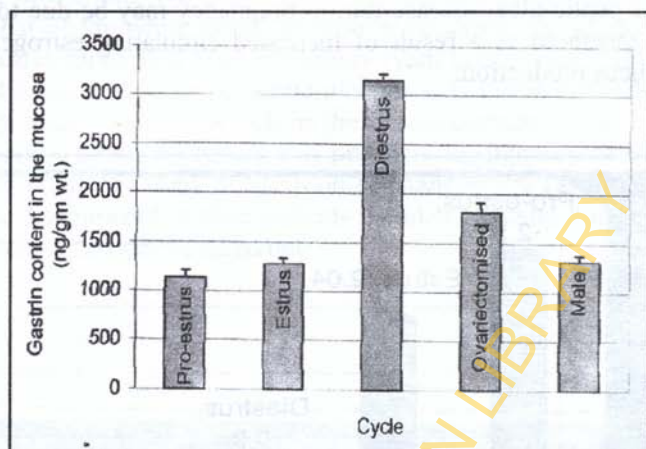


Fig. 4: Gastrin Concentration Equivalent in ngSHG/gm weight during the Estrous Cycle

Next, we studied the pattern of antral gastrin content in pregnant rats. Rats have a gestation period of 21 days. They were divided into early (2-3 days), mid (12-14 days) and late (18-20 days) pregnancy. We reported that the antral gastrin content was highest in early pregnancy and lowest in late pregnancy (Bolarinwa and Amure 1978) (Tab 1).

Table 1: Antral Gastrin Content in Pregnancy

Stage of Pregnancy	Gastrin content (ng/SHG/ml of test solution)
Early (2-3 days) n = 40	1.33 ± 0.02
Mid (4-14) n=40	1.13 ± 0.01
Late (18-20) n = 40	0.86 ± 0.06
Non-pregnant (Control n=20)	1.42 ± 0.09

We also studied the plasma gastrin level in rats during the estrous cycle by radioimmuno assay using gastrin labeled with ^{125}I . We reported that plasma gastrin level is lower in diestrus than in estrous and proestrous. This agrees with the pattern of gastric acid secretion in these phases (Bolarinwa 1981). From the data provided by Presl *et al.* (1967) on the level of circulating estrogen in rats during the estrous cycle, the level of estrogen is highest in proestrous and lowest in diestrus. (Fig. 5). This corresponds to the level of gastrin as observed in this work. The same pattern was observed in gastric acid secretions (Table 2). Claims that estrogen hastens the healing of peptic ulcers or lowers the amount of acid secreted have therefore been challenged. Kaufman and Spiro (1968) did not note any improvement in peptic ulcer as a result of estrogen treatment that could not

be attributed to antacids, frequent visits to physicians or the natural course of the disease. On the other hand, the quiescence of subjective as well as objective symptoms of peptic ulcer disease during pregnancy may be due to the lowering of the pain threshold as a result of increased circulating estrogens as well as increased mucus production.

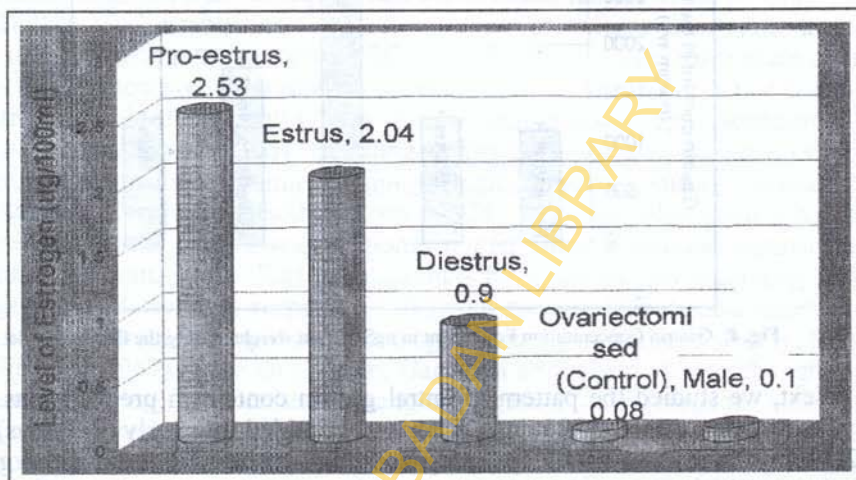


Fig. 5. Estrogen Levels (ug/100ml) During the Estrous Cycle

Table 2: Plasma Gastrin Level and Induced Gastric Acid Secretion during the Estrous Cycle

Animal Group	No. of Animals	Plasma Gastrin (pg/ml)	Acid secretion in response to 100ng/100g
Pro-estrus	60	64.0 ± 3.0	0.018 ± 0.002
Estrus	50	58.0 ± 3.0	0.014 ± 0.001
Diestrus	50	48.0 ± 1.0	0.01 ± 0.00
Ovariectomised	20	40 ± 2.0	0.013 ± 0.03

Source: Bolarinwa, 1981

As drug trials have not provided the desired complete relief in peptic ulcer, attempts were made to investigate the effects of various food materials on the healing and incidence of ulcer. The idea of therapeutic diet was first suggested by Sippy (1915) as a means of alleviating ulcers. He advocated a repeated milk drink as part of his programme designed to neutralize completely the gastric acid. Levy and Siler (1966) proposed milk cream purees and protein hydroxylsate respectively. Tovey in 1974 investigated the buffering action of rice bran, which was used on patients in India for the treatment of ulcers. In Nigeria, Elegebe and

Bamgbose (1976) provided an explanation as to whether some Nigerian local food substances experimentally induced ulceration in rats or not.

In 1986 Oluwole and Bolarinwa studied the buffering capacity of some Nigerian food substances. We reported that the buffering capacity of red beans is greater than that of the white beans. Generally speaking, the grains (beans, rice and maize) buffer more acid than the tubers (yam and cassava) (Fig. 6). It has been shown that the incidence of peptic ulceration is lower in the Northern part of the country where the diet is rich in the grains compared with the Southern part of the country. From the results it is pertinent to suggest that while habitual intake of some relatively weak buffer food substances like cassava products and yam should be discouraged in ulcer patients the idea of gastro duodenal buffering effects of proteins must not be ruled out.

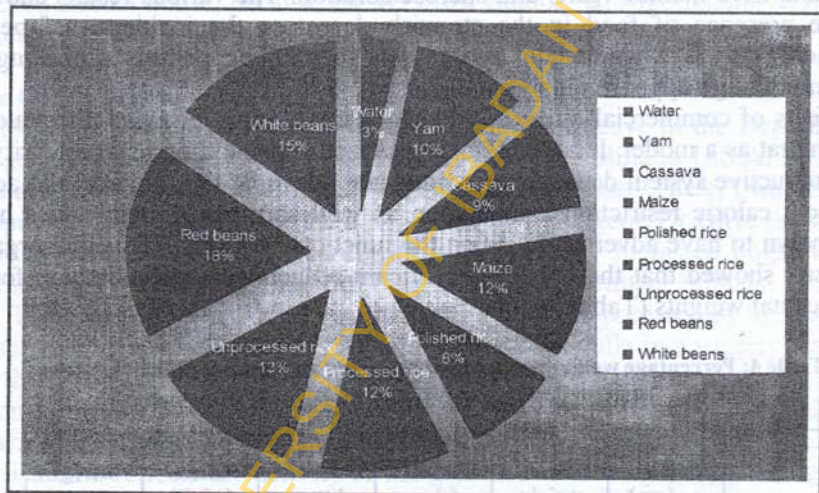


Fig. 6. Buffering capacity expressed as the number of millimeters of 0.1N HCl neutralized to get pH 1.9

Our next line of action was to study the effects of various factors on induced ulceration. Fasting as well as drugs e.g. indomethacin can induce ulcer. Variations in the incidence rates and severity of duodenal ulcers in patients in different parts of the world, most especially in India and Africa have been reported by various workers (Tovey 1974). Thus Oluwole and Bolarinwa (1990) studied the effects of gonadectomy on indomethacin-induced ulceration and reported that castrated male rats with low ulcer scores exhibited significantly higher peptic activities. Also the low ulcer scores in the intact female rats are associated with the very low peptic activity in the same group of rats (Table 3).

Table 3: Peptic activity and ulcer scores in gonadectomised rats

	Peptic Activity	Ulcer Score
Intact male	9.05 + 0.03	18.42 + 0.22
Castrated male	15.84 + 0.06	9.58 + 0.17
Intact female	11.00 + 0.07	8.67 + 0.20
Ovariectomised	17.42 + 0.14	7.67 + 0.16

Source: Oluwole and Bolarinwa, 1990.

Attempts were made to bring together the various aspects, which were reported. Thus in 1990, Evbuomwan and Bolarinwa studied the effects of diet on indomethacin-induced peptic ulceration in pregnant rats. We used local diet like grated and fried manioc (gari) and sucrose solution. The various results showed that the presence of food in the stomach decreases the incidence of peptic ulceration. This is a warning to those who go on long periods of fasting or slimming through appetite suppression.

Effects of commercial diets on pregnancy and parturition were also studied using the rat as a model. It has long been realized that the functional integrity of the reproductive system depends upon adequate nutrition; thus chronic and acute starvation, caloric restriction and vitamin as well as mineral deficiencies have been known to have adverse effects on the functions of the reproductive organs. The result showed that there was a significant reduction in the maternal, foetal and placental weights (Table 4).

Table 4: Percentage weight gain or loss, litter size and mean weights of fetuses and placenta on the 18th day of pregnancy

	Average original wt (gm)	Mean final weight (gm)	% Decrease (-) or increase (+) in wt	Mean no. of litters	Wt. Of litters (+S.D)	Placental wt. (g)
Control (Normal feed)	175	218	+24.6	5.0	4.54± 0.6	0.51 ±0.02
Pure Olive oil	184	180	-2.2	3.8	3.02± 0.02	0.18 ±0.02
Dried milk	195	202	+3.1	4.2	2.75± 0.02	0.30± 0.06
30% Casein	200	254	+27.0	5.6	4.96± 0.10	0.46 ±0.08
3% Casein	195	191	-2.1	1.02	1.08± 0.02	0.13 ±0.01

Bolarinwa and Edemeka, 1991

This work has therefore suggested that the foetuses of women on commercial diets stand the risk of being adversely affected physically and intellectually (Bolarinwa and Edemeka 1991). This is in agreement with the findings of Simic (1971). Women should therefore avoid continuing their slimming effort during pregnancy. Caloric restriction adversely affects the placenta, which may result in placenta insufficiency during pregnancy. This may lead to abortion or death *in utero*.

Majority of this work was done on laboratory animals (mainly the rat) and this was at a time when, as a researcher, one had access to as many rats as were needed. I remember the Physiology Department had a well-run animal house with the late Papa Orenuga in charge. Papa Orenuga was an encyclopedia on various laboratory animals. I remember that as a B.Sc student I was able to use up to 100 rats in a day for my project. Today the story is regrettably different. Physiology Department can no longer financially run an animal house. The situation now is that one rat sells for ₦150.00. It is very difficult to keep a well-stocked animal house, because the very low funding of Nigerian universities has adversely affected many research activities.

The Other Side of Life

In 1982 I had the privilege of spending a sabbatical leave in the Department of Surgery, Duke University Medical Center, North Carolina in U.S.A. At Duke, I was able to appreciate what it truly means to be a scientist. There, I worked in the hospital with two Residents and a Nigerian G.I.T. Surgeon Dr Onye Akwari. We worked on the pattern of interdigestive biliary flow in fasted dogs. We also studied the effect of motilin in cholecystectomized and intact animals.

The beauty of this work is that mongrel dogs were prepared by ligation of the lesser pancreatic duct and insertion of a duodenal cannula in a surgery that lasted for three hours. After recovery the fasted awake dogs had biliary catheter inserted through the duodenal fistula to enable us study the pattern of cyclical biliary flow. The studies showed that bile flow in the canine common bile duct is cyclical and reflects the activity of the gall bladder during fasting. Exogenously infused motilin has little effect on canalicular flow and composition but alters common bile duct flow and composition indirectly through its effects on the gall bladder (Bolarinwa *et al.* 1984).

A few points were obvious from my research work in Duke. You can keep your research animals for as long as you wish to study them. Sometimes this can be up to four to six years. Frank, one of the dogs in our laboratory, had been an experimental candidate for three years before I got to the laboratory in 1982.

A system that makes this possible requires proper funding. The experimental animals in Duke include chim-panzee apart from dogs. These animals were all given a VIP treatment as each had its own quarters and people were paid to take care of them. These quarters were kept better than what some rooms in our halls of residence in this university used to be.

The Alternative

At this period in the life of Nigeria when medical care is beyond the reach of the average Nigerian, attention has turned to the use of local herbs as medication. Many of these local herbs, while being useful in specific ailments, also have adverse effects particularly in pregnancy. One of such herbs studied is *Morinda Lucida*, which has been shown to have suppressive effect on rodent plasmodium berghei malaria (Makinde and Obih 1985). Extracts of this medicinal plant are taken by both male and female and also by pregnant women. Our work has shown that this extract might be a herbal remedy for malaria when used for a short period of about five days even in pregnancy (Adewoye, Bolarinwa and Makinde 1991).

Quassia amara is reputed in traditional medicine to have good stomachic, antianaemic, antibiotic, antiamoebic and antimalarial properties (Polonslay 1985). Many antimalarial agents have been reported to have anti-fertility actions (Meisel and Winterhoff 1993). Our work on this herb has shown that the crude methanol extract of the stem inhibited both the basal and LH-stimulated testosterone secretion in the rat leydig cells in a dose-dependent fashion (Raji and Bolarinwa 1997).

Summary

- (i) The likelihood of peptic ulcer disease is increased in persons of black ancestry, which reflects an increased risk of H pylori infection.
- (ii) Cigarette smoking not only doubles a person's chances of getting an ulcer, but it also tends to slow the healing process of an existing ulcer. People who smoke have a lower rate of recurrent ulcer regardless of what medication they may take. This has been further confirmed by recent research which has shown that the chances of an ulcer healing and staying healed are better if a patient quits smoking and takes no medication than if the patient continues to smoke and receives drug treatment.
- (iii) Persons who use aspirin regularly over long periods of time, such as some arthritis patients, have an increased chance of developing a gastric ulcer.
- (iv) Increased circulating estrogens as observed in pregnancy lowers the pain threshold and this may be responsible for the quiescence of subjective as well as objective symptoms of peptic ulcer disease during pregnancy.
- (v) The buffering capacity of red beans is greater than that of white beans. The grains (beans, rice and maize) buffer more acid than the tubers (yams and cassava), which should be discouraged in ulcer patients.
- (vi) The foetuses of pregnant women on commercial diets stand the risk of being adversely affected as caloric restriction adversely affects the placenta. Women should therefore avoid continuing their slimming

effort during pregnancy. They should however resist the temptation to eat for two during this period.

- (vii) Bile flow in the canine common bile duct is cyclical and reflects the activity of the gall bladder during fasting. Exogenously infused motilin however has little effect on canalicular flow and composition

Recommendations

- (i) There is need for our educational system, at the secondary school level to expose all children to the study of the sciences with particular emphasis on information technology. This will ensure that they are properly educated to know the various options available to them, not only at the tertiary level but also after graduation, in order to avoid moving blindly from "certainty to uncertainty".
- (ii) The government should promptly make up her mind if she wants to run a University system or glorified High Schools. The government should stop biting more than she can chew. I believe that there are enough resources to properly and adequately fund the University Education in this country. Our problem over the years had been bad management of resources.
- (iii) The Universities should begin to bridge the gaps between various disciplines. Interdisciplinary researches are the order of the day all over the world. There is no reason why a Physiologist, a Biochemist, a Nutritionist and a Pharmacologist and various Clinicians cannot work together to isolate and characterize local herbs which can be used for various ailments and which will be safe particularly in pregnancy.
- (iv) There is no reason why a Physicist should not be a member of faculty in the College of Medicine or a Clinician on the Faculty of the Social Sciences. An engineer should be able to work in the hospital in a team without feeling inferior or superior to others. Things seem to have degenerated to a bad state in our university system so much so that there is a polarization even within the same department, faculty or college. People who are supposed to be scientists now talk of "medically qualified" or "non-medically qualified" staff even in our Colleges of Medicine; to the extent that those who are disillusioned by this unfortunate trend have opted to leave the Colleges of Medicine and move into other colleges of Health Sciences. Things have, in some cases, gone to the extent that they have degenerated into unhealthy rivalry, partisanship, animosity, ill-feeling, ostracization and so on and so forth.
- (v) There is need for us to respect one another as we work together. We need one another in a collective fight against illiteracy, disease and poverty. University of Ibadan is the first and the best. Let us take a lead in things that are good.

- (vi) Our medical curriculum needs to be reviewed all over the country. Our medical graduates should be exposed to research methodology in basic medical and clinical sciences during their training, as is the case in most parts of the world except, regrettably, in this part of the continent. This will ensure that our doctors in the teaching hospitals would have access to laboratories where Basic Medical researches as well as Clinical researches are available. The medical students, basic medical postgraduate students and Residents will therefore form part of the team working in such laboratories.
- (vii) Individual Nigerians should be encouraged to fund researches in the Universities. The government alone obviously can no longer be the principal provider of research grants. Very wealthy individuals should begin to support research initiatives by providing the needed grant. We can borrow a leaf from people like Rockefeller, Macarthur and recently Bill and Melinda Gates. There is enough money I believe to go round. There are lots of potentials in our Universities waiting to be tapped. Unfortunately the money appears to be in the hands of many who apparently also do not know what to do with it positively.
- (viii) The government needs to seriously sanitize the money market. Most of the chemicals and laboratory equipment we use come from outside this country and we have to purchase them with hard currency. A situation where in 1987 at the height of the "SAP" one dollar was equivalent to only seven naira but which now has become one hundred and thirty naira, is bad for our Nation. Government should go to the root of the problem and find a solution. We still sell millions of barrels of oil daily, which means we earn loads of foreign exchange. A situation where people illegally and desperately want to take money out of this Nation for untenable reasons will continue to push the value of our naira lower and lower. The government should also put more money into the hands of Nigerians and stop trusting our economy into the hands of foreign consultants and contractors.
- (ix) Nigerians should rally round the government to address the decay in our tertiary institutions. We are all sitting on a gold mine, but if we do not know what to do, it will simply rot away. I dare submit that we cannot and should not allow this to happen.

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SUPPORT THROUGH THE RAGING STORMS OF PAIN

Olaitan. A. Soyawo
Department of Anaesthesia

Introduction

This is the third inaugural lecture from the Department of Anaesthesia, one of the 15 Departments in the Faculty of Clinical Sciences and Dentistry, College of Medicine, University of Ibadan. The first inaugural lecture from the Department was given by Professor J.A.O. Magbagbeola in 1976 and the second by Late Professor C.E. Famewo in 1993. The Department of Anaesthesia was created from the Department of Surgery in 1967 and this illustrates the age-long relationship between Anaesthesia and Surgery. Although the relationship between Surgery and Anaesthesia is often likened to that of husband and wife, this is not a monogamous arrangement. The department works in close collaboration with several other departments including medical, paediatrics and laboratory specialties to promote professional medical education and safety of lives especially during dangerous and critical situations.

The topic of my inaugural lecture is "Support through the Raging Storms of Pain" and this afternoon, I do not intend to make you view anaesthetists as those mere mortals trying to play the role of the Almighty, the Creator as may be implied from the title of this lecture. Rather, I would like to talk on some interrelated subjects, which have continued to be of special interest to me as an anaesthetist. These are the areas of the storms encountered during the multidimensional practice of anaesthesia and pain management, what the anaesthetist has to offer now and in the future. I shall start by giving a brief history of the specialty of Anaesthesia.

The Birth of Anaesthesia

The word 'Anaesthesia' was derived from the Greek words "a" meaning without and "aesthesia" meaning perception. Anaesthesia thus involves the production of a state of reversible insensibility to pain locally or through loss of consciousness. Methods commonly employed in the 18th Century were hypnosis, alcohol and

opium by inhalation of its vapour and by application of the powder to wounds. The latter method still finds some use in modern times during wars when the euphoric effect of opium is still found to be beneficial. Some extreme methods were also employed such as compression of carotid arteries to cut off blood supply to the brain. Phlebotomy or blood letting when carried *out* aggressively enough also caused loss of consciousness and was utilized as a pain-killer! But such methods can also promptly kill (Macht 1915).

Nitrous oxide was first prepared by Priestley in 1772 but it was Humphry Davy who discovered that it relieved pain while suffering from a toothache. Because nitrous oxide was later associated with asphyxia, its use was temporarily forgotten and overshadowed by ether for over 40 years. Dr. Crawford Long, a practising physician in need of safe anaesthetic, realized that those who participated at "ether parties" discovered bruises and other injuries acquired while under the influence of ether but had no recollection of pain. We probably will come across such interesting findings and produce extracts for anaesthesia and pain relief if we study the traditional herbs used by our people during initiation ceremonies and tribal clashes!

Ether, although prepared originally in 1540 by Valerius Cordus and used privately for several years was not introduced into clinical practice until 1846. W. T. G. Morton, a dentist on October 16th 1846, performed the first successful demonstration of its clinical use and brought about the turning point in the history of Anaesthesia. Within a few months, chloroform superseded ether as the most popular anaesthetic agent especially as the famous John Snow, the first full time anaesthetist gave over 4000 chloroform anaesthetics without a death. He succeeded in popularizing chloroform by administering it to Queen Victoria during the delivery of her eighth child (Prince Leopold) in 1857. This action also set down the seal of respectability on the relief of pain during childbirth and deliverance of women from the theological injunction of Genesis Chapter 3, verse 16. Cocaine was introduced for local anaesthesia in 1884 and by 1889 spinal anaesthesia was used widely and opened the doors to development and use of local and regional anaesthetic techniques.

The concept of "Balanced Anaesthesia" was embraced from 1926 when John S. Lundy of the Mayo Clinic introduced the term. He suggested that a combination of agents be used, so that general anaesthesia and pain relief were obtained by a nice balance of agents and techniques such as:

- (i) intravenous agent to produce loss of consciousness quickly;
- (ii) muscle relaxant for muscle relaxation;
- (iii) analgesic drugs for pain relief;
- (iv) other drugs to prevent unwanted reflexes like slowing of the heart.

With this concept, it is now possible to avoid deep levels of anaesthesia and depression of vital centers in the brain. The pace of development has been sustained in all aspects from inhalation agents, drugs, general and regional techniques and equipment. Thus the Schimmelbusch mask and ether drop method of the early days is now replaced with computerized anaesthetic and monitoring

equipment while information management systems are utilized for effective service, teaching and research. The pioneers of anaesthesia in the West African subregion – Waters, Flemming, Beckam, Oduntan, Oduro, Magbagbeola, ffoulkes-Crabbe, Obiaya, Akinyemi, Famewo, Odugbesan also made several contributions.

Anaesthesia as a Medical Specialty

Before World War I, there were few anaesthesia specialists, thus untrained inexperienced care providers including surgeons were assigned to anaesthesia. It soon became clear that this was a big mistake bordering on criminal negligence as those soldiers with massive trauma fared better with the skilled care provided by trained anaesthetists. Thus began the era of specialists in anaesthesia and for us, this is one good result from a world war (Davis 1968). During the World War II, massive trauma care, triage in emergency situations, delivery of anaesthesia outside the operating room, transfusion medicine and treatment of hypothermia all fell into the courts of anaesthetists. In the decade after World War II, several changes occurred in the scope and complexity of surgery. These could not have been possible without matching developments and refinements in anaesthetic practice. Nowadays, many surgical patients are very ill and caring for the patient before, during and after the surgical assault is a major role for the anaesthetist.

The Raging Storm

In the attempt to heal or cure, the surgeon's knife produces tissue damage resulting in pain and an outpouring of stress hormones. This situation is also similar to what a person encounters during major trauma, such as road traffic accident and severe burns. Pain is the most demanding of all symptoms of disease and most people who seek medical treatment actually have pain as a complaint. Historically, for many centuries, philosophers and psychologists followed Aristotle who thought pain to be a purely emotional problem (Dallenback, 1939). Even the Latin word "*poena*" from which "Pain", was derived means a penalty or punishment. But after the discovery of "Pain nerves" and "Pain Tracts", it is now known that pain is a complex experience having a sensory component and an emotional component. By 1979, the International Association for the Study of Pain (IASP) defined pain as an unpleasant, sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage (IASP 1979). To the ordinary individual, pain is unpleasant, a combination of agony and suffering and it is like being caught up in a raging storm.

During surgery, the surgeon requires his patient to be still without moving or complaining while he has a good view of his operating field. Occasionally, he asks the anaesthetist: "Is the patient OK"? The patient simply wants to be unaware of the operation and to be alive at the end. The anaesthetist on the other hand actually has to support the patient's various body organs through the surgical ordeal, which in some instances can even terminate in death. A lot of people say that the anaesthetist only "puts people to sleep". But we know that it is more important and more difficult to be able to wake them up! The

requirements of each individual that is rendered unconscious and the anaesthetic considerations are diverse and I hereby invite you all to join me in looking at some of the case scenarios often requiring the anaesthetist's support.

Let us start our journey with **The Pregnant Patient** who is expected to bring forth the new generation. She may be presented to the anaesthetist for surgery unrelated to the pregnancy, for provision of pain relief during labour or anaesthesia for operative delivery and management of complications related to childbirth. It is well known that pregnancy and labour produce remarkable physiological, anatomical and psychological changes in the mother. Although many of these complications are beneficial and help women survive childbirth, others place the women at increased risk of death. Even the layman is aware of some of these problems, hence prayers are often offered for safe delivery while culturally, several taboos are levied to protect pregnant women against harm. The choice of anaesthesia in the obstetric patient is influenced by the training and experience of the anaesthetist, the facilities available, the clinical condition of the patient and whether the procedure is elective, urgent or an emergency.

The fact that two or more lives (the mother and babies) are under the care of the anaesthetist simultaneously makes obstetric anaesthesia unique with additional challenges. Special considerations when general anaesthesia is employed include the less efficient gastric emptying and risk of regurgitation and aspiration of gastric content, intubation problems and the fact that in the supine position, the uterus presses on the inferior vena cava, leading to severe hypotension – the supine hypotension syndrome. During general anaesthesia, the mother is paralyzed while low concentrations of anaesthetic agents and sedative drugs are administered until delivery of the baby. The use of such “light anaesthesia” is aimed at producing an awake baby with the expectant loud cries. This technique could however lead to the problem of awareness during surgery when the mother would be able to hear and even feel pain.

As our own research contribution to this aspect of anaesthesia, Soyannwo, Elegbe and Odugbesan studied three groups of women undergoing Caesarian Section in 1988. We found that administration of a small dose of narcotic analgesic (pethidine 25mg) with a benzodiazepine (flunitrazepam 0.03mg/kg) was associated with a low incidence (4%) of awareness. Twenty-eight percent of the women in the control group were aware and five of them could repeat some of the statements made while under anaesthesia such as “this knife is not sharp”, “the baby is a little elephant”. Over the last decade, regional anaesthetic techniques especially spinal and epidural have become more popular in obstetric practice and this has minimized the risks associated with obstetric anaesthesia. Thus, in developed countries, maternal deaths attributed to anaesthesia has fallen steadily in the last 30 years (Fig. 2). In the Report on Confidential Enquiries into Maternal Deaths (CEMD) in the UK for 1994-1996, there were no deaths from general anaesthesia (Levy 2001). However, the story is different in our environment where preventable causes, ignorance, late referrals and inadequate facilities even when the women get to the hospital still lead thousands of mothers to their graves.

The Paediatric Patient

A happy and healthy child is a joy to behold and when children have to receive anaesthetic care, the dexterity, knowledge and competence of the anaesthetist are always maximally utilized. One may notice that a two-month old baby is listed on the operation schedule for a minor surgical procedure under anaesthesia but on preoperative visit, discover a tiny baby weighing less than 2 kilograms, who was born three months prematurely at a gestational age of 28 weeks. One also discovers that the baby had severe respiratory distress syndrome (RDS) at birth and was on ventilator support for one week in the neonatal Intensive Care Unit. On the same list may be a fit 10-year-old child for minor surgery. The anaesthetic management thus becomes a much more major event in the former infant who manifests the highest anatomical and physiological variance from an adult.

In 1986, I reported several problems of accessibility to the airway which were encountered in our paediatric anaesthetic practice as exemplified by the six day old baby with a large neck multinodular swelling, six month old baby with adherent upper and lower lips and 5 month old baby with frontoparietal mass (Soyannwo 1987). The latter being fat also posed the problem of venous access and she in fact developed mediastinal emphysema with pneumome-diastinum following traumatic intubation (Soyannwo and Ogunsehinde 1987). In major surgery, on the 4-year-old for excision of Wilm's tumour as reported by Soyannwo (1989); blood loss that has to be replaced accurately by the anaesthetist may be more than the total blood volume of the child. Blood transfusion in the perioperative period including the protection of self and others against the risks of deadly infectious diseases like the Human Immunodeficiency Virus (HIV) and Hepatitis are part of the schedule of the anaesthetist. Problems are also magnified when the children presenting for surgery come as emergency or are on treatment for other concurrent medical problems like sickle cell disease and congenital heart diseases as we reported. The anaesthetist must be knowledgeable on these issues and guard against complications throughout the operation and in the immediate postoperative period.

Patients with Medical Problems and Critical Care

Surgical patients who have intercurrent medical diseases pose a great challenge to the anaesthetist and the challenges are more in the elderly who manifest physiological changes and disease states due to the ageing process. My colleagues and I studied surgical patients in Ibadan in 1996 and found that 9.21 % out of a total of 2,106 consecutive patients had intercurrent medical diseases as listed in table 1.

Table 1: Incidence (%) of Intercurrent Medical Diseases in Surgical Patient in Ibadan (1996)

Type of disease	Percentage
Hypertension	42.27%
Diabetes Mellitus	13.4%
Anaemia	9.7%
Asthma	6.7%
Malnutrition	4.64%
Septicaemia	3.61%
Heart Disease	3.6%

Others include haemoglobinopathy, neurological and respiratory diseases, typhoid fever, thyroid and liver diseases (Soyannwo, Bamgbade and Odutola 1996). Although the physician may be consulted on the management of such diseases pre-operatively when time allows, the anaesthetist has the responsibility of intra-operative management and ensuring that the patient recovers fully from anaesthesia. This area of the work sometimes results in major conflicts between the cautious anaesthetist and the surgeon who is eager to operate even when the patient's disease state is uncontrolled. We reported our experience on surgery of toxic goitre in non-euthyroid patients whose economic situation led to non-compliance with prescribed medication and poor control of their disease. (Ajao, *et al*, 1997).

Because of the expertise in airway control, respiratory care and support of failing vital organs during surgery, the anaesthetist now plays a frontline role in critical care medicine. They are pillars in teams for the A, B, C (Airway, Breathing, Circulation) principles of Basic and Advanced Life Support, Cardiopulmonary Resuscitation, Trauma, Accident and Emergency and Intensive Care. These are areas where the knowledge of Basic Sciences and Clinical Skills of the physician anaesthetist are fully utilized.

The area of Respiratory support has moved from the realms of oxygen administration via nasal catheter or oxygen masks to various modes of mechanical ventilation, and nonventilatory components of therapy. The latter include position changes (supine to prone) for improved ventilation perfusion (V/Q) matching, nitric oxide inhalation in the treatment of severe Adult Respiratory Distress Syndrome (ARDS) and pulmonary hypertension and ventilation with a liquid perfluorocarbon to allow substantial improvement of gas exchange. The University College Hospital, Ibadan has one of the very few Intensive Care Units in Nigeria and this is under the Department of Anaesthesia.

Pain Management

Pain is a common feature in all the situations described above and Anaesthesia prevents the immense suffering it generates. Major surgery provokes prolonged release of catecholamines, which contribute to cardiac morbidity in the postoperative period. Pain can cause significant reduction in the respiratory efforts, heightened stress response and depressed immune function. Poorly

relieved pain has a negative psychological effect, causing sleeplessness and depression. Acute pain as in these cases results from tissue damage, cut nerve endings and maneuvers associated with anaesthesia and surgery. Acute pain usually has a short duration of hours or days of less than three months and improves with healing. Chronic pain on the other hand e.g. backache or arthritis is long standing (over six months) and a cause may not be found readily. Chronic disabling pain, widespread throughout the body is often thought to be a manifestation of psychological distress.

The Pain Message

Through a complex pathway, sensation of pain is transmitted by a variety of nerve fibres with different conduction rates to cells in the dorsal horn of the spinal cord. These cells act as "gate" as was first postulated by Melzack and Wall in 1965. When 'open', pain impulses pass through and pain is felt and if 'closed', no pain or little pain is felt. Descending pain pathway from the brain and several substances such as bradykinin, substance P, prostaglandins modify the pain message (nociceptive input). The message passes through relay stations in the spinal cord, medulla and midbrain to the brain where it is perceived as pain. Involvement of spinal pharmacological mechanisms and various transmitter substances such as peptides, excitatory amino acids, endorphins cause amplification (central hypersensitivity) or alteration in pain states. Knowledge in this area has enhanced various sites for pain treatment from peripherally acting to central measures acting on the brain.

Pain Assessment

You may want to ask, "How does the anaesthetist know that an unconscious patient such as the one under anaesthesia feel pain"? As earlier mentioned, pain is a combination of events, which include metabolic and endocrine changes. Thus, observations like increased heart rate, and respiratory rate, blood pressure, sweating and lacrimation may be pointers towards inadequate intra-operative analgesia. That is why the anaesthetist stays closely and monitors each patient carefully throughout surgery, using his clinical skills to decipher the cause of various changes occurring in the patient. Several monitoring equipment are also available now to assist with monitoring various parameters in the patient, the anaesthetic equipment and even the environment – a similar situation to the cockpit of an aircraft.

The anaesthetist deciphers that an unconscious patient under his/her care has pain but in the awake patient like postoperative, the patient complains of pain. Sound approaches to treatment of any pain must include appropriate assessment in terms of:

Self report-	what the patient says
Behaviour-	what the patient does
Biological methods	how the body reacts.

The patient is usually able to indicate where it hurts e.g. site of operation or distant sites. Specific descriptive terms are used to describe the type of pain e.g. sharp, aching or throbbing may imply likely organic cause related to tissue damage while numb, tingling are suggestive of nerve compression or injury and words like “buzzing”, “funny” when used may point to anxiety or fear.

Pain assessment is now considered to be the fifth vital sign that should be recorded regularly in any patient whether medical or surgical and furthermore, the years 2000 to 2010 have been declared the decade of Pain control and research. It is better to grade pain as objectively as possible before and after treatment while the commonly used English words have to be translated to relevant languages for ease of comprehension by patients. Our multidisciplinary group had to translate the universally employed Verbal Rating Scale (VRS), a part of the McGill Pain Questionnaire to Yoruba (Soyannwo *et al.* 2000)

0=	No pain	<i>Ko si irora</i>
1=	Mild Pain	<i>Irora die</i>
2=	Discomforting	<i>Irora ti o nini lara</i>
3=	Distressing	<i>Irora ti o ba ni lokanje</i>
4=	Horrible	<i>Irora ti o ga</i>
5=	Excruciating	<i>Irora ti o koja ifarada</i>

We are currently working on the translation of a 101 - instrument, the Multidimensional Affect Pain Score (MAPS) for use in Nigerian patients.

Pain assessment in neonates and small children (age < 4yrs) represents a major challenge due to the lack of the language skills and changing psychology. Although the pain rating scales used in adult can be used for older children, other scales are specifically designed for use in children. These scales make use of behavioural and physiologic parameters such as: restlessness, grimacing, vocalization, sweating, lacrimation, pupil dilatation, skin blood flow, tachycardia, hypertension, dyscoordinate respiration. Pictorial scales e.g. Faces scale, are useful for 3-6 years and the child can indicate which face represents the amount of pain being experienced.

Pain Control

The goals of pain management in this millennium emphasize the “process” rather than specific treatment modalities. There should be a collaborative, multidisciplinary approach while patients should be involved in developing the pain management plan. Use of combination of systemic analgesics, topical analgesics, wound infiltration, nerve blocks with safer and longer acting local anesthetics and non-drug therapies including acupuncture, Transcutaneous Electrical Nerve Stimulation (TENS), psychotherapy, peer support and pastoral counselling are now commonly employed.

Over the past two decades, opioids especially morphine and shorter acting preparations have come to the forefront among the drugs used for pain relief. The methods of dispensing have evolved from intramuscular six, eight hourly or as and when required dosing to intravenous, neuraxial, transdermal, and transmucosal as alternative routes. Non-steroidal anti-inflammatory agents including the new COX-II inhibitors and recently α_2 adrenergic agonists are now effective adjuvants to opioid use. During the last decade, the use of epidural and spinal opioids for acute pain control has increased due to excellent analgesia produced and ease of administration. It is now possible for patients to self-administer small doses of Opioids by Patient Controlled Analgesia (PCA) when they experience pain. This is achieved through computer-programmed pumps with a lockout interval to prevent overdose. A background infusion of the analgesic can be delivered to achieve a constant blood level of drug and ensure complete pain relief even during movement, coughing or straining. Where such facilities are available, acute pain teams consisting of a consultant anaesthetist, a nurse, and pharmacist supervise treatment and ensure safety and standard of care.

Many of the above methods can be used safely in children too since it is now proven scientifically that even the smallest neonate responds to pain. For physiological, moral, ethical and humanitarian reasons, pain should be anticipated and effectively controlled in all age groups. We have promoted this philosophy in our department and our research study has shown that even the customary male infant circumcision in Africans need not be accompanied by screams and yelling. Our use of eutetic mixture of local anaesthetics (EMLA) cream applied to the prepuce 45 to 90 minutes before circumcision significantly reduced the pain and discomfort associated with circumcision in infants (Shittu, Soyannwo and Sodipo 1997).

Some of you in the audience who have had major surgery in Nigeria will probably never like to go through the experience again mainly because of the pain experienced. Many studies worldwide including contributions from our department have shown that pain is undertreated. In a recent study, Faponle, Soyannwo and Ajayi (2001) showed that almost 70% of our patients indicate moderate to severe pain following surgery. Such a situation would have resulted in surgeons and anaesthetist being dragged to the law courts in developed countries. But despite the archaic pain management methods, 90% of our Nigerian patients still reported that they were satisfied with their pain relief! It is possible they expect that pain must be part of any surgical procedure or we are able to handle pain better culturally!

The situation for the Nigerian woman in labour is no better and even in this millennium most women still go through the agonizing pains of childbirth. It is now well established that pain relief during labour accomplishes more than just providing comfort because labour is both painful and stressful to the mother. Every effective uterine contraction increases the parturient's cardiac output, and the work of the heart. Her oxygen consumption, carbohydrate metabolism and secretion of stress hormones (adrenaline, noradrenaline, cortisol and cortisone) rise steadily. This taxes the mother's reserves and may deprive the foetus of oxygen and nutrients. Hence, several methods of pain relief are now offered to women during prenatal education.

In 1985, I introduced and confirmed the effectiveness of inhalation of a fixed concentration of 50% nitrous oxide in oxygen (Entonox) for pain relief during labour in Nigerian women (Soyannwo 1995). Pain relief was reported to be satisfactory in 86% of the patients. However, epidural analgesia is currently the most widely used technique to provide pain free labour in many parts of the world. This involves the delivery of weak solutions of local anaesthetics with or without opioid analgesics into the epidural space through an inserted catheter. Drug delivery may be achieved by continuous infusion, by intermittent top-up or by patient controlled administration (PCA), which offers the parturient the additional psychological benefit of being in control. She can even walk around, pain free during labour. The technique provides flexibility to meet the needs of each patient despite varied obstetric courses (spontaneous vaginal delivery, forceps delivery, caesarian delivery). Unfortunately, inadequate manpower and equipment prevent provision of such service on a routine basis in Nigeria.

The province of Anesthesiology also extends to the areas of chronic pain, cancer pain management and terminal care as part of the multidisciplinary team approach to patient care. The long hours spent in the theatre co-coordinating the activities of surgeons, nurses and other theatre personnel and communicating with anxious, distressed and sometimes difficult patients (and surgeons) are great assets. In order to be a pain specialist, the anaesthetist must appreciate and understand the pathophysiology of pain syndromes, be familiar with current psychophysiology, psychotherapy and use his knowledge of nerve blockade techniques.

Patients with difficult pain states including cancer patients are referred to anaesthetists for management. Majority of these cancer patients in developing countries are incurable by the time the diagnosis is made and pain occurs in about 70% of those with advanced disease especially cancer of the breast and prostate in Nigerians. Management of pain and other symptoms are therefore crucial to the quality of their remaining life. It is disheartening to know that this is a neglected aspect of medical care in Africa and Nigeria in particular. Therefore, there is an urgent need for formal education and research in pain and symptom control in terminal illness and establishment of Pain Clinics. After all, death is a price that everyone has to pay but it does not have to be painful.

The idea of formal pain management was initiated by John Bonica, a senior anaesthesiologist with the Madigan Army Hospital, United States of America who started the first Pain Clinic in 1944. He later became the founder of the International Association for the Study of Pain (IASP). Akinyemi and Famewo (1984) established the first Pain Clinic in Ibadan in 1978 while we pioneered the formation of a Cancer Pain Palliative Care Group in 1995. The activities of this group resulted in the inauguration of the Society for the Study of Pain, Nigeria, in 1998. For the first time, doctors, scientists, physiotherapists, psychologist, nurses and non-medical individuals who are interested in pain treatment and research could collaborate while the society has become a chapter of the international body.

Ajayi *et al.* (2000) have identified impediments to the availability of opioids in Nigeria and made concerted efforts for four years to get the Federal Ministry

of Health and its agency National Agency for Food and Drug Administration (NAFDAC) to make opioids available for medical use. These potent painkillers are now available and hopefully, Nigerian patients with cancer can obtain deserved relief using the WHO Guidelines for Cancer Pain Management (WHO 1986). This method stipulates that analgesics should be given "by mouth", "by the clock", "by the ladder", "for the individual", with "attention to detail" while non-opioid, opioid analgesics are employed with adjuncts as required. Regional neurolytic blocks, ablative neurosurgery, chemo-therapy, physical therapy, radiation therapy and other non-pharmacological interventions may also be indicated.

The Making of an Anaesthetist

Even where anaesthetic facilities are optimal like in the United Kingdom, Confidential Enquiry into Perioperative Deaths (CEPOD) revealed, that overall death after anaesthesia and surgery was 0.7% (Buck, Devlin and Lunn 1987). Anaesthesia alone was responsible for death in approximately 1 in 100,000 operations but contributed to 14% of all deaths. Thus like all aspects of life, anaesthesia is associated with risks but these can be kept to an absolute minimum. The training and knowledge of the anaesthetist must therefore be top class while he/she must be of sound mind at all times. Otherwise, he may not be capable of waking those put to sleep! In the developed world, anaesthetists are respected and highly paid and it is now commonplace for doctors who have acquired postgraduate qualifications in Basic sciences, surgery, medicine, paediatrics and other specialties to retrain as anaesthetists or anaesthesiologists.

In 1980, our study (Akinyemi and Soyannwo 1980) revealed how unpopular the specialty of anaesthesia was in a class of graduating medical students at the University of Ibadan. Anaesthesia as "a choice of future career" ranked sixth out of eight specialties presented. This situation has not changed and it is even worse at postgraduate level, which takes six years or more to complete. The senate of the University of Ibadan in its wisdom and based on the need to train postgraduate specialist medical teachers within the country, approved regulations for the Master of Medicine programme in 1964. Anaesthesia was one of the specialties and training took off in 1970. I became the only product of this training in Anaesthesia because a National programme under the Nigerian Medical Council replaced the M.Med. A West African programme under the West African Postgraduate Medical College was also commenced soon after. A University-based Diploma Programme, which was first available in London in 1935, was not commenced in Nigeria until 1967.

Elegbe and Soyannwo have shown in their study that by 1996, only 1 anaesthetist was produced per 49 surgeons trained on the West African programme (Soyannwo and Elegbe 1999). Anaesthesia manpower in Nigeria is therefore still in the lowest range of 1: 300,000 population (compared to 1:10,000 in USA). Hence, like in other countries with shortage especially developing countries, middle level manpower — nurses and technicians are trained to administer anaesthesia. I was privileged to train nurses to administer anaesthesia in The Gambia and install them in 7 newly established secondary referral centres

as part of the country's efforts to improve obstetrics services, thereby reducing maternal mortality (Soyannwo 1992; Soyannwo and George 1995). Such personnel are trained to work under supervision of physician anaesthetists but we found that 20% of those in Nigeria work alone under surgeons who sometimes know less than they do about anaesthetic issues — a very dangerous situation (Soyannwo, Oduntan and Faponle 1997).

What does Anaesthesia have to offer in the new millennium?

In the issue of *Anaesthesia* 2001 :volume 56, pages 272-296, A. Vohra of the Manchester Royal Infirmary U.K., asked: "So what is the role of the anaesthetist in theatre?" And I agree with his answer: "We are the patients' replacement brain. We induce a reversible chemical coma and then take over the functions that the brain would normally perform". Successful surgery requires the coordinated activities of employees with different skills (doctors, nurses, administrators, physiotherapists, pharmacists, technicians, porters etc.) and application of costly supplies and equipment in order to produce the finished product — a patient discharged with successful outcome. The breakdown in any step in this "assembly line" leads to frustration and dissatisfaction to all concerned. When such breakdown occurs on a regular basis as happens in our nation's health sector, dedication is sacrificed for self-gains and the number of colourful obituaries in our newspapers and television screens increase!

An extension of the surgical role of the anaesthetist is carried outside the operating theatre such as the new area of office day surgery, monitored sedation, resuscitation especially in "sudden death" situations, intensive care unit, obstetric unit and chronic pain management. These are areas of great challenge to all clinical anaesthesia providers but the onus is especially on Government and academic centers including our great University of Ibadan to provide required facilities for these clinical activities, research and education since all three are inseparable.

I am proud to have received most of my education and professional training in Nigeria but those were the days when our naira was stronger than the dollar and at par with the pound sterling. Hence, 50% of my annual salary in Nigeria in 1978 was enough to fully support my one-year study leave in Britain. Our country is still a consumer country and all equipment, consumable items and drugs required for teaching, research and service concerning anaesthesia, life support and pain management are imported. The government must therefore note the priority areas and take into consideration the value of the naira when allocating funds to tertiary institutions. A situation where strong opioid analgesics were not imported into the country for several years is unacceptable and government regulatory policies must be streamlined to prevent the suffering brought about through the unavailability of such essential and controlled medications. Nigerian parents, organizations and philanthropists also have a role to play in supporting tertiary institutions. It is pertinent to note that the funds spent on overseas medical bills and emergency air ambulance for a few can make meaningful impact if ploughed into improving educational and health facilities in Nigeria.

In conclusion, anaesthesia has changed from just "putting patients to sleep" to an area of perioperative and emergency medical care. As a team player, the anaesthetist is an indispensable member of trauma emergency response and life support teams, essential obstetric services, safe motherhood, appropriate clinical use of blood and palliative care. Any effort put into developing the specialty of anaesthesia will therefore reap dividends in all these areas where support is required through the raging storms of pain and death. I believe that when anaesthetists receive enough support to evolve into subspecialty and multidisciplinary groups in Nigeria, the specialty will surely attract more practitioners who will not only provide safety in sleep but will ensure freedom from the raging storms of pain.

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GIVING A VOICE TO THE RURAL POPULATION

Janice E. Olowoye

Department of Agricultural Extension and Rural Development

Introduction

It is a privilege to represent the Faculty of Agriculture and Forestry that has so many distinguished and senior professors. At the same time, however, it is overdue that the Department of Agricultural Extension and Rural Development be given this opportunity. In the 25 years of existence as a distinct department, this is the first inaugural lecture to be given from my Department. Although Professor A.U. Patel presented a valedictory lecture and Professor J.A. Ekpere gave a series of University Lectures, no one in the Department has previously been given this opportunity. It is, therefore, a challenge for me personally, but it is also an honour shared collectively by every member of staff of the Department.

Background

When I was a young girl growing up on a small farm in Iowa, U.S.A., I would dream, like any other child, about the future. Like many rural children, I guess my dream was to leave the farm and to have adventure. Never in my wildest dreams, however, did I consider that one day I would be living, teaching, doing research, preaching and raising a family in Africa. But my humble background provided a good training ground for relating with rural people, wherever they may be. I learned the dignity of labouring with one's hands and producing not only for oneself, but also for the household, community and even the nation. I saw the importance of the social support network. I found that there was wisdom in many of the ways of the rural community and in the vast knowledge of rural people, like my father and grandfather, about the land that they farmed. *In America, policy makers and researchers listen to the voice of the farmers, because the 'experts' recognize that the farmers know what they are talking about.*

In Nigeria, we in the academia, research institutes and government often ignore the ideas, aspirations, talents and difficulties faced by rural people who form a large proportion of our population. When the concerns of agricultural development and the needs of the rural population are addressed, the interventions are usually planned and implemented by outsiders with virtually no input from the people most affected by the programmes. ***In countless cases, our development projects and innovations have failed to achieve their objectives because the local population has not been given the opportunity to voice its views.***

This evening, by the help of God, I will try to provide the voice of many wonderful people living in the rural communities across this country and Ghana, that I have had the privilege of meeting and with whom I have interacted. They have taught me much and this is the opportunity I have to present their views, as I have understood them, in a venue of such distinguished personalities. I do not take this responsibility lightly, for to misrepresent their views would be a bigger sin than to ignore them. As I attempt to give a voice to the rural population, you will also see the faces of many of my informants over the past years of my field work.

The Importance of Listening

One of the main reasons why the rural people have not been given a voice in matters that affect their lives is largely because most researchers, development practitioners and policy makers do not listen to them. Communication is not just about talking - it is also about listening. When we fail to listen to the people most directly affected by our actions, problems will result. I will support this assertion with an example from the Bible. In the wisdom given to him by God, King Solomon made the following statement as recorded in ***Proverbs 18 vs. 13: "He that answers a matter before he hears it, it is folly and shame to him."*** This wisdom, however, was not passed down to his son, Rehoboam, who became king after his father. When he was setting his own plan of action for his tenure, Rehoboam consulted the elders and then his friends and mates. Rather than heed the caution of the elders, he decided to do what he and his friends wanted, rather than consider the wishes of the people over whom he was to reign. I Kings 12 vs. 13-14 records the action of the king:

The king answered the people harshly. He disregarded the advice that the older men had given him and spoke to them according to the advice of the young men.

Verse 16 of the same chapter tells us the reaction of the people:

When all Israel saw that the king would not listen to them, the people answered the king, "What share do we have in David? We have no inheritance in the son of Jesse. To your tents, O

Israel! Look now to your own house, O David". So, Israel went away to their tents."

The situation is not so different today. Many politicians, policy makers, academicians, and development practitioners take the role of deciding what they want or what they think the people should want, disregarding the views of the very people who should benefit from their actions. In many cases, the rural population becomes alienated, disillusioned, sceptical and even resentful.

I was greatly affected by a book that I stumbled upon in the 1980's. The title was *Fatal Remedies* by Seiber (1981). The title intrigued me because it seemed to be a contradiction of terms – how can a remedy which implies an improvement in a condition – be considered fatal? Yet, the premise upon which the title rested was that *very often our development interventions leave people worse off than if we had left them alone in the first place*. Unfortunately, experience has shown that this is a reality in some development projects. While it may be impossible to foresee all of the consequences of our interventions, I believe that we have a moral obligation to try to ensure that our projects do result in an improvement in the lives of the intended beneficiaries. One of the ways to facilitate this goal is to obtain the views of the local people and use their ideas as an input into the development of interventions and innovations.

Let me also sound a word of caution. Analysis of the impact of an intervention many times depends on who is doing the assessment. Since the evaluation requires a subjective assessment as to what is an improvement, there may be quite a difference in the views on the impact of a project between the rural population who feel the impact directly and the outside experts who may want to justify their actions.

Need for Academic Humility

There has been significant support in theory for the 'bottom-up' or 'farmer first' approach as opposed to the conventional 'top-down' or 'technology transfer' approach in programme development and implementation, including extension delivery systems (Chambers' 1988). Unfortunately, the communication flow from the rural dwellers 'up' to the policy makers and researchers, in reality, has seldom been encouraged, nor have the messages usually been taken very seriously. Very often, we feel that due to our higher formal education, we know better and should make the decisions for the 'uneducated'. For development workers, this often manifests itself in a feeling of superiority or paternalism on the part of the 'expert'. Allow me to illustrate this with a little story that I often tell my students:

A young graduate of agriculture went to a village as an extension agent to pass across information on innovations to improve productivity. He had a sense of pride with his achievement of an honours degree in agriculture from the premier university in Nigeria. As he went to the village in his

shirt and tie, he met an elderly farmer. The extension agent proceeded to explain to the farmer why the way he was spacing the plants and his combination of crops would not give a good yield. Wherever possible, he added some scientific terms which of course could not be translated into the vernacular. The elderly farmer listened patiently, as is the custom of the elders, and then asked the young man to show him his hand. Though puzzled by this request, the agent held out his hand. The farmer said, "Ah, I can see that this hand has not held a hoe for a long time, if ever. Now look at my hand. This is the hand of experience (Fig. 1). I will now tell you why I farm as I do and you will see that your advice cannot work in this area".



Fig. 1: "This is the hand of experience"

In research, this type of academic arrogance is sometimes expressed in objective questions with all of the possible answers provided. The farmer gives a response according to the categories provided, even if the possible answers do not reflect his position. We must admit that there are reasons and conditions that we may not be aware of, issues of importance that are outside our experience and views that had simply not occurred to us (Richards 1979). Rhoades (1987: 1-2)

presents a very descriptive picture of the limitations of many of our modes of research:

Agricultural scientists have developed and redeveloped methods on how to extract information and data from farmers to fit preconceived ideas about farming: e.g. questionnaires, farm trials, budgeting, cost-benefit calculations and even informal surveys. Yet, in all these methods, something is missing; they remain a one-way process. The questions are still ours and the farmer must struggle to fill in the blanks. Some experienced farmers have even become astute in giving us the answers we expect.

The Great Diversity of Rural People and Rural Places

There is a common saying: "*You've seen one, you've seen them all*". This is inaccurate when referring to rural people or rural places. I have visited well over a hundred rural communities throughout Nigeria and Ghana and I am yet to find two that are the same. Yes, they may look the same in physical terms, but none is a perfect match to another in social terms. This led me to write an article in 1984 entitled, "Degree of Rurality: Questioning the Empirical Existence of the 'Typical' Village". Consideration of these differences also formed the basis for my Ph.D research topic (Olawoye 1986).

There are several dimensions in which significant locality-specific differences can be found.

- In many localities, the socio-cultural picture of a community may be very diverse, having several ethnic and religious groups within, such as in many areas of the Middle Belt and the South-South geo-political zones of Nigeria, while other communities may be relatively homogeneous.
- The gender division of labour may also vary greatly from one group to another, even within a community.
- Ecological variations from one area to another affect the type of crops and other activities of the local population.
- The level of infrastructural development will affect the extent to which rural dwellers can take advantage of economic and other opportunities.
- Within a community, socio-economic status differences will determine the level to which individuals are able to engage in various productive activities as well as their standard of living (Olawoye 2001).

The tendency to over-generalize from the example of one or two cases must be checked. It is this tendency that leads one to believe that there is one master plan for rural development that will work everywhere, but that is simply not the case. In various studies using gender analysis, for example, I have seen such diversity in the income-generating activities, levels of social participation,

involvement in agricultural productivity and attitudes of rural women. Any strategy to enhance female participation in development programmes or to improve their household food security might be very successful in one locality, but be a dismal failure in another.

Linkages to other Villages, Towns and Cities

The conditions and activities in rural communities cannot fully be understood when viewed in isolation from other settlements, towns or even urban centres. Trager (2000: 2) states this position as follows: *“In order to understand what is happening in rural communities today, and to find ways to improve the situation of rural people, we need to look at a wider social field.”*

A study by Okali *et al* (2001) looked at the interactions and linkages between the urban centre of Aba in Abia State and five peri-urban and rural towns and villages in the same state. The basic proposition of the study was that *“rural and urban areas are interdependent localities characterized by exchanges of people, ideas, goods and services, to support livelihoods, rather than two separate and isolated socio-economic entities”*. [The theoretical framework for this study is shown in fig. 2] This assumption was supported by the findings of the study showing that the livelihoods of both rural and urban dwellers were to some extent dependent upon remittances, long or short-term migration, activities that spanned the rural-urban divide, social support and trading. In another study in Southwest Nigeria, Akinwumi and Olawoye (1994) found that one of the coping mechanisms employed by some poor urban residents was to send their children back to the relatives in the village for schooling to reduce their expenses in the city. The rural-rural and rural-urban linkages are of fundamental importance for people resident in either type of community.

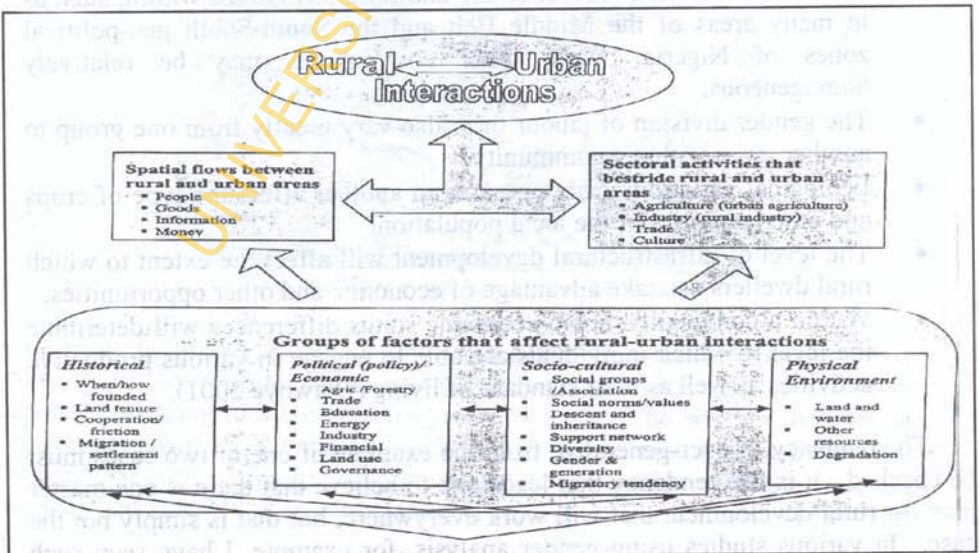


Fig. 2: Conceptual Framework for Rural-Urban Interactions

Rural Livelihood Strategies: How Do Rural People 'Make a Living'?

To understand how the standard of living of rural people can be improved, we must first know how they 'make a living'. The western concept of 'occupation' in terms of one activity by which all needs are met is not relevant to the experience of most rural dwellers in developing countries. The most realistic conceptualization of how rural people meet their needs is by noting the variety of activities engaged in to secure the goods and services required by their households. Loubser (1995) refers to the combining of such activities as 'livelihood', defining it as "*the totality of means by which people secure a living, have or acquire the requirements for survival and satisfaction of needs as defined by the people themselves in all aspects of their lives.*"

In studies with males and females in different rural areas across Nigeria and Ghana, a common finding has been that they engage in multiple income-generating activities. The major activities that result in necessary produce or income include crop farming, livestock rearing, trading, fishing or hunting, gathering non timber forest products, working as a hired labourer, selling cooked foods or snacks, carpentry or bricklaying, blacksmithing, working as a civil servant, tailoring or hair dressing and craft-making. In a recent study covering the six geo-political zones of the country, it was found that the overall average of activities per person, whether male or female, was 3.5. There were variations by locality, but in all areas, people engaged in more than one activity to 'make a living', even including the sampled women in *purdah* in the Northwest zone (Olawoye *et al.*, 2002). The variations by zone and gender can be seen in Table 1. Similar results were found in a study of rural women in different states in Nigeria. The average number of activities for sampled rural woman in Imo State was 3.6, for Oyo State - 3.2, in Niger State - 2.8 and in Bauchi State - 3.1 (Olawoye *et al.* 1994).

Table 1: Average Number of Income-Generating Activities per Rural Respondent by Gender and Geo-Political Region in Nigeria.

Geo-political Region	Average number of activities per male respondent	Average number of activities per female respondent
Northeast	4.3	4.1
Northwest	2.3	1.7
Middle Belt	3.2	3.7
Southeast	3.1	4.7
South-South	3.2	2.1
Southwest	4.9	4.7
Total Sample	3.5	3.5

Adapted from Olawoye *et al.* (2002)

There is a significant reason for understanding the fact that rural people, and indeed most people wherever they reside, combine numerous activities to meet their needs. Development workers tend to be myopic, viewing only the activity that they are directly concerned with, such as crop production. Consequently, they may not understand why the rural dwellers do not jump at suggestions to enhance their yields if the recommendations will require greater time input. For the rural women that are already overworked and need that additional time for their processing activities, gathering of non timber forest products (NTFPs) or tending their small livestock, such a suggestion would endanger their ability to earn extra income or ensure household food security. As my people used to say, "It is risky to put all your eggs in one basket."

One must also note that the sustainability of many of these activities is often not assured with conditions of insecure access to productive and natural resources, environmental degradation and economic instability. The implications for poverty alleviation with these uncertainties are very serious.

In line with the livelihood strategies of rural people, one must ask the question: *Is the rural household really the smallest unit of production?* Agricultural economists argue that it is, but evidence from studies looking at the groupings within the household, particularly separated by gender and generation would suggest otherwise. Females are more likely to have different activities and often separate income streams from males to meet their own specific responsibilities. The idea that all members of the household form a cohesive unit all working toward the same goal(s) and contributing their labour and other resources for shared activities with proceeds distributed for all is not commonly found. This is supported by findings that women are less likely to contribute as much time and resources in a joint venture if they are not likely to share out of the proceeds.

In a comparison of the seasonal calendars prepared by separate groups of rural males and females in a rural community in Southwest Nigeria, the difference in activities is apparent. It can be seen in Table 2 that some crops are planted by both males and females, but activities such as cocoa production, drying and marketing are done only by men while women are in charge of processing other crops such as cassava and palm fruits.

Activity	Male	Female
Planting	Yes	Yes
Harvesting	Yes	Yes
Processing	No	Yes
Marketing	Yes	No
Storage	Yes	Yes
Transportation	Yes	Yes
Other	Yes	Yes

Table 2: Seasonal calendar comparing activities of rural males and females in Southwest Nigeria

Month	Male Activities	Female Activities
January	Land clearing	Processing and marketing of farm produce
February	Land clearing; Bush burning	Processing and marketing of farm produce; Land preparation for early crops.
March	Land preparations; Ridge making	Processing palm oil and palm kernels
April	Spraying cocoa; Planting maize and melon	Processing palm oil and palm kernels; Planting early crops
May	Planting yam; Tending cocoa and kolanut trees	Weeding; Processing
June	Weeding; Spraying; Planting cassava	Weeding; Processing
July	Weeding; Planting late maize; Harvesting and drying cocoa	Harvesting early crops; Marketing; Land preparation for late crops
August	Harvesting dry maize	Planting late maize
September	Weeding	Planting cassava and yam
October	Harvesting early maize	Weeding and tending late crops; cassava processing
November	Cocoa marketing; Harvesting dry maize	Processing; Harvesting maize
December	Cocoa marketing; Harvesting dry maize	Processing, Harvesting; Marketing.

Source: Olawoye *et al.* (2002)

Gender Studies for Rural Development

I cannot leave this section without making a few comments about gender studies. Gender has been an important topic since the early to mid-80's and remains a significant research theme. Many writers have wrongly considered gender studies to be synonymous with studies only on women. In reality, gender looks at the relationships between males and females, recognizing that the roles and responsibilities, privileges and rights, constraints and potentials of males affect and are affected by those of females. From observing numerous studies using gender analysis and interacting with many self-acclaimed gender specialists, however, I feel it is important to make the following observations:

- Many researchers have tried to ‘cash in’ on the gender theme, recognizing that much of the support for research requires a gender component. I have seen persons that have openly expressed contempt for the current emphasis upon gender studies, yet have added ‘gender analysis’ to the title of their proposed research. Ultimately, they fail to capture the gender dynamics that affect nearly all aspects of our lives.
- Not all women are gender-sensitive and not all men are insensitive to gender issues. I do not agree that only women can study women. Sometimes, men can show even greater objectivity in gender studies than some female researchers.

A Special Note on Rural Women

I must take a few minutes to put special emphasis upon the case of rural women. As I have often seen the hard life endured by so many rural women – carrying firewood on the head, a baby on the back and maybe a basket of produce in their hands, or spending endless hours pounding grains and frying *gari* or walking several kilometres to fetch a bucket of water, the thought always comes: “*There, but for the grace of God, go I!*” (Fig. 3).



Fig. 3: “There, but for the grace of God, go I.”

The average rural woman is controlled or limited by so many social, physical, environmental and perception factors. There are often socially imposed restrictions on participation or movement from norms, values or religious beliefs. In such cases, even programmes designed specifically to provide economic, health or educational opportunities for women may not have the desired impact because the women cannot take full advantage of them. In the areas where young women are in *purdah*, the restrictions from going to the market, from involvement in women's groups and from participation in communal activities seriously limits their ability to benefit from many interventions. At the same time, however, one should understand the views of the women living in this social setting. One secluded woman from a village in Northern Nigeria told me, "We are the lucky ones. Our husband can afford to keep us. Poor women have to go out in the hot sun to farm." While I do not advocate maintaining the *status quo* when women's productivity, health and level of education can be improved, yet one should recognize the effect of the local perspective as a force limiting empowerment.

Social change has sometimes resulted in greater responsibility for the rural women in meeting the needs of the household. In the Southeast part of Nigeria, for example, there has been increased population pressure upon arable lands, which have also suffered from soil erosion. For many rural households, the productive resources available are not sufficient to meet the livelihood needs. The male head may then be constrained to migrate in search of salaried employment to supplement whatever the wife and children can produce on the farm. This has greatly increased the work load particularly upon the women.

In a study we conducted in Plateau State on women in tin-mining areas, the era of industrial mining resulted in changes in the traditional gender division of labour. According to our respondents:

Men from this area were once known to be great farmers, but with the advent of industrial mining activities, most of the men were employed by companies like the Amalgamated Tin Mining Company of Nigeria (ATMN). In order to keep their farmlands allocated to their households by the families, the women now started farming. If they did not farm, their in-laws would confiscate the land for lack of use. When the husbands occasionally came home, they were very happy to see how well their wives were maintaining the farms. By the time the industrial mining ended, the husbands came home finally. The men, however, felt that since the women had done so well during their absence, they should continue to handle the farming activities. Both the male and the female respondents agreed that this had now become a social norm, one that the men seem to be quite happy about and that the women seem powerless to change. (Pamma *et al.* 2000).

From the degradation resulting from decades of tin mining, productive activities are far more energy demanding than in the past. Because of this, many of the women have also taken to small-scale mining activities with men. In another example of social change, women are now involved in aspects of mining that were previously only carried out by men. Formerly, men were responsible for digging the wells and going down to extract the ore and the washing was done by women, but now women even go down into the pits to extract the ore. While this is very hazardous and tedious work, the women feel the potential earnings are worth the risk and effort and note that in some cases, they have no alternative.

The physical demands upon rural women with long hours and hard work required to meet their livelihood needs are often greater than they should carry. Research studies have noted that there are health hazards to the types and strains of the work activities taken on by rural women. One rural woman made a remark that I could never forget. In a study looking at how to improve women's productivity in Ghana, I saw that in one village, the women sold their cassava tubers unprocessed for a very low price. The women themselves had recognized that they could make a lot more money if they sold the cassava as flour or in other processed forms. Their constraint was lack of processing equipment. I asked them if they would be ready to process their cassava if they had the proper equipment. They eagerly answered in the affirmative. I had earlier asked them about their daily activities and found that they hardly ever had time to rest. I then reminded them that they were already overworked. One woman looked at me seriously and said, *"It isn't hard work that kills, it is poverty. If we can make money from it, we will do it"* (Fig. 4) (Olawoye and Canocoo 1995).



Fig. 4: "It isn't hard work that kills, it is poverty."

Rural women are very dependent upon environmental conditions for meeting their responsibilities. Declining environmental quality evidenced by deforestation, erosion, desertification and pollution have increased the time required and the hardships encountered in trying to fetch water, gather non timber forest products (NTFPs) such as firewood, snails, locust beans, shea nuts, vegetables and leaves, or produce their crops.

Another important factor affecting the conditions of rural women is their own perceptions of their capabilities and their self-worth. Very often, if one asks a rural woman what is your 'occupation' or what do you produce, she will respond, "Oh, I am just a housewife". Upon probing, however, one will find that she is probably engaged in several different income-generating and productive activities. She no doubt provides much of what the family consumes and spends, yet she has a very low view of her own contribution. Similarly, due to lack of formal education and social beliefs, she has probably also concluded that it is not possible for her to learn certain skills and thereby does not take advantage of some opportunities to enhance her productivity. For example, one women's group in Niger State was dependent upon a young man to operate their rice mill. From a few questions about the price charged for using the mill and the frequency of its use, it was apparent that the operator was cheating the women. He always reported that the profits were only enough to pay his salary. I suggested to the women that they could easily learn to operate the mill by themselves and keep their own records with a little training. I even showed them that I could start the engine. Their response was one of doubt, noting that it is only white or educated women who would be able to handle the equipment and the records. Their lack of confidence in their own abilities or feeling of low self-worth has been a limiting factor (Olawoye, Personal Field Notes, 1994).

Do Not Underestimate the Local Potential

It is common for most people both within and outside the rural areas to concentrate attention upon the local constraints and problems impeding their progress. There is no doubt that the obstacles to progress are many and serious; including low level of productivity, limited access to infrastructural facilities, lack of appropriate technology, high levels of poverty with increasing demand upon available resources, non-literacy of a large proportion of the population and inaccessibility of information sources as well as the poor state of the environment. In our concentration upon the problems, however, I believe we often overlook the positive aspects within the rural areas that can contribute to solutions to these problems. This is captured in the following quotation:

That people continue to function at all under extreme adversity and deprivation is an indication of their fortitude and adaptability, not of their weakness ... Catterson 1988:32).



Fig. 5: Environmental degradation increases rural women's burdens

I have often been amazed at the ability of people to survive and produce in areas with such harsh environments and social restrictions. As I noted elsewhere,

The social support networks, available human and physical resources including labour, the willingness to participate as well as indigenous knowledge and practices are among the important inputs available in the rural communities that can enhance the development process in areas where it might seem on the surface that there is nothing that can be locally contributed (Olawoye 2001:17).

The use of local community leaders - whether an *Oba* or *Eze* or District Head - can result in effective mobilization of the local population for self-help projects or for involvement in an externally-initiated project. Failure to gain the approval and support of the representatives of the people, however, will usually lead to opposition and unsustainable gains.

Developing Programmes Acceptable from the View of the Intended Beneficiaries: Responding to the Felt Needs of the Rural Population

There is no doubt that in most cases, development planners desire to improve the productivity and standard of living of the target population. Without taking the time to listen to them, however, they often miss the target. I will illustrate this point with the following example.

In the town of Savelugu in the Northern Region of Ghana, women's groups had been assisted by IFAD to obtain a corn mill (valued at c2.27 million) and groundnut oil extracting mill. The groundnut oil extractor is not being used because no one comes to patronize them. The women stated that people don't like the way the equipment processes the groundnut oil, leaving very little paste left over to make *kuli-kuli*, from which the women make a bigger profit than from the oil. In the case of the corn mill, the women complained that the machine is always breaking down and so they spend all their profit on its repairs with nothing left over to pay back the loan for the equipment. The women asked me to pass on their appreciation to the IFAD officials, but requested that they should come for their corn mill and oil extracting mill and provide them with a shea nut crusher instead (Olawoye and Canacoo 1996).

Even within the community, there is often a lack of consensus on which needs are greatest. In a recently concluded study on Gender and Rural Transport carried out for the Federal Department of Rural Development, we found that transport and transportation was the commonly stated priority need overall, yet there was variance from region to region, community to community and males to females, as shown in Table 3.

Some Voices are Louder than Others

One of the social realities that is often overlooked in studies of rural people is the fact that there are differences in socio-economic status and social power. These differences are often not easily apparent because it usually appears as if everyone is essentially at the same level of poverty. In reality, however, there are cases where so-called 'poor' farmers may, in fact, be quite wealthy. Cases have been found of 'disguised wealth' in the form of houses and vehicles in town owned by cash crop farmers who otherwise appear to have a low status in their farm residences (Akinwumi and Olawoye 1994).

State	Gender	Priority Need	Percentage
Oyo State	M	Transport	38 (34)
	F	Transport	45 (30)
Zamfara State	M	Transport	47 (40)
	F	Transport	38 (40)
Kano State	M	Transport	55 (50)
	F	Transport	38 (40)
Kaduna State	M	Transport	38 (40)
	F	Transport	38 (40)

Table 3: Rankings by Perceived Importance of Communal Needs by Paired Needs Comparison among Men and Women's groups in Selected Rural Communities of the Six Geo-political Zones

Type of Need	South-South: (Ogoloma, Rivers State)		Southeast: (Okwu, Imo State)		Northwest: (Ungogo: Kano State)		Middle Belt: (Jarawan-Kogi, Plateau State)		Northeast: (Yawi, Borno State)		Southwest: (Ikereku, Oyo State)		Average (rank)
	M	F	M	F	M	F	M	F	M	F	M	F	
Transport – related	1	1	2	1	--	3	4	3	1	3	1	1	1.9 (1 st)
Education / schools	2	6	5	6	2	3	5	1	2	6	--	--	3.8 (4 th)
Water	3	2	1	3	1	1	3	4	1	2	3	2	2.2 (2 nd)
Medical / hospital/ health	4	7	4	2	2	2	5	5	3	4	--	--	3.8 (4 th)
Market	8	4	6	4	--	--	3	2	4	7	--	--	4.7 (6 th)
Electricity	5	5	7	8	--	--	2	4	1	5	2	3	4.2 (5 th)
Agricultural inputs	--	--	3	--	2	2	1	5	5	1	3	3	2.8 (3 rd)

Note: (a) The highest rank is 1, meaning that it is the highest priority among the needs identified by the local population.
 (b) In some cases, there is more than one type of need that has the same ranking. This occurred where the need received the same number of responses.

Source: Olawoye *et al.* (2002)

Within the rural community, as in any social unit, there are some people who are economically and/or socially more powerful and more likely to have opportunities not open to others. While the majority of rural women are resource-poor, there are women who are able to take advantage of marketing or other economic opportunities on their own. In a study on women's involvement in the forestry sector, it was found that the 'timber converters' in Edo State, that is, those who purchased the logs from the timber contractors and hired sawmillers to 'convert' them to sawn wood for sale to carpenters were mostly women (Olawoye 1997). According to these women, lack of money was not their problem. There are also cases of women entrepreneurs who buy up the produce of other women farmers at a lower price and arrange transport to carry the goods to markets in the peri-urban or urban areas where they make a substantial profit (Olawoye *et al*, 2002). Such rural dwellers should not be the target population for poverty alleviation programmes.

It is important to make a point here. One of the defining differences between the poorer and richer rural women has been found to be the individual's ability to take advantage of economic or social opportunities. For poorer women, their only mode of access to productive resources, information or markets is through their groups while richer women can participate fully as individuals (Olawoye 1994). It is true that poorer women often suffer exploitation from men who may take over their resources or income-generating activities once the tasks become less tedious and more profitable. At the same time, however, poorer women often suffer from the exploitative activities of other women who pay them very little as hired labour or buy their produce very cheaply to sell at exorbitant prices in the urban markets. Many of the harmful traditional practices that are against women, such as rituals that widows must endure, are actually perpetuated more by other women than by the men (Olawoye 1998). It is important to fully comprehend the factors that affect the conditions hindering the development of our people.

Social stratification is a reality in the rural areas. There are several groups of rural dwellers that are not only poorer than others, but the social barriers to their advancement often leave them out of development benefits. In such cases, targeting of intended beneficiaries may be necessary to ensure that the gains of the interventions are not 'hijacked'. Idachaba (2000) notes how many of the past agricultural development schemes stated that the intended beneficiaries would be the small-scale farmers, but in reality, those that benefited were merchants, contractors, middle-men, government officials and transporters.

Among the socially marginalized groups are:

- rural poor,
- majority of rural women,
- tenant or landless farmers,
- ethnic minorities or ethnic groups not having political positions, and
- pastoralists.

To ensure that development projects do not further impoverish these people who are often the intended beneficiaries of such interventions, targeting mechanisms for participation in the project are sometimes needed. Among the means for targeting the socially marginalized members of the community are criteria for qualification that may include owning no more than a small area of land, never before benefiting from any formal credit scheme and willing to contribute one's own labour - not hired labour - for the project.

Yet, involving the less privileged members of the society in development programmes is not enough to ensure that they are able to retain the benefits. In Katsina State, I was involved in a supervisory study for a community development project which included land reclamation of severely degraded farmlands that had been abandoned. The landless poor farmers, including women, were given a small portion of land to rehabilitate using time-consuming and tedious methods that were yielding favourable results over a period of years. My major concern, however, was that having improved the land, the long lost owner would come back to claim his land, thereby depriving the poorer farmers from reaping the fruits of their labours. I recommended at that time that the participating farmers should be issued certificate of occupancy or other form of recognized ownership to the lands they had rehabilitated (Olowoye, Personal Field Notes, 1996).

How Can We Hear Their Voices? Participatory Methods

The use of a number of qualitative methods has gained prominence as a means of securing information from the rural population. One of the most commonly used methods is Focus Group Discussion (FGD) Fig. 6. In a group situation, people will usually offer information that they might withhold during an individual interview. Recognizing that discussions might be affected with gender, generational or socially mixed groups, males and females, old or young, better-off and poorer and different ethnic groups are often put into separate groups for the discussions. What women or younger people may not be able to voice out in the presence of older males can be said in a group of social equals.

In-depth Interviews with Key Informants is another important means of securing information on general characteristics of the community or group. Key Informants may be community or religious leaders, leaders of farmers', women's or youth groups or opinion leaders. Development workers from governmental or non governmental organisations can also provide important insights. The significance of Key Informants is that they can provide background information on social norms or beliefs, history of the community, level of infrastructural development and past interventions or self-help efforts.



Fig. 6: FGD with men's group in Northern Nigeria.

Participatory tools including community mapping, seasonal calendars, daily activities charts and ranking of paired needs are increasingly being used as a means of securing information while at the same time providing a medium for interaction between planners and the local population. In developing a diagrammatic illustration of their community, activities and needs, the rural people and the researchers or planners are able to better diagnose the problems and find a more suitable solution. In a recent study conducted in two forest reserves in Southwest Nigeria, community maps were drawn by the local inhabitants of enclave villages to delineate the spatial relationships between the residential buildings, roads, farmlands and the natural and plantation forests. The study was designed to determine the likely impact of the proposed logging of the surrounding forest. Figure 7 illustrates the potential for conflict between farmers and loggers if care was not taken to protect the cocoa and kolanut trees during the extraction of timber trees from the plantation. The location of the road relative to the forest areas shows that the most direct route to extract the logs would be through the farmers' tree crops. The farmers noted that there would be no trouble as long as their crops were not disturbed. From past experience, however, they were aware that loggers have not usually been very considerate of the farmers' rights (Olawoye *et al.* 2000).

Seasonal calendars and daily activity charts help to understand the time constraints of rural dwellers, as well as the complex allocation of time on a daily or monthly basis for the numerous household and communal activities. This can

be very useful when trying to determine the best time of the day or the year for scheduling a meeting or project that will not disrupt the usual activities of the people. In one village that I visited, I was surprised to find out that the literacy classes were being conducted from 6-8 pm. When I asked why it was so late, they responded that in order for the women to participate, the classes had to be scheduled for a time when they would be free. Until 6 or 6.30 pm the women were still busy preparing food and other household duties. Although the men were free from 4 pm., they agreed to this later time, even though some of the lessons were conducted with lantern (Olowoye, Personal Field Notes, 1995).

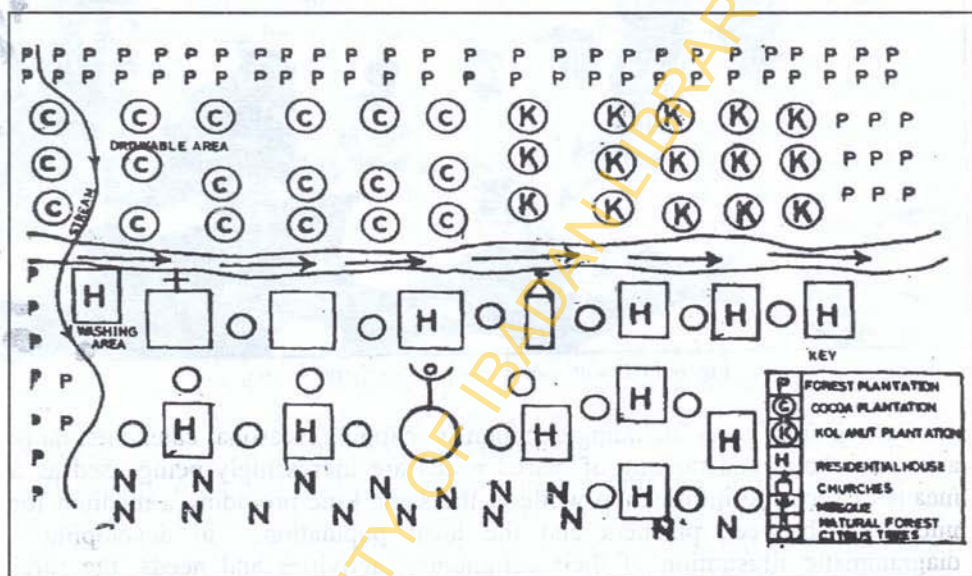


Fig. 7: Community Mapping of Adejori Camp (Plantation and Natural) in Ondo State

Importance of Extension and Rural Sociology for Giving the Rural Population a Voice: The Past, Present and Potential Role of the Department of Agricultural Extension and Rural Development, University of Ibadan

There is currently national and international interest in developing better methods for agricultural extension and rural development. The Federal Government has stated its commitment to improving extension delivery and alleviating rural poverty. It is important that this process is undertaken in a way that is acceptable to the rural population and sustainable for their long-term development. Their voices must be heard.

The Department of Agricultural Extension and Rural Development can play an important role in capacity-building and institution-strengthening to meet national man-power needs to achieve this purpose. Yet, there are constraints to turning our potential into reality. In the 1970s, the Department was well-known for the Integrated Rural Development Project at Badeku. The project site was not only a means of providing services to the society, but it was also a practical

classroom for students and a research 'laboratory' for staff. At one time, the project involved not only staff from the Department, but also from other departments in the Faculty and other faculties as well, including the Department of Community Health and Preventive Medicine from the College of Medicine (Olawoye 1991). When the funding ended, the project also ended. It is unfortunate that due to lack of transportation, we are unable to even take our students to the rural areas, which is a necessary 'extension' of our classroom.

Our Vision

The University is moving forward, to the glory of God. We have seen the commendable efforts of the authorities to give the institution a new look and the 'vision' to restore the enviable position once held as a centre of academic excellence. To have a vision of where one is going is crucial to getting there. Even the Bible says: "*Where there is no vision, the people perish*" [Proverbs 29 vs. 18].

The Department of Agricultural Extension and Rural Development has also developed a vision to be an integral part of this new era. When I became Acting Head of Department on 11th August, 1998, we considered how the Department could become more relevant to the national and local needs for capacity-building and institution-strengthening and to facilitate rural development. On the 21st of August, we submitted a "Plan of Action for the Development of the Department of Agricultural Extension Services." After reading our proposal, the then Vice Chancellor, Professor Adewoye, commented, "*It seems you want to change your image.*" I answered in the affirmative. He then suggested, "*Why don't you change your name.*" That suggestion became the push to change the name of the Department to give it a broader coverage which was more in line with the expanded view of our potential.

One of the needs I expressed at that time was the shortage of specialized teaching staff. Having four areas of specialization – agricultural extension, rural sociology, rural communications and home economics, we were suffering from inadequate human resources. As an example, from 1978 until 1998, I was the only rural sociologist in the University of Ibadan. Staff deficiencies were also found in the areas of home economics and rural communications. I am happy to state that five new teaching positions were created and filled the following year. In terms of human resources, the Department is well endowed.

The academic programme at the undergraduate level has evolved over the years, but an unwelcome intrusion came several years ago with the imposition of the NUC Minimum Academic Standards Programme. At the University of Ibadan, we were already operating above that standard, yet we were constrained to adopt an academically inferior programme. For the Departments of Agricultural Economics and Agricultural Extension and Rural Development, it became even more threatening as one degree programme replaced the previously existing separate and better specialized programmes. In the present dispensation of academic autonomy, the Departments are putting together their proposal for

reviving their distinct and more appropriate undergraduate degree programmes. This will soon come before the Senate.

Curriculum Committee and later the Senate

At the postgraduate level, we have good academic degree programmes for the M.Sc., M.Phil. and Ph.D degrees. We have recognized the need to provide training of trainers for strengthening the capacity of organizations providing extension services and facilitating rural development. To achieve that goal, the Department has already developed programmes for a professional postgraduate diploma in Agricultural Extension for serving extension personnel, a professional postgraduate diploma in Rural Development for rural development workers who might not need specific training in agriculture and a professional Master of Extension and Rural Development. From our survey of training needs, we believe these programmes will not only perform an important function for the nation, but also generate income for the University. These programmes have been approved by the Faculty Postgraduate Committee and we are now carrying out the market surveys. The proposals will then be forwarded to the Postgraduate School. It is our plan to introduce the new programmes progressively, beginning with the PGD for Agricultural Extension. Already we have had several enquiries about when it will commence.

The members of staff of the Department are eager to fulfil the vision of providing qualitative education to meet the needs of the Nation, but we are constrained by the lack of adequate facilities. The Department of Agricultural Extension Services was established as a separate department in 1976, yet we have never had a separate building. In the budget for 1980, The Department was placed on "Priority A" for a building along with Faculty of Technology, Faculty of Medicine and Faculty of Veterinary Medicine. Plans were drawn and the ground was pegged, but our own building never materialized. At the present time, the Department is housed in two locations on campus which is not efficient for proper coordination. The space for offices and classroom is also inadequate. We have not given up, however. As a step of faith, we have erected a signboard on our land (Fig. 8). By the grace of God, the building will become a reality. I use this opportunity to remind the University authorities of this important need. Please, don't pass us by again.

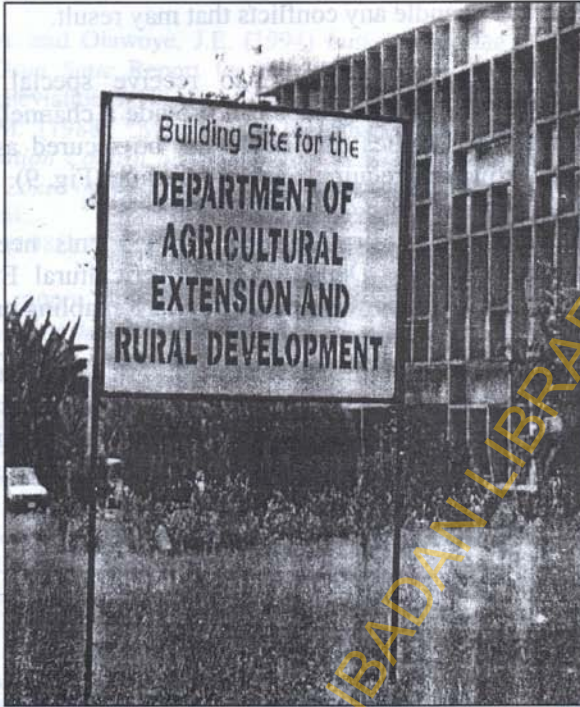


Fig. 8: Proposed Building Site for the Department of Agricultural Extension and Rural Development

Conclusion and Recommendations

1. Too much of our attention to participatory development interventions has been in rhetoric alone rather than action. We speak of the importance of local participation, but then fall into the old ways of deciding and doing for the people, rather than with or by them. There is a need not only to give the rural dwellers a voice, but actually use their ideas as an input to policy formation and implementation as well as later giving them 'ownership' with its attendant responsibilities. This is not only the right thing to do, it is also the wise thing to do.
2. Rural development interventions must be locality-specific, taking into account the unique social and ecological conditions and designed on the basis of information obtained at the local level. Collecting data from the rural population should be achieved through participatory and innovative methods. The felt needs of the rural dwellers should be identified and set as a priority for programmes.
3. Socially disadvantaged groups need to be targeted for assistance. Social mechanisms to ensure that intended beneficiaries are able to obtain and

retain the gains of development programmes must be put in place as well as mitigation measures to handle any conflicts that may result.

4. Poorer rural women should continue to receive special attention in development efforts. Their local groups can provide a channel for members to have access to opportunities that could not be secured as individuals. These groups may, however, require capacity-building (Fig. 9).
5. Many rural development workers and extension agents need innovative training programmes that the Department of Agricultural Extension and Rural Development can provide with the appropriate enabling environment.
6. The University of Ibadan should retake its position as the academic leader for other institutions to follow. Our programmes should be the product of our expertise and not imposed by administrators who find it more convenient for all programmes to be cut in the same pattern. This means we need to encourage the present striving for excellence and actively use the promised autonomy of universities to maximize our potential.



Fig. 9: I pray that one day they will not have to 'move out to move up.'

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NUTRITIONAL ENGINEERING IN MAMMALIAN REPRODUCTION: OBSTETRIC AND GYNAECOLOGIC CONCERNS

A.I.A. Osuagwuh

Department of Veterinary Surgery and Reproduction

Introduction

From the esoteric point of view, reproduction is the gateway to mortality and immortality. But from a scientific point of view, reproduction is more than just two individuals of opposite sexes simply mating or breeding. It is a complex scientific enterprise and a highly well synchronized and timed biological process through the activities of several hormones produced by the endocrine system. Cohen (1977) describes the complete process as the replacement of parents by their progeny. According to his description, the first stage includes the production of haploid gametes by germ cells within the gonads of the first generation; union of gametes to create a diploid conceptus; development of the conceptus through the embryonic and fetal stages; parturition, lactation and various degrees of postnatal care. The off-spring must subsequently grow, reach sexual maturity, mate and produce their own progeny. It must be observed here that the description of Cohen obviously indicates that the complexity of the science of reproduction is appreciated with a good knowledge of endocrinology, physiology, anatomy, embryology, histology, cytology, microbiology and nutrition.

Evolution of the Process of Reproduction

The inauguration, by God, of the process of reproduction in all organisms, including man and animal, is when God is quoted as saying to its creatures "be fruitful and multiply and fill the earth" (Genesis 1:21-28). This indicates clearly that in the beginning there was reproduction in all living organisms and that without reproduction all living organisms could have become extinct. There are, however, variations in the different methods of reproduction among living organisms. A large number of lower organisms propagate mainly by vegetative

or asexual means. With this method endless clones are produced and each clone is identical to the single parent. Such lower organisms like amoeba and paramecium reproduce asexually through a simple division of the parent into two as the protoplasm increases in bulk.

Another asexual method of proliferation is by budding as seen in the yeast and in simple animals like the hydra. These methods of propagation do not require specialized reproductive organs for the production of gametes, and there is no involvement of different sexes.

All forms of asexual reproduction can be highly prolific for they allow quick exploitation of suitable environment and nutrient supplies, but do not allow for genetic variation or adaptation in the same manner that sexual reproduction does.

However, combination of genetic materials is accomplished periodically by bacteria or protozoa through the act of conjugation which involves a temporary fusion and exchange of DNA material. In this case once conjugation is completed the partners separate and continue asexual propagation.

Sexual reproduction, on the other hand, involves the combination of genetic materials as contained in the male gamete (spermatozoa), and the female gamete (usually referred to as ovum or egg). This act constitutes fertilization which is the essential element in sexual reproduction.

Many diverse mechanisms for sexual reproduction have evolved in individual organisms. There are few species that are truly bisexual (hermaphrodite), with individual components of the same organism producing male and female gametes. In this case self-fertilization can occur even though this is not the usual practice. We have several thousand mammalian species but it is only in about 25 species that extensive study of their reproductive biology has been carried out. These include rodents, rabbits, primates (including man) and farm animals.

Reproductive Roles of the Male and Female in Domesticated Mammalian Species

The male gonads produce spermatozoa and male sex hormones. The production can be continuous throughout the year or during the mating season. In Nigeria, as in most tropical countries, all the male domesticated animals and men all over the world produce spermatozoa and sex hormones throughout the year. The spermatozoa are produced within the seminiferous tubules in the testes, and are stored in the epididymis. All males with normal libido should always be willing and able to copulate with a willing or receptive female. The male must be physically capable of mounting the female and have properly functioning genitalia to effect intromission and ejaculation. In some species the male may contribute to post-hatching or postpartum care, protection and education of the progeny. This is true of some non-domesticated mammalian species, as well as man. However, the role of the male in a particular reproductive enterprise in domesticated animals is finished immediately after copulation and ejaculation. Post-partum care, protection and education of the young become the sole responsibility of the female.

On the part of the female, she must produce ova or eggs and sex hormones. Unlike the male, this is done in a cyclic rather than a continuous manner. Again the mature female gametes or ova are not stored as in the mature male. Rather, as the ova approach maturity, the behaviour of the female changes. She becomes more sexually active and receptive and can willingly allow the male to mount her. This is the period of ovulation in most mammalian species.

Following successful mounting, ejaculation and fertilization, the mammalian mother must then provide the proper uterine environment for the normal development of the conceptus and eventually give birth. However, it is not all matings or copulations that result to the birth of a new baby. Reproductive wastages or losses occur in mammalian reproduction due to fertilization failure, early embryonic death, intrauterine fetal death, abortion, fetal death resulting from dystocia, or difficult birth and neonatal death. Some of these wastages can also occur due to bacterial infection such as brucellosis, viral infection, protozoa infection, poor housing and poor nutritional management or manipulation during pregnancy. With very good obedience to the laws of hygiene and strict application of prophylactic principles in any mammalian reproductive activity, poor nutrition becomes a limiting factor.

Nutritional Needs During Pregnancy

Nutrition aims at providing all essential nutrients in adequate amounts and in optimum proportions. Based on their chemical structure and functions in the body, nutrients can easily fall into a six-fold classification:

- Carbohydrates
- Fats
- Proteins
- Vitamins
- Minerals, and
- Water.

Nutrition is basic in all mammalian physical, physiological and spiritual activities. From conception to birth, from birth to sexual maturity, the mammalian species are nutrition dependent. No wonder then, it has been stated that "a hungry people listen not to reason nor are its demands turned aside by prayers" (Seneca 4BC-65AD).

Aristotle was correct in asserting that procreation and feeding are the main pre-occupations of living animals. The nutritionist may go further in suggesting that of these two pre-occupations, feeding is of overriding importance, for without the urge and ability to seek and consume their food, animals would not reach sexual maturity and could not reproduce themselves. In fact in some species the first signs of an inadequate level of nutrition is a failure in reproduction.

From conception to birth, all parts of the fetus are made of nutrients from the maternal store and diet. The quality and quantity of milk produced by the mother

post-partum for the feeding of the young is a function of the quality and quantity of the diet provided to the mother during pregnancy and after (Osuagwuh and Akpokodje 1992).

Placental Development and Nutrition

Following fertilization in mammalian species, a new temporary organ develops within the uterus. This temporary organ is called the placenta and will be discharged from the uterus soon after birth. It performs respiratory, absorptive and excretory functions for the developing fetus. It also functions like an endocrine gland producing array of hormones that not only help in the maintenance of the pregnancy but also in the expulsion of the fetus at birth.

The placenta sets the physical framework that allows fetal growth. It grows more rapidly than the fetus in the first two-thirds of pregnancy and then ceases growth over the remaining one-third. Based on the fact that the placenta is a versatile and metabolically active organ, one is tempted to conclude that poor nutrition in early pregnancy might restrict the size of the placenta and therefore reduce the ability of the fetus to grow normally later in pregnancy, even under good nutrition.

For example, it has been shown that severe under-feeding in early pregnancy will reduce placental size (Everitt 1964, 1968; Alexander and Williams 1971).

Fetal Growth and Nutrition

Fetal growth is known to be affected by several factors such as heredity, dam size, parity, nutrition, placental size, sex and ambient temperature. Of all these, it is considered easier to manipulate the nutritional factor in order to avoid pregnancy losses than the other factors (Osuagwuh and Aire 1990). Even though the fetus is generally believed to be privileged nutritionally studies have shown that the level of maternal nutrition during the last stages of pregnancy has marked effect on the birth weight. For example, Chow and Lee (1964) have shown that restricting the feed allowance of female rats during pregnancy and lactation by 25 to 50 percent, caused permanent stunting of the young from which they did not recover. Thompson and Thomson (1953) report that pregnant sheep on low level nutrition produced small and weak lambs, most of which died at birth or soon after. This was in contrast to vigorous lambs and few deaths recorded for sheep on a high level nutrition. However, a pregnant animal under nutritional stress will abort the fetus (Osuagwuh, Akpokodje, Akusu, 1986).

Overfeeding in late pregnancy, particularly of animals in relatively poor condition, increases the size of the fetus when compared with that in control animals. Unfortunately, this kind of increased feeding during late pregnancy usually leads to increase in fetal size and can cause and do cause reproductive losses due to difficult birth (Curll *et al.* 1975; Osuagwuh 1992). Because of the high reproductive losses resulting from both underfeeding and overfeeding, there is considerable controversy about the most appropriate way to manage the feeding of pregnant domestic animals to minimize these losses. As a veterinary obstetrician and gynaecologist, I find myself professionally competent to attempt to settle this controversy.

In my academic sojourn in this University, I have spent most of my time studying the reproductive constraints of the West African Dwarf (WAD) goats with special reference to its nutrition during pregnancy. Goats, generally, were for long, neglected in research activities especially in the area of reproductive nutrition. This, no doubt, may be related to the relative unimportance of the goat in temperate regions of the world. And, more importantly, there was this common assumption that the findings in nutritional studies in the dairy goats and cows can be extrapolated or used for the non-dairy tropical goats.

My research interest in reproductive nutrition in West African Dwarf goats was based on the results or the investigations I carried out at the University of Ibadan Teaching and Research Farm in 1981. The study involved the analysis of 176 kidding, involving 320 kids from an original population of 85 female adult goats. The study was an attempt to evaluate the reproductive performance of the WAD goats and to assess their reproductive potentials (Table 1).

Table 1: Reproductive Performance of the West African Dwarf Goat

Trait	Value
Age at first kidding (months)	19.82 ± 4.60
Kidding interval, (d)	242.33 ± 50.63
Annual kidding rate	1.68 ± 0.25
Birth weight (kg)	1.20 ± 0.24
Prolificacy (5)	181.30
Mortality % (first three months)	38.60
Stillbirth (%)	7.39
Abortions (%)	25.70

± Standard deviation

Source: Osuagwuh and Akpokodje 1984

The results obtained in that study indicated that the WAD goats are early maturing, prolific and non-seasonal breeders. However, a high level of reproductive wastage due to abortions, stillbirths, low birth weights and neonatal mortality was recorded (Osuagwuh and Akpokodje 1981, 1984). Because most of these pathologies occurred during the dry season when fresh forage and grass were in short supply, nutrition was therefore queried. To evaluate this nutritional problem during pregnancy, which is considered a controversial subject, two questions were asked:

- What are the dynamics of fetal growth and development including some organs and endocrine glands?
- How can one manipulate the nutritional needs of the pregnant animal based on the dynamics of fetal growth in order to minimize reproductive losses due to prenatal mortality?

To attempt to answer these questions, the intrauterine growth rate of the WAD goats and their fetal brain, heart, liver, thyroid, pituitary and adrenal glands were

studied. The work involved 25 pregnant goats and 58 fetuses from them. The animals were maintained on a standard farm ration and the fetuses harvested by caesarean section at 30, 60, 90, 120 and 140 days of pregnancy. An exponential growth model was used in the analysis of the data obtained which were subjected to multiple linear regression to obtain the daily growth rate and maximal rate of increase of the variables studied.

The results showed that fetal body weights and those of the brain, hearts, liver and the glands were significantly ($P < 0.01$) related to the age of the pregnancy. The coefficients, b_1 and b_2 were also significant ($P < 0.01$). That the coefficient b_2 was significant and negative indicated that the relative growth rate of the variables was not a constant as would be assumed by a simple exponential function, but were variables that decreased as pregnancy advanced. It was also observed that some of the variables considered in the study showed different maximum rates of growth and different initial instantaneous growth rates which also decreased at different rates for each day of pregnancy. However, the maximum growth rate of the adrenal gland could not be determined within the period covered in this study (Osuagwuh and Aire 1990, 1992).

Nutritional Implications of the Characteristic Growth of the WAD Fetus, Organs and Glands

Growth has been defined by Brody (1964) to include cell multiplication, enlargement and incorporation of nutrient materials taken from the environment. The period of maximum growth rate may occur when most of these activities are at their peak, especially cell enlargement and incorporation of nutrient materials referred to as the period of hypertrophy (Winick and Noble 1965). It has been observed that fetal growth can be retarded during the period of accelerated growth or hypertrophy (Winick and Noble 1966). This period of intense development and rapid cell division could be referred to as the critical period. If cell division and final cell number achieved in an organ is limited due to malnutrition during this critical period, full recovery may not occur. This is because the events meant to occur within this period must occur only then not later.

Malnutrition within this period has been associated with stillbirths and prolongation of pregnancy in sheep (Osuagwuh, Taiwo and Ngere 1980), abortion and neonatal death in goat (Osuagwuh, Akpokodje, Akusu 1986), and low heart and brain weight in goat (Osuagwuh 1991). The inability of the fetal pituitary gland to grow normally due to poor nutrition during the critical period, has been associated with marked underdevelopment of the adrenal cortex (Liggin and Kennedy 1968). This will in turn jeopardize the role of the adrenal cortex in initiating parturition or delivery. In the case of an organ like the liver, poor nutrition of the pregnant animal during the critical growth period will result in the reduction of its glycogen content which may affect the neonatal survival of the baby animal. This is because the hepatic glycogen store serves as the immediate source of energy for the animal neonate (Hafex 1969).

In human, the critical period for neural tube development is said to be from 17 to 30 days of pregnancy (Whitney *et al.* 1998). It is therefore, within this period

that neural tube development is most vulnerable to nutrient deficiencies – a time most women do not even realize that they are pregnant. Abnormal development of the neural tube or its failure to close completely has been associated with major defects in the central nervous system causing serious mental handicaps, abortions or stillbirth (Whitney *et al.* 1998). It has been stated (WHO 1984) that 19.7 percent of babies born in Africa are below 2.5kg. This low birth weight reflects the devastating consequence of malnutrition during the critical period of fetal growth during pregnancy. Such babies are more likely to die before the celebration of their first birthday than those weighting more than 2.5kg. Even when they survive, the chances of normal healthy growth and development are greatly reduced thereby increasing the number of destitutes in the society.

It is therefore clear from this study that the accelerated growth period of the developing fetus, including the associated body systems, is critical to the survival of the fetus whether in or outside the uterus of the mother following delivery. This period, no doubt, is crucial in any feeding programme during pregnancy in order to ensure normal fetal growth and birth weight.

Nutritional Engineering During Pregnancy

In the obstetric and gynaecologic context, the concern over birth weight is three-fold. First, large fetuses contribute to difficult birth (dystocia); second, undersized fetuses are susceptible to neonatal death and disease, and third, poorly nourished fetuses stand the risk of being aborted or may result in pregnancy toxemia as in the sheep. The question now is, how can the nutrition of a mammalian species during pregnancy be engineered, strategized, formulated, supplemented or manipulated to ensure the prenatal and postnatal survival of the fetus.

Based on the pattern of the growth of the fetus, the fetal organs and glands of the WAD goat, (Osugwuh and Aire 1990, 1992) and the nutrient requirements of pregnant WAD goats, (Osugwuh and Akinsoyinu 1992), an experiment was designed to provide the scientific basis for successful nutritional engineering that ensures a normal birth weight. The study was carried out on 15 pregnant WAD goats. They were divided into three groups (A,B,C) of five animals each.

Varied quantities of concentrate supplement were fed to each group at different pregnancy periods. All the animals were provided with forage *ad libitum* throughout pregnancy. One group (A) was fed on concentrate at the rate of 50g/kg metabolic weight per day, per animal throughout pregnancy. Group (B) animals were offered concentrate from day 61 to 120, and 121 to term at the rate of 50g/kg and 25g/kg metabolic weight per animal per day, respectively. The animals in group (C) were provided with concentrate from day 61 to 120 and 121 to term at the rate of 25g and 50g/kg metabolic weight per animal per day, respectively.

The result obtained in this study showed that there was no abortion. Two animals from group (A) had difficult birth (dystocia). There was no significant difference between the mean birth weights and neonatal growth rates of kids from groups A and B. The mean birth weights and neonatal growth rates of kids from group C were significantly ($p < 0.01$) lower than those of groups A and B.

There was no significant difference between the udder circumference of animals in group C and those in groups A and B. All neonatal deaths recorded were from animals in group C. From the results of this study the following can be concluded:

- That a high level of feeding during the first 60 days of pregnancy or after 120 days of pregnancy may not be necessary.
- That the period of fetal vulnerability is from 60 to 120 days post-conception, for group C fed on 25g instead of 50g/kg metabolic weight per animal per day during this period had kids with low neonatal growth rate and some died soon after birth.
- That the level of nutrition offered to the pregnant animals during this period is crucial to the prenatal survival of the kids.
- That reduced concentrate intake as parturition approaches may not significantly affect the birth weight and neonatal performance of the kids.
- That high concentrate feeding during late pregnancy may lead to difficult birth (obstetric problems).
- That the high level of concentrate fed to the animals in group C as parturition approached did not improve the birth weights of the kids, neonatal survival and growth rate. This shows that the retarded intrauterine development of the fetus due to feed restriction or malnutrition between days 60 and 120 of pregnancy is not reversed towards parturition following increased nutrient intake. The lack of abortion in the group C animals indicated that the level of feeding was sufficient to maintain intrauterine fetal survival but not neonatal well-being.
- That there was no significant difference in the mean udder circumference in the three groups of animals. This may be due to the fact that udder development during pregnancy is known to be most rapid during the latter stages of pregnancy (Ferrell, *et al.* 1976).
- That the high rate of neonatal death recorded in group C animals cannot be associated with low milk production but the inability of the kids to stand up and suckle because they were born weak hence their death is due to starvation.

The principle of nutritional engineering used in the WAD goats here could be applied to other pregnant mammalian species including man (Osuagwuh 1992).

Utilization of Research Findings for Sustainable Livestock Development in Nigeria

The primary objective of sheep and goat production in Nigeria is meat, and the demand is indeed high. An annual off-take of 70 per cent from goat has been estimated (Nuru, 1982). Based on public abattoir figures, it has been estimated that sheep and goats contributed, on the average, 23 per cent of the meat

consumed in Nigeria between 1978 and 1980 with average carcass weight of 11kg (FAO 1980). Goat alone was estimated to contribute 16 per cent of the total domestically produced meat in Nigeria which was estimated at 813,000 tons per annum (FAO 1982).

In addition to its role as source of meat, the goats skin forms necessary raw material for the local leather industry and for export too, especially the skin of the red Sokoto goats which is the most valuable of all goat skins.

Goats also provide handy alternative source of income, especially to the rural people to meet their social needs. They feature prominently during marriages, naming and burial ceremonies. Goats in most Nigerian communities are given as a token of love and friendship. The goat, therefore, occupies a high position in the socio-economic life of Nigerians.

It is indeed sad to note that despite the importance of these animals, little or nothing has been done to improve their lots through the utilization of research findings aimed at improving the productivity of these animals.

Pre-independence records show that in 1957, livestock contributed only 10.4 percent of the country's gross domestic product (GDP) whereas crops contributed 84.9 per cent (Oyenuga 1967). The situation remains the same today. In the United States of America (USA), United Kingdom (UK), Australia and New Zealand, animals and their products contribute higher values to the total agricultural economy than crops (Table 2).

Table 2: Estimated Value of Relative Output of Crops and Livestock in four Countries in 1960 Compared with Nigeria

Country	Total value of Agriculture	Value of Crops	Value of Livestock
USA	34014.0* (10%)	15076.0 (44.3%)	18938.0 (55.7%)
UK	3622.92 (100%)	742.28 (20.5%)	2880.64 (79.5%)
Australia	2287.45 (100%)	655.12 (28.5%)	1635.33 (71.5%)
New Zealand	1018.64 (100%)	84.56 (8.3%)	934.00 (91.7%)
Nigeria	1481.5 (100%)	1319.9 (89.09)	161.6 (10.91%)

Source: Oyenuga, 1967.

* = millions of US dollars.

Another noteworthy feature in Nigeria is that the percentage of human population that is economically active in agriculture ranged from 69.6 per cent in 1975 to 65.5 per cent in 1988, whereas in the USA the corresponding figures were 3.9 and 2.5 percent (Table 3).

Table 3: Percentages of Human Population Economically Active in Agriculture in Some Countries Compared with Nigeria (1975-1988)

Country	Years					
	1975	1980	1985	1986	1987	1988
Switzerland	7.0	6.0	5.0	4.8	4.6	4.4
France	11.1	8.6	6.7	6.4	6.1	5.8
Australia	7.4	6.9	5.8	5.7	5.5	5.3
USA	3.9	3.5	2.8	2.7	2.6	2.5
UK	2.7	2.6	2.3	2.2	2.2	2.1
Nigeria	69.6	68.1	66.5	66.2	65.8	65.5

Source: FAO Production year book 1988.

The very high percentage population of agriculturally active people in Nigeria notwithstanding, available record (Table 4) shows that in the USA, animal protein intake per person per day between 1984-1986 was 70.9g while in Nigeria it was given to be 6.8g (FAO 1988).

Table 4: Food Supply: Protein from Animal Products Per Caput Per Day (grams)

Country	Years			
	1961-63	1969-79	1979-81	1984-86
France	57.3	62.9	72.4	74.8
Australia	63.6	64.6	64.4	65.0
Switzerland	50.4	54.5	61.5	63.3
USA	65.4	70.3	68.7	70.9
UK	55.8	56.0	53.1	52.0
Nigeria	6.5	7.0	10.0	6.8

Source: FAO Production Year Book 1988.

These observations indicate that it is not the number of people involved in agricultural activities that determines the volume of the output but the technology involved in the operation. The present low level of animal protein consumption in Nigeria is a reflection of the poor productivity of the traditional animal management system which Nigeria still depends upon.

Protein is a vital body building element, which is largely sourced from livestock products. Lack of adequate protein to pregnant women or animals can lead to irreversible damage to the developing fetus, neonatal mortality, slow rate of growth, poor development, increased susceptibility to infections and possible permanent physical stunting. The reported high frightening figures of Africans dying of HIV/AIDS infection may be related to malnutrition resulting from low protein intake that adversely affects the immune system of the human body. There is real problem. The problem is a very simple one – the inability of the Nigerian government to put in place well-structured, home-based financed strategies, programmes and policies to make use of research results littering all our universities that are involved in livestock research, including poultry. With all humility, if all the research results in the areas of animal and poultry health, reproduction, nutrition, breeding and management from the Faculty of Veterinary Medicine and the Department of Animal Science of this university alone, are consciously put into use, the livestock subsector of the economy of this nation will be transformed for the good of all. The National Agricultural Research Strategy plan 1996-2010 projected growth rate of 6.4 per cent per annum for goat meat and mutton and 8.7 per cent per annum for beef within this period, provided appropriate policies and improved technologies generated by research are applied. It was, however, noted that despite the projected increased output of the various livestock products, the daily protein intake per person by the year 2010, would be only 5.32g which is still far below the FAO recommendation of 34g.

It is a known fact that there is no current serious mechanism put in place by government to achieve these goals that the government set for itself by making use of new technologies for improved livestock production based on research findings.

The current moribund research-extension linkage model adopted in Nigeria involved five zonal coordinating research institutes, the Federal Agricultural Coordinating Unit (FACU), National Agricultural Extension and Research Liaison Services (NAERLS) and National Agricultural Research Institutes (NARI). Then we have the Agricultural Development Project (ADP) which is provided with technical support by the other groups in the areas of on-farm adaptive research, monthly technology review meetings and extension services operation. This research extension linkage model is considered comprehensive, for it will generate a favourable climate for close interaction between research and extension organizations.

Following the initial success of this model in some selected states, ADP services were introduced to all the states of the federation where they form the extension arms of the state ministry of agriculture. The ADPs were mostly financed by the World Bank and when the World Bank withdrew their financial support, the programme became moribund and not much is happening as of today. But more disturbing is the fact that when the programme was fully operational the livestock subsector was virtually neglected, for it mainly concentrated on crops.

No nation can really take its rightful place among other nations without a viable, strong and all-round agricultural base. This is because a stable agricultural

sector of any national economy, including the livestock subsector, guarantees food security, industrial growth, economic growth, improved quality of life and political stability. No nation or organization can develop another nation or organization to the point of self-sufficiency. Let us stop running to the World Bank or IMF or both for financial support for our programmes or policies meant to develop our country for they will abandon us when they are mostly needed. Nigeria has all it takes to develop this country without asking for foreign loans. All that is required is for the people in high places to develop the political will and minimize the level of looting of the national treasury for personal economic and political power.

It is Nigerians that are impoverished by few Nigerians, keeping the impoverished perpetually below the poverty line so that the few rich Nigerians will maintain their social, economic and political dominance on the poor rural masses, grassroots, or the common man on the street as they call them. This group of Nigerians are used in formulating policies and programmes that are poorly implemented or not implemented at all. This is because the politicians consider them irrelevant on their way to political power; for they usually by-pass the ballot box, instead of going through it. And that is why they can move from one political party to the other without any reference to their so-called constituency that elected them into political power.

There is no programme that can be more poverty alleviating or poverty eradicating than a well-constructed, home-based and continuously financed programme of utilizing indigenous research results for national development. A nation is as strong as its ability to make effective use of indigenous research results. Research leads to knowledge and knowledge leads to power, supremacy, and dominance. All great nations all over the world practise the law of silence as far as break-throughs based on research are concerned. There is nothing like "Technology Transfer". It is a ploy to keep the uninformed countries under the intellectual dominance of the developed countries of the world.

They have come with their beautiful concept of "Globalization and Free Trade Liberalization". If this hydra-headed concept is blindly and fully accepted and practised by any developing nation like Nigeria, it will spell doom for its industrial growth and development.

The government should be well advised to properly finance this country's educational system based on the minimum UNESCO recommendation and make proper use of research results from our universities and research institutes for the overall development of this great nation. "The wise hears and gets wiser", it has been said.

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SPATIAL ENGINEERING AND ACCESSIBILITY

C. O. Ikorukpo

Department of Geography

Introduction

Geography is one of the most misunderstood and, indeed, one of the most maligned disciplines. To the uninitiated, geography is simply about the names and locations of places and geographical features. Given this orientation, geographers are expected to know the names, locations and characteristics of such geographic individuals as the world's cities, countries, lakes, rivers, etc. What is the capital of Afghanistan? What is the population of Myanmar? How far is Toronto from New York? What is the size of Bayelsa State? These and similar questions are the ones geographers are expected to answer and correctly too at the blink of an eye. Geographers study such geographic features but these are not what geography is about.

Another widely held view is that geography is about maps, and, therefore, geographers are map-making technicians. There is no doubt that the map is a very important tool of the geographer. However, it is not what geography is about. There is also the perspective that geography is simply about exploration, expedition and discovery of places. A corollary is that geographers study exploration, expedition and the discovery of places. Exploration and discovery may provide new vistas for geographic analysis; but geography is not simply about exploration, expedition and discovery. If these were what geography was about the discipline would have died long ago and might only have resurrected with relatively recent exploration of the outer space.

These various perceptions of geography, though largely wrong, have some historical basis. Geography had its greatest followership during the age of exploration and discovery (from the 15th to the 19th centuries) when geography and geographers provided meaningful information on new places and regions. Geographers were effectively involved in the mapping and description of such areas. Subsequent colonial interests and expansion aided the ascendancy of geography as geographical societies, which promoted expedition and discovery,

were rapidly established worldwide. The first modern geographic society was established in Paris in 1821, followed by that of Berlin in 1828. The Royal Geographical Society of London was founded in 1830. By 1885, about 100 geographical societies with a membership of over 50,000 were in existence worldwide (Holt-Jensen 1987; Freeman 1961).

The Royal Geographical Society was not only active in expedition and discovery but also in academics. It was fundamental in the appointment of the first geography lecturer in each of Oxford (1887) and Cambridge in 1888 (Coones 1989; Stoddart 1989). It is remarkable that the foundation lecturer at Cambridge, Henry Guillemard, was a medical doctor who was active in expedition and discovery and in the work of the society. He was apparently so involved in expedition that when he was pressed to give up his geography lectures, he resigned (Stoddart 1989).

Be this ascendancy of geography during the age of expedition and discovery as it may, the discipline remained maligned and misunderstood. For instance, the Oxford historian, J.R. Green, declared in 1879: "No drearier task can be set for the worst criminals than that of studying a set of geographical textbooks such as children in our schools are doomed to use" (quoted in Coones 1989, p.13). Indeed, even the "dark continent" imagery of Africa has been equated with geography. Jonathan Swift, the renowned Irish satirist, Anglican cleric and author of the well known novel, *Gullivers Travels*, in his work, *On Poetry: A Rhapsody*, published in London in 1733, said of geographers and Africa thus:

*So Geographers in Afric - Maps
With Savage-Pictures fill their Gaps
And o'er uninhabitable downs
Placed Elephants for want of Towns.*

The malignity the discipline has been subjected to in modern times is aptly illustrated by the demise of geography in a leading American University-Harvard. Geography was abolished there in 1948 not necessarily because of what geography is but partly because it was alleged that the Head of Department/Chairman was a homosexual (Smith 1987). How times have changed!

It was to this misunderstood and maligned discipline I returned late in 1974 after my one-year national service in the present Zamfara State. This was at a time geography was in a state of flux, consequent largely on the Quantitative Revolution with origins in the late 1950s/early 1960s. The increased employment of mathematical and statistical techniques, which, characterized the revolution, aided model building and theory formulation and launched geography into the frontiers of the scientific revolution. Realizing that the frontiers of a given discipline are not necessarily impervious, geographers adapted and reinvented a number of concepts and theories from other disciplines. For instance, the gravity model; derived from Newtonian physics and its later extension entropy model from thermodynamics, came to be widely used in transport geography and related sub-disciplines.

Whereas geography gained considerably from such fertilization, too many disciplines realized too late what difference some injection of a geographical perspective could make in their insight. For instance, health planners realized late how useful a Central Place theoretical framework could be. Even economics, which together with geography hybridized economic geography, discovered economic geography rather late. The discovery is due to the work of a contemporary economist – Krugman – described by the great ‘positive economist’ Paul Samuelson (1994, p. vii) as “the rising star of this century and the next”. Realizing that space, which is the central focus of geography, matters, Krugman has over the last two decades or so applied geographical principles to his analysis of trade, regional development, economic and monetary integration, localization of industry, externalities, strategic industrial policy, path dependence and globalization (see Martin and Sunley 1996; Dyrriksi 1996). His two most celebrated works in this regard are *Development, Geography and Economic Theory* (Krugman 1995) and *The Self-organizing Economy* (Krugman 1996). In the former, he utilized what he referred to as the five “exiled traditions” of economic geography, that is, location theory, land use modelling, social physics, local external economies and cumulative causation, and lamented the “retreat” of economic geographers from quantitative modelling into Marxist and post-Fordist interests. In the latter work where the self-organizing space economy is modelled, the central place theory and Von Thunen’s isolated state theory occupy pride of place in the analysis. It is noteworthy that one of the chapters of Krugman’s 1995 work is captioned “Geography: Lost and Found”.

My return to Ibadan in late 1974 was also at a time the debate about relevance in geography was on. This debate and the quantitative revolution influenced the focus of my Ph.D thesis. The topic – *Spatial Structure and Efficiency in a Physical Distribution System: A Case-Study of the Nigerian Gasoline Distribution Industry* – reflected the physical distribution crisis that plagued the country’s petroleum products industry. The thesis, examined in December 1977 and accepted in January 1978, applied a heuristic programming approach in assessing and proposing the location of products depots and analyzed the structure and efficiency of gasoline distribution, employing techniques such as factor analysis. Since my Ph.D thesis is in transport geography, my research has not only been in this area but also others, particularly regional development, environmental studies and political geography. If I were to summarize the focus of my research, I would say it has been spatial engineering and accessibility. Transportation is about accessibility and the other areas address spatial engineering in varying degrees. My choice of topic for an inaugural lecture has thus long been obvious to me. Let me, for the sake of clarity and completeness, now address the issues: What are spatial engineering and accessibility? And how are they related?

Spatial Engineering and Accessibility: The Concepts

Engineers need not be agitated that geographers are about to take over their profession and disciplines. The central concern of geographers is spatial analysis. As the International Charter on Geographical Education puts it, “some of the

central concepts of geographical studies are location and distribution, place, people environment relationships, spatial interaction, (and) region" (I.G. U. 1992). Locations, places and regions could be manipulated. Indeed, people could also be manipulated over space. Spatial engineering is about this manipulation. Morrill (1996) defines spatial engineering in terms of territorial manipulation. Coates, Johnston and Knox (1977) and Okafor (2000), following them, conceptualize it in terms of the spatial manipulation of social well-being.

Spatial engineering is necessitated by the realization that the so-called invisible hand of the free market mechanism cannot and has not always assigned scarce resources equitably. Even if all the perfect competition assumptions of conventional economic wisdom were to hold, non-economic considerations, which are sometimes much more fundamental limit the usefulness of the market mechanism. Even the United States of America, the doyen of capitalism, realized by the 1930s when the Tennessee Valley Authority was set up that the market mechanism could not wholly be relied on. There is indeed no country that does not attempt to manipulate space for development. Ikorukpo (1983) divides the attempts in Nigeria into two broad groups based on a spatial perspective.

Spatial engineering is usually conceptualized in terms of the attempt at reorganizing space in order to benefit a people. The fact that there could be spatial reorganization intentionally meant to make a people or communities disadvantaged is often glossed over. I believe that there are both positive and negative spatial engineering. The positive one involves manipulating space for the benefit of people while the negative is meant to enthrone a disadvantage. Gerrymandering is a typical example of negative spatial engineering. "The term 'gerrymandering' immortalizes Governor Elbridge Gerry of Massachusetts (U.S.A) who signed into law a districting designed to maximize the election of Republican-Democrats over Federalists" (Morrill 1994, p.104). Gerrymandering is simply the manipulation of regional or district boundaries in order to place some people or areas at a disadvantage. It was commonly used in the U.S.A. in the early 19th century to prevent the election of black Congressmen.

Whether the interest is in positive engineering or its negative variant, the essence is relative accessibility. In manipulating space, accessibility or inaccessibility is the consequence. What then is accessibility? Times were when Peter Gould (1969, p.64) opined that accessibility "... is a slippery notion ... one of those common terms that everyone uses until faced with the problem of defining and measuring it." Since Gould's assertion several works have expounded the concept (for instance, Ingram, 1971 ; Stutz, 1973; Pirie 1979; Ikorukpo 1987). Accessibility could be conceptualized in terms of the ability to get to a place quickly and cheaply and the availability and affordability of a utility. Various measures of accessibility are used, namely, simple distance, graph theoretical indices, opportunity index, eigen functions and socioeconomic indices.

In general, the concept has two fundamental components. These are locational and effective accessibility (see Ikorukpo, 1987). The locational aspect pertains mainly to proximity while that of effectiveness is essentially whether or not there are any socio-economic and indeed political constraints in the way of

utilization. For instance, a very good clinic or school could be in a neighbourhood or even village but individuals living close by may not utilize the facility because of prohibitive cost. How many children from the villages in which they are located attend some of the very expensive private secondary schools that have become a feature of Nigeria's educational landscape? Indeed, there is a hypothesis that utilities are usually less available to those who need them more. This is the basis of Hart's (1971) inverse care law, which states that "the availability of good medical care tends to vary inversely with the need of the population served".

Effective accessibility raises the issue of spatio-social equity and justice and, indeed, in some cases environmental justice. The basic consideration is whether some people or areas should enjoy defined privileges at the expense of others. Where such privileges exist, could they be said to be fair? In terms of environmental justice, which is particularly pertinent in this discussion, the issue is whether a people or community should be unduly exposed to environmental hazards in order to satisfy the needs of all. The groundswell of opinion is that where such an exposure to environmental hazard is inevitable people or communities so affected must be adequately compensated. As several studies have shown, this is a worldwide practice (see Ikporkpo 2000a).

Nigeria and, in particular, the Niger Delta region have been my geographical area of research focus. It is therefore to them that I shall now turn to examine a number of issues of spatial engineering and accessibility. The focus is the manipulation of political and economic spaces to the advantage of some areas or groups of people and to the disadvantage of others.

Manipulating Political Space

The bases for intensive and extensive struggle for access to political power and hence for the manipulation of political space were laid long before the country's independence in 1960. The British colonial government itself realized this. The perspective of the *Report of the Commission appointed to enquire into the fears of Minorities and the means of allaying them* [Henry Willink's Commission], which was set up in September, 1957 [Nigeria 1958], is instructive and is therefore quoted *in extenso*.

At the Constitutional Conference of 1953, it was decided after long discussion that Nigeria should be a Federation of three Regions (and the Small Federal Territory of Lagos), residual powers resting with the Regions. This decision was acquiesced in reluctantly by one of the principal parties, the National Council for Nigeria and the Cameroons which had previously advocated a strong centre and a larger number of constituent states, smaller and with less powers than the present Regions. The NCNC gave way ... when it became clear that continued disagreement would bar advance towards independence. The result of this decision was a *Federation of an unusual composition, in that one of the three constituent elements was slightly larger in population than the other two together, while*

in each of the three Regions it was possible to distinguish between a majority group of about two-thirds of the population and minority groups amounting to about one-third. (p.1).

Understandably, even before independence, there was a clamour for political access through spatio-political reorganization. It is significant that it was not only ethnic minorities that were involved but also parts of at least one major ethnic group that had a feeling of political power not being accessible. The demands that came before the Willink's Commission are shown in fig. 1.

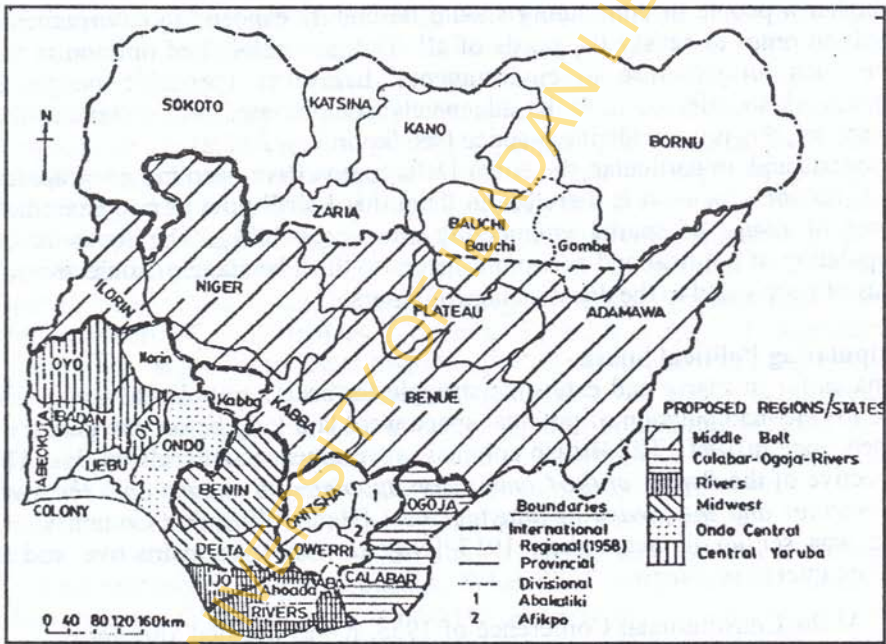


Fig. 1: Pre-independence Demands for Regions/States

In the Western Region, there were demands mainly for a Central Yoruba State made up of Oyo and Ibadan Provinces, an Ondo Central State from Ondo Province and a Mid-West State to be made up of Benin and Delta provinces. The demands in the East were for Calabar-Ogoja-Rivers (COR), Rivers, Calabar and Ogoja States while in the Northern Region, the clamour was for a Middle Belt State. In addition to these, there were demands for merger. The most significant were the demands by Ilorin and Kabba Divisions of the Northern Region to be part of the Western Region and Western Ijaw Division of the West to be part of a Rivers State.

Apart from these major demands for merger, there were a number of less significant ones. These included the expressed desire of Ndoni Clan of Aboh Division in Western Nigeria to be part of Ahoada Division of the East, of Ete District in Nsukka Division of Eastern Nigeria to be part of Igala Division of the North and that of Asaba and Ika Divisions wishing to be in Eastern Nigeria. There were also the cases of the Akoko-Edo District's demand to be part of Ondo Province (Western Region), the Igbirra area of Afemai Division of the West to be in Kabba Division of the North while the villages of Sobe and Ijagba in Ondo Province, Western Region, agitated for merger with Benin Division (Nigeria 1958; Ikporukpo 1986a; Gana 1987).

The basic factor in all these demands was self-determination, that is, effective access to political power base. In all the cases, except those of Yoruba Central and Ondo Central States, the allegation was that the major ethnic group had a domineering tendency, which stifles political participation by other groups. The agitators for Yoruba Central and Ondo Central States asserted that political power was totally inaccessible to them because they were being victimized by a government controlled by the Action Group given that they were, in the main, followers of another political party, the NCNC. In the North, there was a religious coloration in the demand while in the East and the West, political access was agitated partly for economic reasons.

The debate on the creation of the Mid-West was the most intense and most significant and showed very clearly the struggle for political space. The agitators, the government of the Western Region and the majority party, the Action Group, provided different perspectives. The Mid-West Movement demanded political autonomy on the grounds that the major ethnic group, the Yoruba, was discriminating against the other groups in the areas of economy, appointments and culture. It was also alleged that the Yoruba regarded people from the proposed Mid-West as inferior. The Willink's Report put this allegation succinctly thus:

The Yorubas, we were told used the term "Kobokobo" to describe an Ibo and applied the term contemptuously to the people of Benin as well; it means, we understand, one who speaks unintelligibly. We were told that the Leader of the Opposition, Mr. Denis Osadebay, had been asked to surrender his leadership to Alhaji Adelabu, who was a Yoruba, on the grounds that no one in Yoruba country would vote for a party which might give the Region a "Kobokobo" as a Premier (p.3).

Interestingly, all the three groups supported the creation of a Mid-West State, although each had a different orientation. The Mid-West State Movement argued that the proposed State should be made up of Benin and Delta Provinces. The villages of Sobe and Ijagba in Ondo Province were to be part. The Action Group's position was that all Edo-speaking people should be united in one State while the Ibos of Asaba and Aboh should be in the East and the Ijaws with the Ijaws of the East. Apparently, to underscore the significance of party-followership, it was argued that the Yoruba-speaking Akoko-Edo and the Itsekiri

and Ishan Division should remain in the Western Region. What a great showcase of gerrymandering it would have been! The perspective of the Western Regional Government was similar to that of the Action Group, except that it included Akoko-Edo and Ishan in the proposed State.

In spite of the debates which accompanied the Willink's Commissions sittings and the various Constitutional Conferences, no new states emerged before independence. With independence, old and emergent feelings of inadequate access to political power by various groups, whether real or just perceptual, resulted in intensive and extensive cries for access through state creation (see Osaghae 1985; Ikorukpo 1986a; Suberu 1994, 1997). For instance, the cry of political marginalization which was a minority-ethnic group phenomenon became the chorus of Igbo nationalism. The Igbo feeling was hinged on the fact that in the state creation exercise immediately preceding the Nigerian civil war in 1967, the area was constituted into just one state. Indeed, by 1987, the minorities of the former Eastern Region where the Igbo were the political overlords, had three states while the Yoruba and the Hausa-Fulani each had at least four states with the Igbo restricted to only two. The operation of the Federal character principle which emphasizes the equality of States in access to power (see Ekeh and Osaghae 1989) exacerbated the relative inaccessibility to political power of the Igbo. The clamour for states was such that the 1980s and 1990s were in many respects the decades of the state agitators. For instance, in 1983, the National Assembly received as many as 48 formal requests for new states. Sixty-five requests were presented to the Mbanefo Committee, and the National Constitutional Conference of 1994 received forty-five. There have also been merger requests. The most significant of these have been those from Bomadi and Burutu Local Government Areas to be in Rivers State, of Borgu Local Government Area of Kwara State to be in Niger State and of Doma Local Government Area of Plateau State to be in Benue State.

The spatial engineering that followed the agitations is reflected in fig. 2. Whereas in 1914 and in 1946, there were only two and three regions respectively, apart from the Federal Capital Territory, the number increased to four in 1963, twelve in 1967, nineteen in 1976, twenty-one in 1987, thirty in 1991 and thirty-six in 1996. The various regions before independence were largely a creation of the British (the colonial master), with little or no input from Nigerians. The earliest sub-divisions of the country were no doubt based on administrative convenience, although the amalgamation of the Northern and Southern Protectorates in 1914 was informed mainly by the economic consideration that the North was unviable and needed the South to avoid its being an economic burden to Britain (Osuntokun 1979; Yaqub 1997).

Since independence, the perspective of stakeholders has been influential in the pattern of spatio-political organization. For instance, as General Babangida, the then Head of State, put it, the state creation exercise of 1991 was, in part, to satisfy, "the expressed wishes of the people and communities" agitating for states (Babangida 1991). Thus, virtually all the states agitated for at the sittings of the Willink's Commission, but were not recommended, were created not long after independence; with the Mid-West being the first.

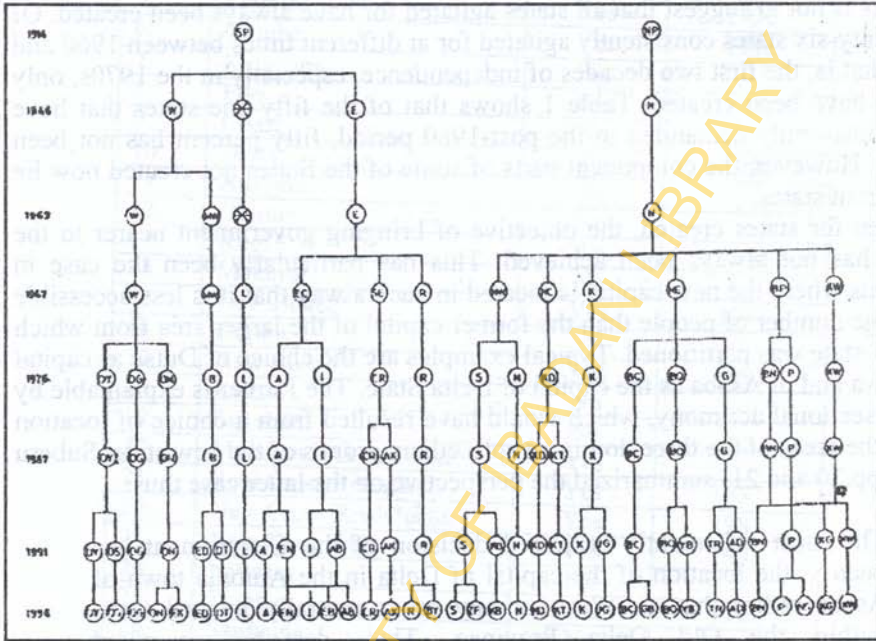


Fig. 2: A Schema of the Evolution of Nigeria's Political Regions

Key to Figure 2 (Only new Regions/States are defined in each year)

- 1914: SP=Southern Protectorate, N P = Northern Protectorate.
- 1946: W = West; * = Capital Territory (Lagos); E = East;
N = North.
- 1963: MW=Mid-West.
- 1967: L = Lagos; EC = East Central; SE = South Eastern;
R ==Rivers; BP= Benue Plateau; KW = Kwara.
NW = North Western; NC = North Central;
K = Kano; NE = North Eastern;
- 1976: OY=Oyo; OG=Ogun; ON=Ondo;. B=Bendel; A = Anambra;
I= Imo; CR = Cross River; S = Sokoto; N = Niger;
KD= Kaduna;
BC = Bauchi; BO = Borno; G = Gongola,;
BN = Benue; P = Plateau.
- 1987: CR=Cross River; AK=Akwa Ibom; KD=Kaduna;
KT= Katsina.
- 1991: OY=,Oyo; OS=Oshun; ED=Edo; DT=Delta; A =Anambra;
EN = Enugu; I= Imo; AB = Abia;

S= Sokoto; KB = Kebbi; K = Kano; JG =Jigawa;
 BO = Borno; YB = Yobe; TR = Taraba;
 AD = Adamawa; BN = Benue; P = Plateau; KG = Kogi; KW = Kwara.

1996: ON=Ondo; EK=Ekiti; EN = Enugu; EB=Ebonyi;
 AB = Abia; R = Rivers; BY = Bayelsa; S = Sokoto; ZF=Zamfara;
 BC=Bauchi; GB=Gombe
 P = Plateau; NS = Nassarawa.

This is not to suggest that all states agitated for have always been created. Of the twenty-six states consistently agitated for at different times between 1960 and 1980, that is, the first two decades of independence, especially in the 1970s, only sixteen have been created. Table 1 shows that of the fifty-one states that have been consistently demanded in the post-1980 period, fifty percent has not been created. However, the component parts of some of the States not created now lie in different states.

Even for states created, the objective of bringing government nearer to the people has not always been achieved. This has particularly been the case in situations where the new capital is located in such a way that it is less accessible to a large number of people than the former capital of the larger area from which the new state was partitioned. Typical examples are the choice of Dutse as capital of Jigawa and of Asaba as the capital of Delta State. The former is explainable by fear of sectional acrimony, which would have resulted from a choice of location within the areas of the three dominant sub-ethnic groups of the new state. Suberu (1994, pp.20 and 21) summarized the perspective on the latter case thus:

The most vehemently criticized decision of the Government has been ... the location of the capital of Delta in the Anioma town of Asaba rather than in Warri or any other centrally located town within the Old Delta Province. This decision generated considerable acrimony between the Igbo and Urhobos, and has been portrayed by critics as an act of marital favouritism, in reference to the Asaba origins of the country's flamboyant First Lady, or as an exercise on political vindictiveness, in allusion to the prominent role that was played by Urhobo elements in the abortive attempt in April 1990 to unseat the Babangida Administration. Yet the government's ostensible act of political compromise in giving the Delta people a State without a capital and the people of Anioma a capital without a State cannot be isolated from the serious crisis engendered by the divisions between the Urhobos and Itsekiris on the State-issue.

Table 1: The Status of the Major Post-1980 Demands for States

S/No.	Name of State	Whether Created	Date Created
1.	New Anambra*	Yes	1991
2.	Enugu@	Yes	1991
3.	Wawa@	Yes	1991
4.	Aragah	Yes	-
5.	Ebonyi	Yes	1996
6.	Gombe	Yes	1996
7.	Katagum	No	-
8.	Edo	Yes	1991
9.	Coast	No	-
10.	Delta	Yes	1991
11.	Anioma	No	-
12.	Okura+	No	-
13.	Kogi+	Yes	1991
14.	Makurdi	No	-
15.	New Benue*	Yes	1991
16.	Gujiba	No	-
17.	New Borno*	Yes	1991
18.	Kukawa	No	-
19.	Calabar	No	-
20.	Mainland Akwa Ibom**	Yes	-
21.	Real Cross River@@	Yes	1987
22.	New Cross River*@@	Yes	1987
23.	New Gongola*	Yes	1991
24.	Nyasara	No	-
25.	Taraba	Yes	1991
26.	Sardauna	No	-
27.	Aba	No	-
28.	Abia	Yes	1991
29.	Nyaba	No	-
30.	Katsin	Yes	1987
31.	New Kaduna*	Yes	1987
32.	Ghari	No	-
33.	Hadejia	No	-
34.	Jigawa	Yes	1991
35.	Tiga	No	-
36.	Lautai	No	-
37.	Ijebu	No	-
38.	New Ondo	No	-
39.	Ekiti	Yes	1996
40.	New Oyo*	Yes	1991
41.	Osun	Yes	1991
42.	Nassarawa	Yes	1996
43.	Middle Belt	No	-
44.	Port Harcourt	No	-

45.	New Rivers	No	-
46.	Kebbi	Yes	1991
47.	Zamfara	Yes	1996
48.	Oke-Ogun	No	-
49.	Abayelsa/Bayelsa	Yes	1996
50.	Oil Rivers	No	-
51.	Upland Rivers	No	-

*Word "new" dropped on creation.

+Name adopted by people from two different areas.

**Word "Mainland" dropped on creation

@/@@ Same area; difference only in terms of name adopted by different groups.

Nos. 1-47 are demands with roots in the 1980s.

Nos. 48-50 are demands with roots in the early 1990s.

Source: Compiled by author from various sources.

Manipulating Economic Space

In spite of the limitations of state creation as a strategy for access to political power, it has brought the second tier of government nearer to the people and has engendered access to political power at the federal level, particularly with the enthronement of the federal character principle. After creating many states, especially from the 1967 twelve-state exercise, the Federal Government realized, that most States were largely economically unviable. The chorus of government then changed largely from bringing government nearer to the people to one of ensuring that no part of Nigeria lags behind in the development process. The manipulation of economic space has been the result. This involves the flow of financial resources from federal government to the state and local government areas, making some states and local government areas advantaged and others disadvantaged.

The economic unviability of the States became more marked as the years went by. For instance in 1980, Niger State generated less than 9 percent of its revenue internally, and Kwara State less than 10 percent. By 1989, Niger State generated only about 5 per cent, Bauchi less than 7 percent and Sokoto 9 percent. There is no doubt that part of the problem is a weak revenue-collection drive by states (Ikporukpo 1996).

The economic unviability of the states was at a time petroleum had emerged as the mainstay of Nigeria's economy. When petroleum was first exported from the country in 1958, it counted for only about 0.1 percent of the revenue: As fig. 3 indicates, the percentage increased to more than 26 in 1970, about 78 in 1975, more than 81 in 1980 and a peak of more than 86 in 1992. Its percentage contribution to export value has been much more.

Given the significance of petroleum, the Federal government, staunchly supported by the non-oil producing States, turned to it as the panacea for pursuing its policy of ensuring even development in all parts of the country. The circumstances leading to the seizure of petroleum resources from the oil-producing areas by the Federal government are very interesting and needs to be quoted *in extenso*.

apologized for what appeared to be “*coup de grace*” which appeared to him to be a good thing for the unity of the country. I pointed out the inconsistency in preserving the derivation principle for cocoa and groundnuts. He thought we should submit a supplementary Council memo on the abolition of derivation principle for cocoa and groundnuts. Professor Adebayo led the attack on the proposed abolition of the derivation on cocoa and groundnuts. General Gowon replied that the Council has to be consistent and Council decided that the Federal Government should occupy “the commanding heights of the economy” (Ayida 2001, pp.12 and 13).

Whatever the circumstances, the Federal government, through various decrees by the various military regimes between the late 1960s and the late 1970s, took over the control of the country’s petroleum resources and thereby de-emphasized the principle of derivation. For instance, the Petroleum Decree of 1969 and the Off-Shore Oil Decree of 1971 vested in the Federal Government the entire ownership and control of all petroleum found in any part of the country the continental shelf and territorial waters. Similarly, by the Land Use Decree of 1978, all land is owned by the State. The implication is that the petroleum resources are much more accessible to the Federal government than the state or local governments through a vertical revenue allocation system devised by the Federal Government (Ikorukpo 1996; Nigerian Economic Society 1999). Given these various laws, apart from the technicalities of the 1982 United Nations Convention on the Law of the Sea, the Supreme Court judgement of 5th April, 2002 that the control and ownership of off-shore petroleum resources should be vested in the Federal Government was to be expected.

If the petroleum resources are less accessible to the states of the Niger Delta, which produce virtually all the petroleum, how do these states fare when compared to the non-petroleum producing ones? The Federal Government operates a Federation Account (formerly called the Distributable Pool Account) in which a proportion of the total revenue collected from all sources is kept and allocated to the states. This is dominated by revenue from oil. The allocation to the states is based on defined criteria. Since the dethronement of the derivation principle, population size, equality of states and land area have become the most significant criteria. The implication of this is that more populous and geographically larger states benefit more. The dilemma of the petroleum-producing states is that they are all relatively small both in terms of population and areal extent. Table 2 shows that as the derivation principle declined in significance and as the number of states increased, the proportion of the revenue flowing to the major oil-producing states of Delta/Bendel and Rivers declined. In 1980, Rivers and Bendel each accounted for about 10 per cent of the allocation while Sokoto counted for 5. Kano 6.7 and Oyo 6.3 percent. By 1989, Bendel’s percentage had declined to 6.4 and Rivers; to 5.2 while Kano’s rose to 7.3, Sokoto’s to 6.2 and Oyo’s to 6.7. Indeed, from 1990 to 1996, Bendel accounted for 25 percent, and Rivers 3 percent although Kano’s percentage was nearly 11.

Table 2: Distribution of Allocated Revenue Among the States

States	Distribution in Percentage			
	1980	1985	1989	1990-96
Abia	-	-	-	2.3
Adamawa	-	-	-	2.2
Akwa Ibom*	-	-	4.1	3.1
Anambra	5.1	4.1	5.4	2.5
Bayelsa+	-	-	-	0.9
Bauchi	4.1	4.1	4.2	3.2
Benue	4.2	4.3	4.1	2.9
Borno	4.6	4.6	4.8	3.1
Cross River	5.2	4.9	2.8	2.1
Delta (Edo) Bendel	10	5.9	6.4	2.5
Ebonyi+	-	-	-	2.5
Ekiti+	-	-	-	1.1
Enugu	-	-	-	2.6
Gombe+	-	-	-	1.2
Imo	6.4	5.5	5.9	2.9
Jigawa	-	-	-	2.8
Kaduna	5.4	5.5	3.4	2.8
Kano	6.7	6.8	7.3	10.9
Katsina*	-	-	4.1	2.9
Kebbi	-	-	-	2.4
Kogi	-	-	-	2.5
Kwara	3.6	3.4	3.5	2.4
Lagos	3.4	3.7	3.9	3.2
Nasarawa+	-	-	-	1.1
Niger	3.2	2.9	3	2.6
Ogun	3.5	3.2	3.3	2.7
Ondo	4.4	4.4	4.6	3
Osun	-	-	-	2.2
Oyo	6.3	6.4	6.7	3.1
Plateau	3.9	3	3.8	3
Rivers	10	5.6	6.2	3
Sokoto	5.8	5.9	6.2	3.5
Taraba	-	-	-	2.4
Yobe	-	-	-	2.7
Zamfara+	-	-	-	1.3
FCT Abuja	-	1.7	1.7	3.2
TOTAL	100	100	100	100

*Created in 1987 +Created in 1996

Source: Computed by author from various sources.

In terms of access, the oil-producing communities are particularly disadvantaged. Consequent on the Land Use Decree, no compensation is paid for loss of land or water bodies in the process of oil exploration and exploitation. It is only loss on improvement to land such as crops that is paid for. Compensation for crops, as experience has shown, is usually far below the market rate because of frequent under-valuation (Adewale 1995; Human Rights Watch 1999). As Adewale (1995) observed, resort to litigation hardly results in higher rates because of the obvious disadvantaged position of the rural farmers and fishermen. For instance, in the case of *Jacob Yule and others vs. Shell BP* in the early 1970s, the plaintiffs demanded ₦60,000 compensation in earlier negotiations but were offered only ₦3,000 by the company for crops, economic trees and shrines destroyed. In a subsequent litigation, only a total of ₦313.50 was awarded by a Port Harcourt judge as damage, that is about 10.5 per cent of what the company offered to pay during the earlier negotiations!

Even the products from petroleum – refined petroleum products – are geographically and economically more accessible to most non-petroleum producing areas than the riverine areas of the Niger Delta. Before the introduction of a uniform pricing system on November 1, 1973 and the setting up of the Petroleum Equalization Fund, prices varied over the country. This was because the price of products was then determined by ex-refinery, cost, insurance, freight cost and a profit margin determined by the marketing companies (Ikorukpo 1997). The result was that petroleum products were cheaper in areas near the coast and much more expensive in far inland locations such as Maiduguri and Sokoto. The prices are now the same everywhere except in the riverine areas of the Niger Delta, which suffer from problems of relative geographic inaccessibility. The Political Bureau, which was set up in the middle 1980s to chart Nigeria's political course, lamented the situation thus:

It is one of the most repulsive ironies of Nigeria that petroleum products cost more in Bonny, for example, where Nigerian Bonny crude (which is about the best) is produced than elsewhere in the country. (Federal Republic of Nigeria 1987, p. 171).

The pattern of access to Nigeria's petroleum resources has become a very controversial issue. Three schools of thought and their variants have emerged. These are that:

- (i) the Federal Government should continue to have exclusive right;
- (ii) some strategically located non-petroleum producing states should have exclusive control; and
- (iii) the exclusive right should be that of the producing areas (states, local government areas or communities).

The school of thought that canvasses a federal control and the distribution of the resources among all component units of the federation, bases its argument on the need for even development, national unity and the fact that petroleum is a gift

from God. The school which has followers from many groups, individuals and governments in the non-petroleum producing areas argues that a federal control is necessary because this will ensure that there are no sharp regional disparities in development across the country. In other words, if there was no federal control, the oil-producing states might be highly developed while many of the non-producing areas would continue to be highly underdeveloped. This state of affairs, the school asserts, is not good for the goal of national unity. It believes that any damages suffered by the producing areas are adequately compensated for by the social action programmes of the oil companies. The gift of God argument is succinctly put by Kano State government presentation to the Okigbo Commission on Revenue Allocation thus:

...just because they (the petroleum resources) happen to be located in a place by accident.... does not mean that they are derived from that State... (Furthermore) in creating the wealth from mineral extraction, the efforts of the people (in the oil-producing areas) not directly involved (Federal Republic of Nigeria, (1980, pp.180 and 181).

The gift of God argument has been amplified mainly by some Northern Nigerian academics led by the historian Bala Usman (Ekeh 2001) to propose that some non-oil producing States should have control of the petroleum resources. The argument, though ridiculous, is based on the geological processes involved in the formation of petroleum. It is asserted that the sedimentary Niger Delta Basin where petroleum is found was built over the centuries from sediments transported mainly from states around the rivers Niger and Benue in the northern part of the country. Therefore, these states should have much more right than the states where the resources are found; the latter being only the secondary producers while the former the primary producers. Bala Usman put it thus:

those states of Nigeria upstream from the delta in the Niger-Benue basin should take exclusive ownership and control of the river water and its sediments drained away from them to form the delta and its hinterland and demand their share from the returns from the export of crude oil and gas in proportion to what their vegetation faeces, dead bodies, animal remains and fertile soil generally contributed to the making of these minerals for hundreds of thousands and even million years. (quoted in Ekeh, p. 8).

The basic trend of the argument is that the Niger-Benue basin states contributed overwhelmingly to the formation of the Niger delta and should, therefore, exert an overwhelming influence and control over the resources.

The best known and most publicized school, particularly since the re-introduction of a democratic government in the country in 1999, has been the school that argues that petroleum resources should be controlled by the producing states. The cliché "resource control" which expresses the desire of this school of thought, recently led by the Governors of the oil-producing South-

South geographical zone, has become very current in Nigeria's political economy debate. The origins of the school, however, date back to the late 1960s and early 1970s. This school hinges its argument on four foundations. These are: (i) the relative underdevelopment and neglect of the Niger Delta region; (ii) the practice in the country before petroleum became significant; (iii) the practice in other federations and other oil-producing countries; and (iv) the need for environmental justice.

The governments and various groups and individuals in the oil-producing states assert that the Niger Delta region is one of the least developed parts of the country. This situation is largely due to neglect by the various regional and Federal Governments. The school argues that since the area now has a resource which could be the basis for its development, no other part of the country or federal government should lay claim. The second foundation is that before the discovery of petroleum, the natural resources of the country, such as solid minerals and agricultural resources, were exploited for the exclusive development of the producing areas. Now that petroleum has emerged as the dominant resource, there is no reason why the situation should change. The reference is to the derivation aspect of the revenue allocation formula, which was at a time the only criterion. The school also argues that the practice in other federations is not control by the federal government but the producing areas; Nigeria should not be an exception. The environmental justice argument is that the area has been subjected to a long period of environmental damage, which has been neglected and can only be effectively addressed through "resource control".

Responding to Economic Gerrymandering

The state of affairs where petroleum resources are apparently more accessible to many non-producing states than the producing ones has been sharply criticized as unjust by many well-meaning Nigerians and non-Nigerians alike. For instance, a well-known political scientist and one-time Minister of External Affairs, Professor Bolaji Akinyemi (2001, p.9), expressed it thus:

It is an act of self-deception for anyone to argue that there is nothing wrong with the revenue allocation formula. We have had basically two systems of revenue allocation in Nigeria. The first system, which we practised during the First Republic, allowed the North to keep the proceeds from its groundnut and cotton, the West to keep the proceeds from its cocoa and East to keep the proceeds from its coal and oil palm produce. Then we changed the system so that the Federal Government got its hands on the proceeds from on-shore and off-shore crude petroleum, and, yet we don't expect the minorities in the oil producing areas to perceive that this is an injustice done to them.

People in the oil-producing areas perceive the situation as internal colonialism and some sort of economic gerrymandering. Various groups and organizations, some of which are external to the oil-producing areas, have emerged to enthrone justice and equity (Ikorukpo 1996; 2000).

This fight for justice could be divided into four phases. These are the early civil society stage, the Ogoni phase, the Ijaw Youths phase and the wilderness phase. The approaches employed include advocacy, protest marches/civil disobedience, sabotage/blockade and armed protest (Ikporukpo 1996). The *Ogoni Bill of Rights*, the *Kaiama Declaration* of Ijaw Youths, the *Charter of Demands* of the Ogbia People and the *Aklaka Declaration* all through advocacy demanded for justice and effective access to petroleum resources. Protest marches have been very characteristic of the struggle by various groups. The most spectacular has been that by the Ogoni on January 4, 1993 which involved a predominant proportion of all Ogonis. Men and women demonstrated peacefully in Ogoniland, displaying placards depicting their grievances and demands. Typical placards read: "No Oil Right No Peace"; "Save Ogoni from Pollution"; "UN Save Ogoni"; and "Shell, Save Ogoniland" (Saro-Wiwa 1995; Ikporukpo 1996).

Sabotage and blockage have since the 1980s become significant. Oil company sources indicate that since the 1970s sabotage has emerged as a major cause of oil spills, although equipment failure continues to be a dominant factor. For instance, between 1977 and 1979, sabotage accounted for 31 percent of all oil spills in Nigeria and was the second most significant cause. In a cross-national study of 40 countries, of the seven major oil spills due to sabotage or vandalism in 1983, Nigeria accounted for four. Among the three countries that recorded sabotage-induced spills, this factor accounted for only 2 percent of the spills in the U.S.A. whereas in both Nigeria and Nicaragua, the figure was 33 percent. Nicaragua was then more or less in a state of war (Ikporukpo 1986b). Of the total 340 oil spills that were recorded in Shell Petroleum Development Company's (SPDC) operational area in 2000, 137 were attributed to sabotage. This cause accounted for 57 percent of the 30,751 barrels spilled (SPDC 2001). Although NGOs and communities accuse oil companies of unduly attributing spills to sabotage in order to avoid compensation (Ikporukpo 2000b), even the people of the oil-producing areas acknowledge the fact that there have been sabotage-induced spills (Ikporukpo 1995).

Blockades of oil production activities, some of which are violent, became particularly prominent in the 1990s. Figure 4 shows the rapid increase in the blockades and work stoppages in SPDC's oil production activities between 1994 and 1998. In 1994 and 1995, the occurrence was less than 100 annually. This increased to 150 in 1997 and as many as 325 in 1998; although there was a decline thereafter. Some of these were peaceful invasions while others involved the use of firearms. For instance, of the 176 incidents in 2000, 18 per cent involved the use of firearms. Youths from virtually all parts of the oil-producing areas, have been involved in such incidents which affect not only SPDC, which is the largest company, but also all others. SPDC (1999 p.13) provides a dramatic description of one incident thus:

On Wednesday, December 16, 1998, a group of armed youths from the Isoko National Movement attacked SPDC accommodation facilities in the Olomoro-Oleh oil field. They killed one of the field guards who was unarmed and preceded to loot the facilities. They

later issued a letter, "Why We Struck", claiming marginalization of the Isoko people by the Nigerian government.

The basic reasons for such blockades vary from compensation disputes through demand for employment to political issues. Essentially, the factors pertain to lack of political and economic access. Some of the issues, particularly the political ones, are clearly outside the orbit of oil companies. The setting can, however, be explained in terms of SPDC's perspective that "in many Delta communities, underdevelopment has led the people to perceive SPDC (or any other oil company) as the only form of "government" they know. In recent years, "this proximity to host communities has increased SPDC exposure to growing community discontent with government" (SPDC 1999b, p.7).

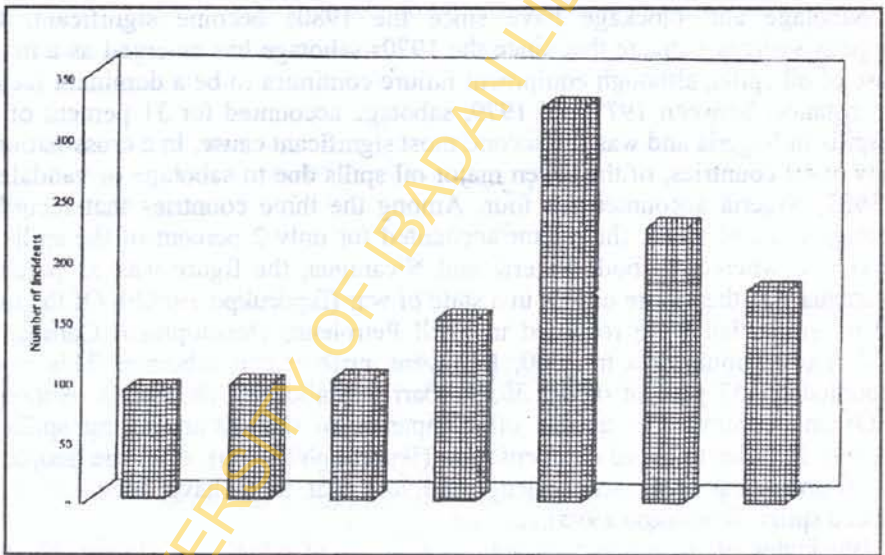


Fig. 4: Pattern of Blockade of SPDC Operations

Be these incidents involving firearms as they may, the most celebrated armed protest has been that of the Niger Delta Volunteer Service led by Isaac Jasper Adaka Boro, a one-time Students Union President of the University of Nigeria, Nsukka, and a former police officer. On 23rd February 1966, Isaac Boro declared an area (now the southern parts of Bayelsa, Rivers and Delta States) "The Niger Delta People's Republic" and proceeded to defend its territorial integrity. The revolt was meant to end a situation where "petroleum ... is being pumped out daily from ... (the) veins" of the people of the area (Boro 1982, pp.116-117). It was to demonstrate to the world at large what and how the people felt about oppression. In keeping with the basis of the secession, oil pipelines linking the area to Port Harcourt refinery and to the major flow station were blown up. The revolt came to be known as "The Twelve-Day Revolution", for, federal forces quelled it within twelve days.

The response of government, particularly the Federal Government to the crisis in the oil-producing areas, has had much more of stick than of carrot. The Federal Government has over the years attempted to address the developmental needs and environmental problems. Unfortunately, the attempts through the Niger Delta Development Board and Oil Mineral Producing Areas Development Commission dismally failed, due largely to the lack of commitment by government and corruption (Ikporukpo 1981; 2001). The recently established Niger Delta Development Commission is another hope; though too early to assess.

Whereas concrete developmental approaches to the problems of the Niger Delta have been pursued half-heartedly, programmes of suppression have been vigorously implemented. The incidents of State repression are too many to recount. However, Ikporukpo (1996) and Human Rights Watch (1999) discussed the most significant. In the Umuechem incident of 1990, the police killed 80 unarmed demonstrators and destroyed or badly damaged 495 houses. The destruction of life and property by the notorious so-called Rivers State Internal Security Task Force in Ogoniland, the hanging of the Ogoni Nine and the destruction of Odi in 1999 have been the most spectacular.

Social action programmes by the oil companies have had very limited effect (Ikporukpo 1993; 1998). Shell Petroleum Development Company (1999, p.7) summarizes the development situation in the Niger Delta thus:

Despite widespread poverty, decaying social and physical infrastructure, massive youth unemployment and rising crime, there is little visible social investment in the area by government or traditional donors. Poor governance has led to revenue allocation practices unfavourable to the region and has discouraged donor investment. Historically, overall support to the Delta appears to have been less substantial and intensive than in many other – and more prosperous areas of the South.

Conclusion

How can the crisis in the Niger Delta be resolved? Is it through spatio-political re-engineering or through spatio-economic reengineering? Let me emphasize that there need not be any dispute about the fact that whereas political power and economic power are relatively inaccessible to the people of the Niger Delta, environmental hazard is so accessible. Nigeria flares much more of its natural gas than any other producing country. According to the World Bank (1995) in 1991, Holland did not flare its natural gas at all, U.S.A. 0.6 percent, Britain 4.3, former U.S.S.R. 1.5, Mexico 5, Algeria 4, Iran 19, Saudi Arabia 20 and Libya 21. The figure for Nigeria was 76 per cent. Indeed, where only associated gas is considered, the Nigerian figure rises to more than 90 per cent. Similarly, between 1982 and 1992, 40 per cent of Shell's worldwide spills were in Nigeria although production here accounted for only about 14 per cent of Shell's total oil production (Gilbert 1999).

The question raised about re-engineering could be put differently. Is it resource control or political power control that will effectively address the crisis in the Niger Delta? In theory, whether the petroleum resources are controlled by the Federal government or even by the States of the Niger-Benue trough, what is important is how effectively the resources could be used for the development of the producing area. In practice, given the nature of the Nigerian State and the Nigerian nation, who controls is pertinent to development. Obviously, if the Niger-Benue trough states were to control, the development of the Niger Delta will be doomed. Nevertheless, resource control cannot be arrogated to the states. For it to be meaningful, there must be diffusion to the local government and community levels, but taking into consideration the fact that the other parts of the country need also to develop. Control at the lower echelons is necessary because a feeling of stake increases with decreasing levels of governance. For instance, public funds could be more easily embezzled without repercussions at the federal or state levels than at the community level. The political control aspect particularly through the practice of true federalism is important; for, this is the most practicable channel for enthroning resource control. Various studies, for instance, Ikporukpo (1996) and Taiwo (2000) have shown that the pattern of spatio-economic access to petroleum resources in Nigeria is against the basic tenets of federalism.

There is no justifiable reason why the Niger Delta should continue to be disadvantaged. Stereotype images of the Niger Delta (Ikporukpo, 2001) need not be obstacles. A common image is that the Niger Delta cannot be developed because it is all water. Indeed! Where did the billions of dollars expended on building a new federal capital city come from? Where did the enormous financial resources employed to manage the traffic problems of Lagos come from? Where did the billions of naira expended on dams to make the dry far north wet come from? Do the Nigerian state and nation lack conscience?

To conclude, I wish to seek refuge in parts of Ken SaroWiwa's immortal last statement to the special tribunal that paved the way for his "judicial murder":

We all stand before history. I am a man of peace, of ideas. Appalled by the denigrating poverty of my people who live on a richly endowed land, distressed by their political marginalization and economic strangulation, angered by the devastating of their land, their ultimate heritage, anxious to preserve their right to life and to a decent living, and determined to usher to this country as a whole a fair and just democratic system which protects everyone and every ethnic group and gives us all a valid claim to human civilization, I have devoted my intellectual and material resources, my very life, to a cause in which I have total belief and from which I cannot be blackmailed or intimidated. I have no doubt at all about the ultimate success of my cause, no matter the trials and tribulations which I and those who believe with me may encounter on our journey. Nor imprisonment nor death can stop our ultimate victory. I report that we all stand before history. I and my colleagues are not the only

ones on trial. Shell is here on trial. On trial also is the Nigerian nation, its present rulers and those who assist them. Any nation which can do to the weak and disadvantaged what the Nigerian nation has done to the Ogoni, loses a claim to independence and to freedom from outside influence. I predict that the denouement of the riddle of the Niger delta will soon come.

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28

ENERGY, EXERGY, THE ENVIRONMENT AND THE FUTURE

Olayiwola Fagbenle

Department of Mechanical Engineering

Contribution to Boundary Layer Analysis

Ideal fluid of Classical Hydrodynamics

Classical hydrodynamics, with its humble roots in the Daniel Bernoulli [1] equation of 1738 and the Leonhard Euler [2] equation of 1755, ordinarily deals with “ideal or frictionless fluids”, that is those media which show only an insignificant dependence upon fluid internal friction or viscosity over a wide range of flow parameters. The laws of classical hydrodynamics even in this space age, still enable the engineer to calculate and study some important properties of flows, albeit within known limits of their validity. For example, classical hydrodynamics is unable to explain such real observed phenomena as drag, flow separation and wake in the flow over a body, as in the cylinder of Figure 1; or the pressure loss in pipe flow, all of which are direct or indirect manifestation of the viscosity of the flowing media. Early engineers confronted with this glaring contradiction simply developed the empirical science of hydraulics, which was based on a large amount of experimental data.

The problem defied resolution for such a long time partly because air and water, the two most common and important fluids, possess such small viscosity that the corresponding viscous force is negligible compared to the other forces such as gravity (a body force) and pressure forces. Thus its influence on fluid motion was not expected to be as important as it turned out to be later in the early 20th century.

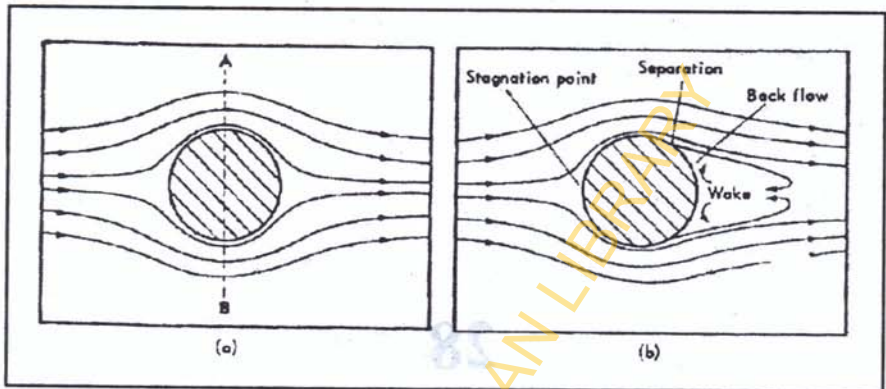


Fig. 1. Flow around a circular cylinder; diagrammatic only. (a) Assuming ideal fluid; (b) With boundary layer, leading to separation, backflow and formation of a wake; flow in wake is unsteady. From (Laminar Boundary-Layer Theory by Harry L. Evans, Addison-Wesley Publishing Co. Inc. 1968; P. 1).

The Navier-Stokes (N-S) Equations of Real Fluids

That it was known early 'in the 19th century that the viscosity effects needed to be accounted for is evident from the work of Navier [3] in 1827 and Stokes [4] in 1849 who mathematically formulated the conditions for the equilibrium of forces in a fluid, i.e. the surface (viscosity) forces, inertial forces, pressure forces and body forces, the body forces being such forces as centrifugal and buoyancy forces, among others. The resulting system of second order, nonlinear partial differential equations known as the Navier-Stokes equations still continues to present extraordinary mathematical difficulties today, and exact solutions of the equations have been found for only a few simplified forms of the equations. Thus, progress on the utility of the N-S equations was retarded for about 50 years until 1904 when Prandtl [5] proposed some simplifications resulting in what is now known as the Prandtl Boundary Layer Equations.

Prandtl showed that viscosity, as long as it is small (which we have noted to be true for many real fluids), or more precisely, for large values of a dimensionless flow parameter called the Reynolds number, affects the flow only in a relatively thin "boundary layer" near the surface or the "wall". Within this boundary layer, the fluid velocity rises from zero at the wall (the no-slip condition) to virtually the full value of the undisturbed "outer layer" velocity, this outer layer being the ideal fluid flow problem of classical hydrodynamics.

Boundary-layer has the peculiar property that under certain conditions the flow adjacent to the wall becomes reversed resulting in separation of the boundary layer from the solid surface over which the fluid is flowing. This

separation is generally accompanied by the formation of eddies in the wake of the body, thereby changing the pressure distribution radically from the ideal fluid pressure distribution. Such a deviation results in what is termed "form drag" which can be calculated with the aid of boundary layer theory. The theory also enables the determination of the shape of a body necessary to avoid the detrimental flow separation. The phenomena of stalling associated with the point of maximum lift of an airfoil can similarly be understood and satisfactorily predicted with boundary layer theory, as is the problem of heat transfer between a surface and the fluid interfacing with it, be it internally or externally. Figure 2 shows an application to vehicle body design. Applications of boundary layer include the calculation of the skin-friction drag on a body moving through a fluid, e.g. the drag on: a flat plate at zero incidence; a ship hull; an airplane wing; aircraft nacelle; gas and steam turbine blades; compressor blades; pump impellers; as well as geometries such as pipe- and channel-flows, among many others.

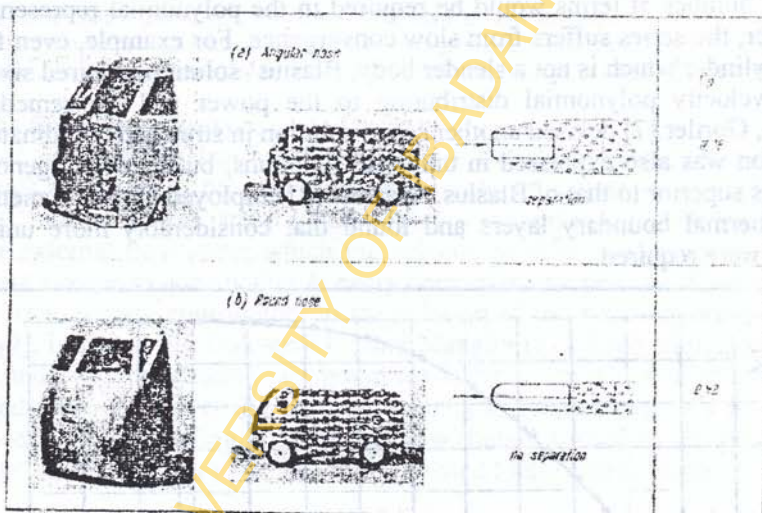


Fig. 2. Flow about a model of a motor vehicle (Volkswagen delivery van), after E. Moeller. Angular nose with separated flow along the whole of the side wall and large drag coefficient ($C_D = 0.76$); b) Round nose with no separation and small drag coefficient ($C_D = 0.42$). (From Boundary-Layer Theory by Dr. Hennann Schlichting, McGraw-Hill, 1968; P.35)

The Prandtl Boundary Layer (PBL) Equations

Consequent on the relatively small thickness of this boundary layer (with respect to any physical dimensions of the problem), some of the mathematically intractable terms in the N-S equations drop out on account of becoming negligible compared to the remaining terms in what is termed an order of magnitude analysis. We then obtain the PBL equations differing from the Euler equations of motion of ideal fluids by the only one additional term which accounts for the influence of viscosity.

PBL equations have since become the starting point of a special area of research within hydromechanics which bridges the gap between classical hydrodynamics and the empirical science of hydraulics. As in the case of the N-S equations, a general analytical solution of the PBL equations, simplified as it is, is yet to be found. Nevertheless, "exact" solutions have been found for a few special cases of practical significance. One of the earliest significant milestones was the work of Blasius [6], who in 1907, was able to compute the drag force on a flat surface or plate in laminar boundary layer flow from the solution of the PBL for a special case of flow with zero pressure gradient. Blasius' calculations were in excellent agreement with very careful measurements, as Figure 3 shows. Blasius was among the first to introduce the use of universal functions which could be tabulated once and for all in the solution of steady, two-dimensional, laminar, constant-property PBL equations. Blasius' method requires that the external stream velocities be expressed as polynomials of the stream-wise distance measured from the front stagnation point, and it was quite effective for flows over blunt objects. However, for slender or streamlined objects, an excessive number of terms would be required in the polynomial representation, and further, the series suffers from slow convergence. For example, even for the circular cylinder which is not a slender body, Blasius' solution required six terms and the velocity polynomial distribution to the power x^{11} ! To remedy this drawback, Gortler [7] devised another series solution in stretched coordinates and the solution was also expressed in universal functions, but its convergence was not always superior to that of Blasius. Sparrow [8] employed Gortler's method to analyze thermal boundary layers and found that considerably more universal functions were required.

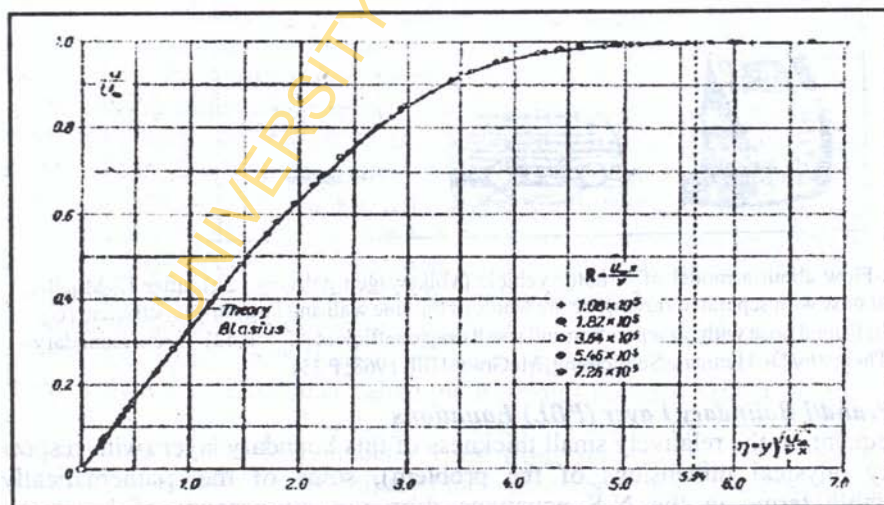


Fig. 3a. Velocity distribution in the laminar boundary layer on a flat plate at zero incidence, as measured by Nikuradse.

(From Boundary-Layer Theory by Dr. Hennum Schlichting, McGraw-Hill, 1968; P.132)

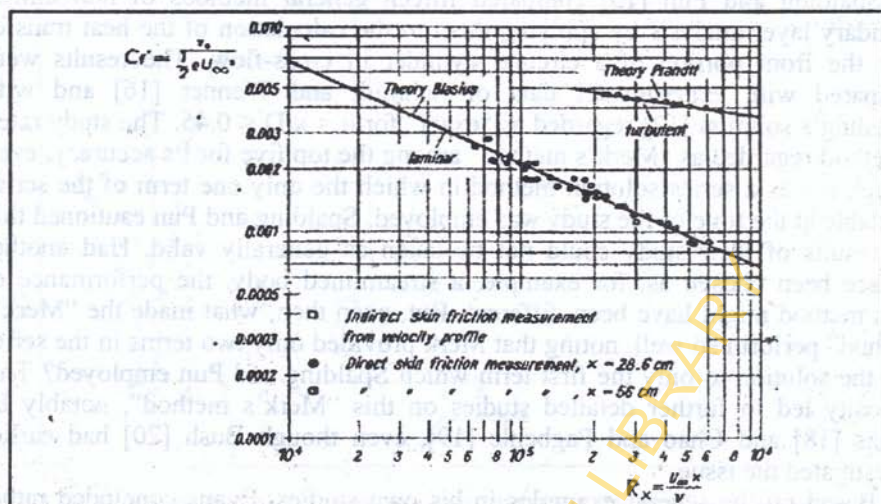


Fig.3b: Local coefficient of skin friction on a flat plate at zero incidence in incompressible flow, determined from direct measurement of shearing stress by Liepmann and Dhawan (From Boundary Layer Theory by Dr. Hermann Schlichting, McGraw-Hill, 1968: p.133)

Similar Boundary Layers

Blasius' solution for laminar flow along a flat plate (flow without pressure gradient) turns out to be merely a special case of a class of general solutions termed "similar flows", and the PBL theory was used to establish the conditions for the external flow under which the velocity profiles of the laminar boundary layer are similar to one another at every corresponding point in the flow. Among the most important contributors to the solution of this problem are Falkner and Skan [9], Hartree [10], Goldstein [7] and Mangler [12]. Such similar solutions of the boundary layer equations are possible for the entire region of accelerated and retarded flows whenever the external velocity is proportional to a power of the distance from the leading edge of the flow, hence known as the power-law or "wedge" flows, i.e. $U \propto x^m$ where "m" is related to the wedge angle.

Non-similar Boundary Layers

Although the majority of practical flows are non-similar in general, yet there are regions of such practical flows that are "locally similar", such as near the forward stagnation point of blunt bodies. Thus, the considerable early effort spent on similar flows is very well spent. Substantial effort has also been expended on methods of analysis of non-similar flows, with considerable variation among the methods in their level of complexity and the computational labour entailed.

A category of "wedge" methods which provides a rigorous refinement of the local similarity concept is that of Merk [13], who derived the PBL equations in transformed coordinates similar to those of Gortler and of Meksyn [14]. Universal functions are also used to present the resulting series solutions, and the method is essentially an extension of Meksyn's procedure.

Spalding and Pun [15] compared fifteen general methods of non-similar boundary layer analysis by applying them to the calculation of the heat transfer over the front portion of a circular cylinder in cross-flow. The results were compared with experimental data of Schmidt and Wenner [16] and with Frossling's solution [17] regarded as "exact" for $0 < x/D < 0.45$. The study rated a method regarded as "Merk's method" among the top five for its accuracy, even though it was a series solution method in which the only one term of the series available at the time of the study was employed. Spalding and Pun cautioned that the results of their study could not be taken as generally valid. Had another surface been chosen as, for example, a streamlined body, the performance of each method might have been different. But, even then, what made the "Merk's method" perform so well, noting that Merk provided only two terms in the series and the solution to only the first term which Spalding and Pun employed? This curiosity led to further detailed studies on this "Merk's method", notably by Evans [18] and Chao and Fagbenle [19], even though Bush [20] had earlier investigated the issue.

Based on the several examples in his own studies, Evans concluded rather unexpectedly that "indeed there is some evidence, but this is not conclusive, that the use of just one term in the series will generally give better agreement with the other methods and with experiment than the use of two terms.....". The reason for such anomaly was given by Chao and Fagbenle [19], who demonstrated that the second terms of both the series as given by Merk and by Evans were in error for both the flow and the temperature boundary layers. Even though Bush [20] had earlier reported the error in Merk's equation in a brief research note which escaped the attention of both Evans and Chao and Fagbenle, the "corrected" equation presented by Bush loses the essential feature of the Merk method whereby rapid calculations of the significant boundary layer quantities are made possible with the aid of a limited number of universal functions. The correct equations of the Merk method and their solution in terms of universal functions were given by Chao and Fagbenle [19]. Figs. 4 and 5 show the velocity distribution and the skin friction coefficient for flow over an elliptic cylinder from the modified series of Chao and Fagbenle compared with experimental data, being one of several applications which they studied.

This then is the essence of the contribution by Chao and Fagbenle, which continues to be acknowledged upward of twenty years afterwards through applications and extensions. The first extension was the paper by Fagbenle [21] presented at the 12th biennial conference of the West African Science Association and the 21st Annual Conference of the Science Association of Nigeria, which held at the University of Ife on July 20-26, 1980. Fagbenle used a two-parameter series expansion to obtain solutions in terms of universal functions to the problem of mixed free (natural) and forced convection laminar flows over a two-dimensional or rotationally symmetrical body. Although the paper was well received, in all likelihood it did not get any further audience beyond the conference walls. Indeed, I doubt the proceedings ever came out since the paper has long disappeared from my Curriculum Vitae!

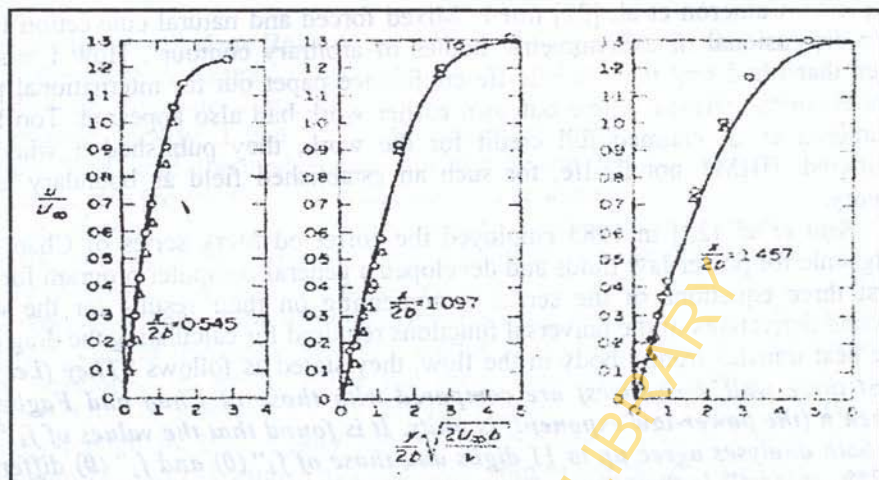


Fig. 4. Comparison of predicted velocity distribution in boundary layers over Schubauer's elliptical cylinder with experiments. (From Chao and Fagbenle, *Int. J. Heat and Mass Transfer* [19], P. 233)

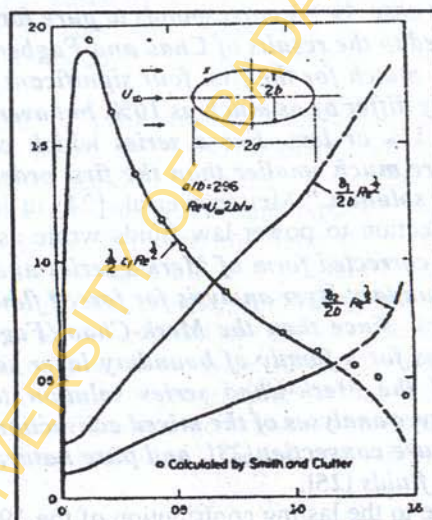


Fig. 5. Skin friction, displacement thickness and momentum thickness of boundary layer over Schubauer's elliptical cylinder. (From Chao and Fagbenle, *Int. J. Heat and Mass Transfer* [19], P. 234)

Shortly thereafter, I put aside this line of research due to lack of stimulating environment — computing and library facilities and supportive “boundary layer research family”. Imagine my surprise and joy therefore, at coming across a series of publications in the *International Journal of Heat and Mass Transfer* (IJHMT), all acknowledged as applications, extensions or adaptations of the *corrected Merk series of Chao and Fagbenle*, while I was on sabbatical leave at South Bank University, London in 1994! I was particularly struck by the 1991

paper by Cameron et al. [22] titled "Mixed forced and natural convection from two-dimensional or axisymmetric bodies of arbitrary contour". How I wished then that I had sent the 1980 Ile-Ife conference paper out for international peer review in the IJHMT where our own earlier work had also appeared. Too late, Cameron et al. claimed full credit for the work; they published it where it mattered, IJHMT not Ile-Ife, for such an established field as boundary layer theory.

Kim et al. [23] in 1983 employed the corrected Merk series of Chao and Fagbenle for power-law fluids and developed a general computer program for the first three equations of the series. Commenting on their results for the wall second derivatives of the universal functions required for calculating the drag and the heat transfer from a body in the flow, they stated as follows "*They (i.e. the first three wall derivatives) are compared with those of Chao and Fagbenle when n (the power-law exponent) is unity. It is found that the values of $f_0''(0)$ in both analyses agree up to 11 digits and those of $f_1''(0)$ and $f_2''(0)$ differ by 0.25% at most*". In their paper, Cameron et al. [22] developed the corrected Merk series of Chao and Fagbenle for two parameters, which was then applied to obtain the solution for the mixed forced and natural convection problem. They state as follows: "*The case $A_B = 1$ corresponds to pure forced convection and as such, can be compared to the results of Chao and Fagbenle. For the first order equations, the results match for the first four significant figures. Higher order functions occasionally differ by as much as 10%, but over most of the range for A_3 , the difference is 1% or less. For a series which converges rapidly, the higher order terms are much smaller than the first order term and have little effect on the overall solution.*" Meissner et al. [24] in introducing their 1994 paper on mixed convection to power-law fluids wrote as follows: "*Chao and Fagbenle put forth a corrected form of Merk's series and used it to perform a universal, laminar boundary-layer analysis for forced flow of Newtonian fluids over isothermal bodies. Since then the Merk-Chao-(Fagbenle) approach has been used with success for a family of boundary layer solutions. Some of the latest applications of the Merk-Chao series solution technique have been universal boundary-layer analyses of the mixed convection to Newtonian fluids [22], and the forced pure convection [23], and pure natural convection to non-Newtonian power-law fluids [25].*"

Perhaps as a tribute to the lasting contribution of the 1974 work of Chao and Fagbenle, the 1st International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics which held in South Africa on 8-11 April 2002 accepted for presentation the paper by Fagbenle [26] on "*The thermal boundary layer transfer for non-isothermal surfaces using the modified Merk series of Chao and Fagbenle*" after a rigorous international peer review. Consequent on this, a formal invitation was extended to Fagbenle to be a member of the International Advisory Committee of the 2nd International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics to be held at Victoria Falls in 2003, according to the correspondence, "*because of your outstanding contributions to the theme of this Conference*". To God Almighty be all the glory. Amen.

Contribution to Nuclear Reactor Analysis and Safety Research

As a Presidential Research Appointee in the Reactor Analysis and Safety Division of Argonne National Laboratory, Illinois, a US Atomic Energy Commission facility, I had the good fortune to work with top scientists on coolant fluid- and thermodynamics for the liquid metal-cooled fast breeder nuclear reactor programme of the laboratory. The amount of that rare fissionable uranium isotope U_{235} , as a primary energy source in conventional nuclear reactors, is perhaps more limited than that of any of the other primary finite energy sources such as coal, oil, or natural gas; it is a very finite resource indeed. U_{235} represents only 0.7% of natural uranium and it is expected to be in short supply at current utilization rate in a matter of decades. Thus breeder reactors were developed in which either the more commonly available isotope of uranium, U_{238} , or alternatively the thorium isotope, Th_{232} , is placed in a reactor initially fuelled by U_{235} . Under neutron bombardment, U_{238} is converted into plutonium Pu_{239} , or thorium Th_{232} into U_{233} , both of which are fissionable. Thus, by means of a breeder reactor, in principle, all of the more commonly occurring natural uranium U_{238} or thorium Th_{232} can be converted into fissionable nuclear reactor fuel. The energy released by the fissioning of only one gram of U_{235} or of Pu_{239} or of U_{233} is truly enormous, amounting to 8200 MJ, approximately equivalent to the heat released by burning 2.7mt of bituminous coal or 13.4 barrels of crude oil.

The work by Fagbenle [27], which was a thermodynamic analysis of the two-phase flow of a boiling liquid metal (Na) coolant and its vapour in a breeder nuclear reactor — a reactor accident condition — was presented locally at the 1st International Conference on Theoretical and Applied Mechanics held at the University of Lagos in 1976. The work highlights the conditions under which a loss of coolant accident could take place in a liquid metal-cooled fast breeder nuclear reactor, in particular the choking conditions and the critical mass flux, conditions that needed to be avoided to prevent reactor meltdown. It was presented at this conference with the hope that such work would interest the Nigerian government to begin a programme for the peaceful application of nuclear energy, particularly for power generation. This hope was partly realized a few years thereafter when both OAU, Ile-Ife and ABU, Zaria began nuclear research.

Contribution to Solar Energy Research and Development

The above interest in boundary layers is traceable, in part, to the fact that my undergraduate admission at the University of Illinois was actually for aeronautical engineering, although after giving its not too bright future in a developing country a thought, I changed into mechanical engineering in my second year. Thus, I was under no illusion that the research facilities at my disposal in the USA would be available on returning to Nigeria, which accounts for the little resistance to abandoning boundary layer research after the 1980 Ile-Ife conference. By that time, the global energy situation was real after the first Middle East oil crisis in 1972 and renewable energy was seen by its apostles as the long-term solution needed. Along with some others who may be here today, I took up energy research in general, but particularly renewable energy research.

As with all research efforts at the time as is even now, funding was grossly inadequate, particularly for large demonstration projects that could impact on society at large. The miniscule funding at the institutional level and within some government Ministries sufficed only to churn out crude students' projects in which "oil-rich" Nigeria of the time was uninterested. I dare say not much has changed even now, particularly if one were to take account of the highly devalued naira over the years.

I therefore embarked on fundamental investigation of the solar energy regime in Nigeria with a view to providing as much scientific information as possible for designers of solar energy equipment and systems to be used locally. I believe that today, together with the effort of other co-workers in this field, there is no basis for a solar energy equipment designer to moan for design database in Nigeria. What is lacking is the will — particularly at government policy-making level — to move forward with the rest of the world on large-scale application of this infinite energy resource. How infinite? From recent measurements of the solar constant, the thermal power of the solar radiation intercepted at the edge of the earth is about 174,000,000 GW, roughly 5,000 times all other steady fluxes of energy on the earth combined! It is also expected to continue at this rate for geological periods of time into the future. The origin of this energy is the nuclear fusion process of hydrogen into helium in the sun's interior, and we have already noted the enormity of nuclear energy from just one gram of heavy atomic isotopes. The mass of the sun is approximately 2×10^{33} g or 2×10^{27} tonnes, which is 330,000 times heavier than the earth though only in the middle range of the stellar masses.

The largest concentrations of solar radiation reaching the earth's surface occur in desert areas within about 35° of latitude north and south of the equator, thereby including both the Sahara and the Khalahari desert areas of Africa. From the measurements of total solar radiation in Ibadan by Fagbenle [31] to be discussed later, the rainy season solar radiation — minimum of the year — averaged over 24 hours is 110 W/m^2 . Assuming a 10% efficient conversion device such as solar photovoltaic (PV) modules (actual commercial modules of amorphous solar PV cells are about 15% while crystalline solar PV cells average 18% efficiency or higher), the electrical power available from 1 km^2 of collection area would be 11 MW. For an electrical power plant of 1000 MW capacity, the collection area required would be about 90 km^2 . Thus, to generate 4000 MW current national generation capacity of the National Electricity Power Authority (NEPA), we would require a collection area of about 360 km^2 . This is a little less than the area of Ojo Local Government Area (LGA) of Lagos State (375 km^2) or just about the combined area of Ibadan North, Ibadan South West and Ibadan North East LGAs (355 km^2). As a fraction of Nigeria's land mass area of about $930,000 \text{ km}^2$, it is an insignificant 0.04 %, less than half of one-hundredth of one per cent! And what is more, this area does not have to be virgin land, it could be achieved from retrofitting roofs and walls of existing buildings in cities with building-integrated solar PV cladding which could also be grid-connected. We shall later consider such developments in Europe, America and Japan as well as the 1998 work of Fagbenle *et al.* [53] on its potential for Nigeria.

We shall now take a quick look at some highlights of my modest contribution to solar energy research and development in Nigeria.

In 1979, Fagbenle *et al.* [28] presented a paper on the design and operation of a solar seed-germinator for an oil palm research institute at the 18th International Conference on Solar Energy in Milan. The idea was to use a solar air heater (collector) to replace the electrical heaters in the oil-palm seed germinator room, with all the associated controls activated by solar electricity from a solar photovoltaic panel. The work generated a lot of interest at the time, with requests for copies of the paper coming from researchers in many countries through most of the 1980's. Yet funding problems prevented its completion, particularly on the controls side. That was my first baptism in inter-institutional research and its unique management problems in Nigeria. Some of the lessons learnt were put to use later in an institutional-government research project.

Sol-air temperature and solar radiation estimation

In ventilation and air-conditioning engineering, the sol-air temperature is defined as the temperature of the outdoor air which, in the absence of all radiation exchanges, would give the same rate of heat transfer into a surface as would exist with the actual combination of incident solar radiation, radiant energy exchange with the sky and other outdoor surroundings, and convective heat exchange with the outdoor air. It is therefore a useful quantity in the estimation of energy exchanges between building surfaces and the surroundings, as in the transient analysis and simulation of the cooling load of a large central air-conditioning system. In 1984, the hourly variation of the sol-air temperature for horizontal surfaces, such as flat roofs, and for clear days was given by Fagbenle [29] using meteorological data for Ibadan.

Since solar radiation data is not readily available in all locations in many developing countries, reasonable estimates must be found from correlations with other meteorological data such as sunshine hours, relative humidity, cloud cover, etc. An estimation of the total solar radiation in Nigeria was thus given by Fagbenle [30], with the aid of meteorological data from the Nigerian Meteorological Services which has a considerable amount of raw data from its installations nationwide. Of the two major empirical methods studied, the Angstrom-type equations were found to give the best estimation. The climatological constants "a" and "b" are provided for sixteen cities all over the country to assist estimation of the solar radiation once the relative sunshine is known at the location. Total solar radiation generally increases with latitude in Nigeria, the month of August experiencing the least radiation in the year throughout the country, with its value ranging between 13 and 20 MJ/m² - day depending on locality.

Results of a one-year experimental data on total and diffuse solar radiation were presented by Fagbenle [31] at the 1st World Renewable Energy Congress in Reading, UK in 1990. The work was the outcome of a research funded by the Federal Ministry of Science and Technology on generating diffuse solar radiation data for two cities in southern Nigeria. As far as I know, that represented the first attempt at generating continuous diffuse radiation data in Nigeria for such a long

period. The least-squares linear fit and the maximum-likelihood quadratic fit to the data are: $K_d = 0.3798 - 0.1838 K_t$ and $K_d = 0.524 - 0.793 K_t + 0.618 K_t^2$, with a maximum deviation less than 5% from the data. K_d is the ratio of the diffuse to the total solar radiation on a horizontal surface and K_t is the ratio of the total solar radiation to the extraterrestrial solar radiation at the same location. Before this work, the usual practice worldwide was to use the internationally acclaimed Liu-Jordan correlation, two of the earliest US solar energy researchers. The diffuse component in Ibadan however appears to be much lower from our data than predicted by the Liu-Jordan correlation especially at the low values of cloudiness index K_t encountered in the study.

Arising from this same conference at the University of Reading, Fagbenle [32] published a conference report on African contributions and challenges in energy research for the 1990-2000 decade. There was no African contribution to the Congress in the following areas of renewable energy research: wind turbine technology, concentrators and solar thermal power generation, hydrogen technology, wave and tidal energy technology, geothermal energy and mini-hydro; yet these are vital areas of energy research where the continent has good endowment of requisite resource. In such areas as photovoltaic technology, materials science, solar refrigeration and space cooling, solar desalination and solar cookers, there was much more research activity from Arab Africa than sub-Saharan Africa. Only in biomass technology did sub-Saharan Africa appear to have a higher research activity level. Significantly, although Africa contributed 19% of all the papers presented at the conference, there was not a single plenary speaker from Africa out of the nine plenary speakers. The paper identified areas of energy research that have been glaringly neglected and underscored their importance to the continent. The problems and challenges facing African renewable energy researchers were outlined and the suggested lines of action given for improved renewable energy research, development and demonstration programmes on the continent. The paper ended with the following still relevant caveat to African governments on their support for new and renewable energy research: "In concluding, perhaps a quote from a recent (1990) editorial of the New York Times is appropriate to the African situation'... two-thirds of US Federal research and development money is devoted to military purposes. If Washington continues to cling to this old agenda, the US will fall behind on research on new energy technologies that will generate riches as fossil fuels are replaced in coming decades. If the US loses its market share of new energy technologies, it will end up importing them as it now imports oil with the same implications for its political and economic strength...."

Professor Sayigh of the University of Reading, UK and Chairman of the World Renewable Energy Congress and an editorial board member of the Nigerian Journal of Renewable Energy (NJRE) wrote as follows to the editor of the journal: "*It (the NJRE) has an excellent article by Mr. Fagbenle about our Congress and the African contributions. Please thank Mr. Fagbenle on my behalf for such an excellent report.*"

On prospects and problems of applying solar energy in transport technology in the 1990's, Fagbenle [33] in 1991 suggested the use of solar photovoltaic cell

(PV) cladding on vehicles, particularly long-axle articulated trucks and transport trucks. The solar PV cells would provide all the electrical needs of the vehicles, including its electric drive systems and its refrigeration system for refrigerated trucks. By 2000, solar PV clad trucks have been in operation in parts of Europe, as suggested in that paper. This is a lesson to younger academics to take the twin issues of patents and intellectual property rights (IPR) very seriously while developing their academic career.

Non-tracking solar collectors normally have to be oriented towards the equator and tilted at some angle to the horizontal in order to maximize the total solar radiation collected, textbook recommendations generally giving the tilt angle as the (latitude $\phi \pm 15^\circ$). Fagbenle [34] in 1991 analyzed the radiation from sixteen Nigerian cities and found that the optimum tilt angle is generally (latitude $\phi + 5^\circ$ to 10°), and the average yearly solar energy, $E_{av,yr}$ in kWh/m^2 , incident on the collector so tilted can be estimated from the following logarithmic functions, depending on the latitude ϕ of the location:

$$\ln E_{av,yr} = 7.405, \quad 4^\circ < \phi \leq 7^\circ\text{N}$$

$$\ln E_{av,yr} = 0.35 \phi + 4.29, \quad 7^\circ < \phi \leq 10^\circ\text{N}$$

$$\ln E_{av,yr} = 0.0129 \phi + 7.66, \quad 10^\circ < \phi \leq 14^\circ\text{N}$$

These equations suffice to carry out a preliminary design of a solar energy system designed for optimal energy collection.

The cloudiness index, K_t , is the ratio of the total solar radiation to the extraterrestrial solar radiation at the same location, and it is an important design parameter for solar systems. To assist solar equipment design engineers, Fagbenle [35] provided a table of recommended average day and the associated monthly-averaged daily extraterrestrial radiation for fifteen Nigerian cities and for each month of the year. The choice of the average day lay between (i) the Julian day represented by a specific day for each month of the Julian calendar, (ii) the mid-month as represented by the 16th day of the month, and (iii) the day in the month with the least deviation from the monthly-averaged extraterrestrial radiation. Most of the earlier work was done in temperate climates of the northern latitudes where the Julian day was recommended average day for each month. The study for the lower latitudes of Nigeria recommended a mix of the three possibilities and provided copious design tables for each of the 15 cities.

Stochastic models and synthetic radiation sequences

A serious drawback to the exclusive use of historical data in design, planning and analysis of solar energy systems is that a particular sequence of observations does not occur in an identical form over a future period. Stochastic models are therefore used to produce computer-generated likely or synthetic sequences of future events such as solar radiation sequences. The objectives of stochastic

analysis of a time series could be descriptive, predictive or control. A useful application of such stochastic analysis is when a limited set of solar radiation measurements is available in a particular location where it is desired to install a solar energy system such as solar water- or solar air- heaters whose time constants are of the order of only a few hours at most. Stochastic models can prove quite useful in long-term performance analysis of solar systems and in forecasting both short- and long-range sequences from limited data.

In their stochastic study of 2,182 sequential hourly global solar radiation at Ibadan, Fagbenle *et al.* [36] found out that the solar radiation does indeed have some memory with a one-hour lag autocorrelation coefficient $R(1) = 0.4$ for K_T . The relatively fast decrease in the autocorrelation coefficient with lag hours also indicates small memory and hence relatively high variability in the sequences. Much higher coefficients would be expected for the northern areas of the country. An analysis of the synthetic sequences generated from the Markov transition matrix of the K_T sequences compared satisfactorily with the original data.

Using the detrended average daily solar radiation sequences for 17 years (1973–1989) from the International Institute for Tropical Agriculture (IITA), Fagbenle and Ighodalo [37] also generated synthetic radiation sequences which were found to sufficiently characterize the actual sequence regarding trend, variance, and internal characteristic structure. Contrary to the hourly radiation sequences, the autocorrelation coefficient of the daily sequences was found to decrease relatively slowly with time, indicating that the daily insolation at Ibadan has fairly good memory with insolation on a given day being related to that on distant days apart.

Solar radiation correlations and charts

Solar radiation has for long been successfully correlated with sunshine hours, as in Fagbenle [38] where the 10-year (1979–1988) monthly average insolation in Ibadan was correlated with the average relative sunshine (S/S_0) by the equation:

$$H/R_0 = 0.281 + 0.490(S/S_0) - 0.188 (S/S_0)^2$$

with a coefficient of multiple correlation $r_{1,23} = 0.76$. Similar studies for diffuse radiation include Fagbenle [39, 40] and Fagbenle and Karayiannis [41].

In the measurement of sunshine duration developing countries however generally suffer from instrumentation problems in regard to the most often used Campbell-Stokes type heliographs or the Foster sunshine switch or the normal incidence pyrheliometer. The Campbell-Stokes recorder charts have to be changed daily, implying the ready availability of spare charts and the personnel to effect the change daily at sunset. Besides, instrument errors of up to 15% have been found by Benson *et al.* [42]. Thus, correlation of solar radiation with other meteorological parameters have been sought by several investigators, as with precipitation, rainfall, relative humidity, temperature, cloud cover and cloud amount, among others. Stigter [43] in a study of cloudiness in Tanzania concludes that point cloudiness observations yield only about 4% error in

radiation estimation, with such visual observations being done twice daily by trained personnel. For developing countries, particularly in remote locations, it therefore appears attractive to estimate sunshine from cloud observations as long as trained observers are available. Fagbenle [44] studied the Department of Meteorological Services' cloud data on 16 Nigerian cities and provided the coefficients of the cubic regression equations for each city. An area-wise regression for the country also yielded the following useful equations:

$$(1 - n/N) = 0.344C - 0.0925C^2 + 0.00827C^3, \text{ for latitude } < 9^\circ\text{N, and}$$

$$(1 - n/N) = 0.222C - 0.0649C^2 + 0.00643C^3, \text{ for latitude } > 9^\circ\text{N.}$$

where n/N is the relative sunshine and C is the cloud amount in oktas. Thus, with availability of reliable cloud data, sunshine duration can be obtained from this work for any part of the country.

In an effort to provide a quick design guide for solar systems designers, Fagbenle [45] employed all the known correlations on total solar radiation in Nigeria to produce twelve isoline charts, one for each month of the year. Thus, through the charts, it is possible to rapidly estimate the expected average radiation at any site in the country and for an average day of any month of the year.

Harmonic or Fourier Series Analysis of solar radiation.

The use of harmonic or Fourier series analysis to study solar irradiation has several advantages. Firstly, the solar irradiation data itself is in a time series form *ab initio*, making it immediately amenable to the method. Secondly, it enables data consolidation, reducing digital data by orders of thousands without significant loss of information content on the observed phenomena. It also allows the possibility of data rehabilitation, whereby incomplete data sets may be selectively filtered for noise to obtain relatively clean signals. Finally, the harmonics and their phases contain detailed information which give insight into its spatial and temporal distribution patterns. The Fourier series tool had been applied in hydrology and water resources for much longer, Thomann [46] for example. The earliest applications to solar climatology were in 1983 by Balling [47] and by Baldasano *et al.* [48], both dealing, not unexpectedly, with data from USA and Europe. Applications to data from the tropics was lacking, particularly to confirm or otherwise, the various findings from the temperate northern latitude solar harmonics. Thus, in a harmonic analysis of a 10-year dataset for Ibadan (1980-1989 IITA daily global solar radiation data), Fagbenle [49] found out that the first harmonic was not a dominant factor as was the case in the northern latitudes of Europe and the USA. The values for Nigeria in seven out of the ten years is about 30%, the other years yielding 13%, 60% and 70%. Balling [47] found a remarkable coherent spatial pattern with values ranging between 92 and 99.9% for the 221 US stations studied. Similar results were given for Spain by Baldasano [48] and Herrero [50]. Thus it appears that the relative importance and dominance of the first harmonic diminishes near the equator. Nevertheless, global solar irradiation estimates from the parameters of the first harmonic given in the work by Fagbenle are accurate to within 10% of the data for any year.

Fagbenle and Karayiannis [51] also carried out a harmonic analysis of the solar radiation data from 28 stations of the Department of Meteorological Services, providing the pertinent amplitudes, phase angles, and harmonic angles at each station. The study revealed that the first harmonic is only marginally more dominant than the second one and that between them both, they account for over 80% of the variance at most stations.

In the design, simulation and testing of solar energy systems, considerable use is made of computer programs and design packages which have the Test Reference Year (TRY) as a key input. Fagbenle [52] generated a TRY for Ibadan from a 10-year global solar radiation IITA data set using the selection method of Finkelstein-Schafer statistics. The representative year was thus identified for each month and the corresponding solar radiation tabulated in a ready-to-use form in the relevant solar design packages.

Solar PV-clad buildings and electrical power generation

Within the past decade or so, solar photovoltaic (PV) electricity has been undergoing pioneering applications particularly in Europe, where roofs and walls of both public and private buildings are being clad with solar cells and the balance of electricity generated is connected to the national grid. Perhaps the best known is Germany's 100,000 Roofs National Programme (revised in 2000) whereby generous subsidies are given to homeowners to purchase solar PV roof cladding interconnected to the national grid. Similar programmes are the 1995/96 (revised 1998) Japanese Solar 1.2 to 1.4 million Roofs Programme and the US 1 million Solar Roofs Programme of the early 1990's. On its own, the Sacramento Municipal Utility District (SMUD) in California has over 8 MW of grid-connected solar PV clad roofs on residential and commercial rooftops, car parking lots, church and school rooftops, and stand-alone solar PV substations.

Fagbenle *et al.* [53] undertook a study of the potential of PV-clad residential and commercial buildings in Nigeria and came out with some startling findings. The study found that some selected solar PV-clad buildings in Ibadan and Lagos alone could easily have met the 1997 total national installed and generating capacity of about 6GW and 15 TWh respectively. Gross estimates for PV-clad buildings in 5 to 10 largest cities give a range of 7.5 to 15 GW for the installed capacity and 35 to 75 TWh for the generating capacity, enough to meet the projected national installed and generating capacity for the year 2020, Fagbenle *et al.* [60]. The pricing structure for electricity however is stacked up against such new technologies, particularly in developing countries. It was found that PV-clad electricity from buildings would cost about 83 times more than the then (1997) electricity price. But then conventional electricity generation does not pay for the damage to the human and environmental health — the so-called externalities — it inevitably causes through fossil fuels combustion.

There are other contributions of note in solar energy research and development which space and time will not permit us to consider in this lecture include the use of salt gradient solar pond for power generation (Fagbenle [54]).

Contribution to Wind Energy Research

Wind energy is a renewable energy of great importance to many countries in Europe, the Americas and Asia, contributing significantly to economic activity traditionally in milling and water pumping and lately in decentralized and grid-connected electrical power generation. According to Renewable World Review Issue for 2000-2001, by 2000, nearly 14 GW of wind power capacity was installed worldwide with the global wind turbine market worth US\$ 4 billion at end of 1999. The cumulative installed wind power capacity by 2000 in various countries were as follows: 5600 MW in Germany; 3400 MW in Spain; 2800 MW in the US; 2100 MW in Denmark; 400 MW in Britain; and 260 MW in China. Africa had no significant wind power generation even as Japan and several Asian countries made some progress towards wind power generation. Considerable effort is now being devoted to off-shore wind farms to complement the coastal and on-shore wind farms that constitute the bulk of the generation noted above.

The use of wind machines in Nigeria dates back to the last stages of colonial administration in the 1950's when multi-blade windmills were installed in selected villages of the then northern region. Invariably, these windmills were directly coupled to reciprocating pumps by long shafts and used to pump potable water from deep wells for the villages and their environs. Propeller-type two-or three-bladed wind turbines were also being used for electricity generation in the tin mines of the Jos area of Plateau State. That the colonial powers did not site any wind machines outside of the north suggests that the wind energy resource of the southern Nigeria was relatively small. Thus, there was a need to undertake a systematic study of the wind energy potentials of Nigeria in order that this resource can be optimally used.

Of the considerable excellent work on the weather in Nigeria by the Meteorological Services Department, that of Adejokun [55] provides a firm base for the understanding of the Nigerian weather system. In one of the earliest studies of the wind power potentials of Nigeria, Fagbenle *et al.* [56] found that a modal class speed of about 3 m/s characterized the 1951-1960 wind data from twelve meteorological stations, and that the Weibull power density could be estimated by a third degree polynomial of the mean wind speed:

$$P/A \text{ (W/m}^2\text{)} = -47.8 + 74.2 V - 34.5 V^2 + 5.1 V^3$$

Other previous studies include those of Ojosu and Salawu [57] who studied the wind data from 22 stations for the period 1951-1975 and of Adekoya and Adewale [58] whose studies of the wind data from 30 stations covered various periods ranging from 8 to 22 years. The mean wind speeds found in these studies have been found to be consistent with those of Fagbenle *et al.* [56].

Fagbenle and Karayiannis [59] in 1994 made a detailed study of the 1979-1988 wind data of the Meteorological Services Department which included (i) the hourly surface wind data for 18 stations, (ii) highest gusts data for 13 stations, and (iii) upper winds data at 1200 hours for two stations, at elevations 610m, 1220m, and 2440m. It should be noted that these stations are usually airport or aerodrome stations established primarily to aid air navigation. Instrument height

at the stations is not standardized — about a third have 5m anemometer height while the rest have 10m heights. Only Lagos had a 15m height anemometer. A deliberate program to map the wind regime in the country would ideally locate the data sites rather differently, as well as the anemometer heights. For example, the data sites would be located at the windiest sites across the nation and data at 10m, 25m and 50m would be standard at each site.

Fagbenle and Karayiannis also gave the Weibull parameters c and k as well as the power densities for each of the 18 stations of the study. The wind speed is distributed as the Weibull distribution function if its probability density function $f(V)$ fits the equation:

$$f(V) = (k/c)(V/c)^{k-1} \exp[-(V/c)^k]$$

The mean wind speed V_m and the average power density P/A are respectively given by :

$$V_m = c G(1 + 1/k), \text{ and } P/A = \frac{1}{2}(I - F_0) \rho c^3 G(1 + 3/k)$$

where G is the gamma function, F_0 is the probability of observing zero wind speed at the location and ρ is the wind density.

Generally, the mean wind speed increases with latitude across the country, although the lowest mean wind speeds occur at the mid-latitude station of Bida with a mere 1.3 m/s. Power densities vary over a wide range, from 29.1 W/m² at Sokoto to 0.76 W/m² at Bida. Sokoto was found to have a good possibility of 24-hour useful energy extraction from the winds whose mean speed rarely fall below 3m/s and which exhibits less than 10% calms throughout the day.

Gusts of 20 to 50 m/s occur annually, usually accompanying the first few rains of the year. Adequate designs must therefore be made for the structures of wind power machines — windmills and wind turbines — to withstand these gusts.

An upper winds analysis of Maiduguri showed a power law fit of the mean speed — height variation, with exponent n ranging from 0.08 to 0.15. Incidentally, this is a boundary layer type velocity distribution with the no-slip condition at the surface of the earth!!!

The study recommended a deliberate and well-coordinated wind energy resource mapping programme for Nigeria at 10m, 25m, 50m and at both wind turbine hub-height and upper winds, with particular emphasis on the following possible wind farm sites:

- (i) Adamawa and Bamenda highlands in Adamawa and Taraba states;
- (ii) Biu plateau and the Mandara mountain areas of the northeast;
- (iii) Flatlands of Sokoto, Kebbi, Niger and Oyo states;
- (iv) Mountain ranges of the southwest merging into Kwara through Osun State;
- (v) Coastal and offshore sites of the Atlantic coastline

Contribution to National and Regional Energy Policy Development and Implementation

National Energy Issues

In a 1997 case study of Nigeria's power sector, Fagbenle *et al.* [60] in a paper in the International Journal of Global Energy Issues projected that the electricity demand of 5.881 GW (installed) and 14.79 TWh (generating) would double by the year 2020. The technically and economically feasible hydro potential of Nigeria is about 9.85 GW installed capacity and 45 TWh generating capacity, about a third of which has already been developed. Thus continued development of all the remaining hydro resources would just be barely sufficient to meet the 2020 demand.

Although the petroleum resources are able to meet this projected demand, there are serious financial and environmental constraints associated with their use. Petroleum resources are part of the conventional, exhaustible, finite fossil energy resources that any nation so endowed has the onerous responsibility to plan carefully to optimize its benefits to its people and their future generations as well as the environment.

The energy sector has been characterized by the World Energy Commission as a large consumer of national resources which demands large expenditures, skilled manpower and steady foreign exchange outflows [61]. It could not be any more true than in Nigeria, where in 2001 alone, US\$446.9 million appropriation to NEPA to ensure steady electricity nationwide by December 2001 failed to produce the expected change.

Even with the LNG exports, Nigeria still has about 22 billion cubic meters of natural gas proven reserves remaining. This much gas could provide approximately 230 TWh electricity annually, dwarfing the 30 TWh projected demand for the year 2020. Translating this much resource into the needed product implies long-range planning, dedication, commitment, fiscal discipline, well-trained personnel, and a lot of foreign exchange. In particular, attention needs be paid to downstream chemicals industry that could supply value-added input to the upstream oil and natural gas which now is mostly exported and the balance used internally as fuel energy. There is need to develop our capacity in production and utilization of LPG and CNG in the domestic and transportation sectors. The deadline on flaring should be strictly observed; it is only wise to leave the resource untapped until industry finds it economic to invest in any of the well-known gas recovery technologies.

A case was also made in the work for two nuclear power plants each of 1000 MW capacity to take care of half of the additional 15 TWh that would be required in 2020, while gas/oil fired stations could provide the remaining 7.5 TWh. On the African continent, only South Africa has nuclear power stations, with its two units of 11.76 TWh generating capacity and 1.842 GW installed capacity. It is noted that about 30% of the world's uranium oxide reserves are in Africa (South Africa, Namibia, Niger, Gabon, Central Africa Republic, Algeria and Zaire). Africa ought to benefit more from nuclear technology than just the economic gains from nuclear fuel export with no value-added.

Energy efficiency and conservation (Demand Side Management), energy-conscious building design, solar passive and active building systems, all have their place in limiting or reducing the energy demand. Indeed, about 30% of the energy generated by NEPA was unaccounted for through its billing system in the study of 1980-1996 generation by Fagbenle *et al.* [60] and count as losses. Measures to reduce inefficiencies in electrical energy production, transmission, and distribution in Nigeria, coupled with reduction in end-use inefficiencies could reduce the projected 30 TWh demand in 2020 by 30% to 50%. Equipment and appliance energy efficiency rating now exists in many European and American countries, stimulating equipment manufacturers to strive for more energy-efficient products. The down side of course is that the old energy-guzzling equipment will eventually find their way to the developing countries most of which are mere consumers, unless they have knowledgeable law makers and public administrators. Public education and awareness training are essential for a successful demand side management programme. A look at Nigeria's current market in "Tokunbo" electrical appliances and vehicles is enough confirmation of the worst of my fears for developing countries!

Other measures include the mandatory use of solar water heaters for all institutional and commercial (hotels, hospitals, etc.) sectors, and industrial processes requiring less than boiling temperature water, and the encouragement of the domestic sector to install solar water heaters if water heaters are needed.

Large central solar PV systems are suggested to assist in meeting peak load demand which generally coincide with maximum solar radiation period, typically 1200 – 1500 hours. With such design in mind, the capital outlay on storage will be minimal and the overall cost reduced accordingly. Building integrated solar photovoltaic (PV) grid-connected systems are also now advocated in the light of recent developments worldwide. It is to be noted that from environmental considerations, hydro, solar PV, and the other renewables are much preferred means of generating electrical energy but the conventional fossil (oil-, gas-, or coal) — fuelled thermal power stations have tradition, the industry might and muscle, and economics of scale in their favour. For example, within the last decade and on a per kilowatt (electrical) installed basis, fossil-fuel plants burning natural gas have the least installed cost at \$200-300, followed by oil-burning plants at \$250-350, coal-burning plants also at \$250-350, nuclear plants at \$300-1200, while solar PV costs are in the range \$400-70,000 (Fagbenle *et al.* [60]), a reflection of the absence of externalities in the cost structure of fossil-fuelled power plants.

The above notwithstanding, the average annual world market for solar photovoltaics (PV) over the past five years is about 200MW per year, and it is a rapidly growing market. Renewable Energy World Review Issue 2000-2001 forecasts 650 MW for 2005 and 1700 MW in 2010 for solar PV. The corresponding dollar value of this world solar PV at a conservative 8 US\$/Watt, (from Fagbenle [62]) is about US\$ 1.6 billion annually over the past five years. The trend and forecast in grid-connected residential/commercial solar PV worldwide was also given (in MW installed capacity) as:

Year	1990	1993	1996	1997	1998	1999	2000	2005	2010
MW	1	2	7	27	36	60	110	300	800

The estimated market value of this grid-connected solar PV trade is about US\$1 billion annually. Can Nigeria truly afford to be shut out of this market with all the energy and environmental benefit clearly seen by the rest of the world except Nigeria? Is the President of Nigeria aware of the huge renewable energy deployment in Europe, America, Japan, Asia, and even in oil-soaked Arab and gulf states over the past decade? It is a matter for regret that Nigeria which sorely needs solar PV and other renewables in both decentralized and grid-connected system modes is, as usual, the ever sleeping giant, only to awake someday when everyone else has acquired and got used to later generations of the technology, a la Nigeria's first generation GSM and the internet!!!

On liberalization and privatization, Fagbenle *et al.* [60] argued for a break up of NEPA into three autonomous organizations — one each for generation, transmission and distribution, respectively. Liberalization and privatization could then proceed in the distribution and marketing sub-sectors, while for security reasons, generation and transmission would have to remain largely state-controlled for quite some time. The first step towards the liberalization stage is full commercialization. NEPA must be made to run as a successful commercial organization making profits and paying dividends to stakeholders (government in this case).

The on-going “subsidy” dispute between the Federal government, NEPA and the Lagos State government over the 270 MW Independent Power Project (IPP) at Egbin is a lesson to us all. That gas turbine cycles, on their own without combined cycles, are highly unlikely to be viable base-load power stations has been taught to all my thermodynamics students from the 1970's. They are very efficient topping cycles, and when planned into an effective maximum demand tariff structure that has in-built peak-load control mechanisms could be an attractive economic solution. The whole structure of IPP's and EPP's (Emergency Power Projects) needs to be undertaken within a reviewed and holistic National Energy Policy as will be discussed later.

Sub-regional and regional energy issues

As the first Director of Energy Affairs in the Republic of Botswana and later the Energy Advisor to the government, I was opportuned to make some contributions to the development of the energy sector not only of Botswana, but also of the Southern Mica sub-region (SADC) and of the Africa region. Through membership of several high-level regional committees, as Director of Energy Affairs, I had the good fortune to be called upon to contribute meaningfully to the development of the SADC energy sector. The SADC regional energy regulatory reform process had its maiden meeting in March 2000 in Botswana at which I was invited to present the welcome address outlining the issues of energy sector regulatory reform worldwide, and the subsequent approval by the SADC Energy Ministers Meeting of the Regional Energy Regulatory Association (RERA) in Luanda, Angola in June 2000 had notable input from the Botswana delegation.

The Director of Energy Affairs has the responsibility for the overall management of the nation's four major national energy programmes, viz.: the National Photovoltaic Rural Electrification Programme (US\$1m), the National Rural Power Supplies Programme (US\$32.2m), the 70 Villages Accelerated Rural Electrification Project (US\$48m) and the National Coal Development Programme (US\$3.6m). The Energy Affairs Division itself has an average annual development budget of about US\$6.1m and an average annual recurrent budget of about US\$5.4m in a nation of only 1.5 million people! The Botswana Power Corporation (BPC), internationally ranked alongside South Africa's Eskom as the two most efficient power utilities in Africa, reports through the Director of Energy Affairs to the Permanent Secretary of the Ministry of Minerals, Energy and Water Affairs. The following projects were developed during my term as Director and prepared in co-operation with other agencies:

1. Global Environmental Facility (GEF-UNDP) Proposal identifying and overcoming barriers to widespread adoption of photovoltaic electrification in Botswana. PDF Request: US\$245,000 was approved by the GEF early in 2001. Project was developed in cooperation with the Botswana Technology Centre (BOTEC) and the Rural Industries Innovation Centre (RIIC) of Botswana.
2. Wind Energy Resource Mapping in Botswana Proposal to the British Foreign and Commonwealth Office. In co-operation with the AEA Technology Environment, Harwell, UK, BoTeC and RIIC. FCO Contribution UK £82,000; First Phase Report approved and Second Phase Funding approved in July 2000.
3. Developing Energy Efficiency and Conservation Standards for the Building Sector in Botswana — *Project* approved for funding by DANCED to the tune of Pula2.0m (approx. US\$400,000), in September 2000.
4. The Development of an education and training needs analysis tool for projects within the Clean Development Mechanism of the Kyoto Protocol — Proposal submitted to the UK Foreign and Commonwealth Office for funding to the tune UK £58,900 by the Centre for Energy Studies of South Bank University in cooperation with the Energy Affairs Division of the Ministry of Minerals, Energy and Water Affairs, Gaborone, Botswana. Status of linkage severed at end of my term.
5. Economic and Environmental Benefits of Energy Efficiency and Conservation at the Bamangwato Concession Ltd. (BCL) Copper Mines — Project funded by the African Energy Policy Research Network (AFREPREN), Nairobi, Kenya. Final Report submitted and accepted in June, 2000. A PDF-B GEF Project Proposal arising from the study report was submitted to the UNDP in May 2000.

6. Coal beneficiation plant cooperation agreement discussions and negotiations with the Chinese government through the Chinese Embassy in Gaborone, Botswana. By May 2001, indications were that the Chinese government had agreed to set up a coal beneficiation plant in Botswana to the tune of about US\$2.5m within the anticipated agreement.
7. Initiation and concluding a co-operation agreement on energy between the United States Department of Energy and the Botswana Ministry of Minerals, Energy and Water Affairs, an agreement signed by the US Secretary of Energy and the Botswana Minister of Minerals, Energy and Water Affairs in Durban, South Africa in December 2000.

Exergy and the Environment

The use of energy, particularly conventional fossil energy resources especially in the industrialized nations has continually grown since the industrial revolution age. Developing countries have also witnessed relatively substantial growth in their own conventional energy resource use over the past thirty to fifty years of their nationhood. Nigeria, for example, has witnessed an increase in its electricity generating capacity from under 2 TWh to about 15 TWh in the thirty year period of 1970-2000, only about a third of which is from renewable hydro resources, Fagbenle *et al.* [60]. Thus two-thirds of this generation is from the finite, exhaustible primary or conventional fossil resources — mainly petroleum and natural gas. Similar large increases in the use of primary energy resources are found in the domestic, commercial, industrial and transportation sectors.

These conventional or primary natural energy resources of the world have taken several centuries to form in the earth's crust, and we all know the expected result of a spending rate that is greater than wealth accumulation rate. In the case of fossil energy use, the result is even more serious than going bust: the natural environment and its habitat are left worsened by the associated land degradation, environmental pollution, human, animal and fauna health effects; global warming effects, etc. — the so-called externalities.

The technical fix solution aims at identifying and focusing on the more important energy resource conversion processes and technologies that can produce the optimum resource use for the desired effect. Thus, we resort to the science of thermodynamics and particularly its first and second laws to study the use of energy resources in such processes in terms of first- and second-law efficiencies. It is in the use of the second law efficiency that the word *exergy* has been coined. Through the exergy analysis of sectoral energy resource use, aspects of processes and systems where more efficient technologies can produce large improvements are readily identified as in Reistad [63]. The first law of thermodynamics is basically an energy accounting law, which observes the principle of energy conservation. Thus the energy contained in all the input streams to a process or system must be accounted for somewhere in the output streams or accumulated within the system in which the process takes place. There is no room for any ghost or missing energies. The second law of thermo-

dynamics, on the other hand, evaluates the inherent capability of energy and matter streams to cause change, that is the quality of energy or matter streams and it affirms that the quality of such streams is degraded or even destroyed due to irreversibilities in practical processes. It is conserved only in ideal reversible processes. As an example, Fagbenle and Karayiannis [65] have developed useful thermodynamic expressions to evaluate the exergetic efficiency of a solar absorption refrigeration regenerator.

To get an idea of irreversible and reversible processes, consider the electric heater — the electric coil or kettle or bathroom geyser. Now the heater coil element is at temperatures of the order of several hundred degrees or even a couple of thousand degrees and yet the desired water temperature is only about 80°C for tea or coffee brewing and 30°C for bathing. Transferring heat across large temperature differences is an irreversible process whose inefficiency can only be uncovered with the second law exergy efficiency analysis, yielding an exergy efficiency of $\epsilon < 10\%$. The first law would give a false picture of an efficient heater at about $\eta \equiv 60 - 70\%$ efficiency. In this example very high quality electric energy is being used wastefully, degraded so to speak, in low-heat applications. Heat can be transferred reversibly only across an infinitesimally small temperature difference, like stairway steps, until we get to the desired end point.

Table 1 below indicates the first and second law efficiencies for several processes (from Rosen and Dincer [65]). It is noticed that the exergy efficiencies in the table are lower than the corresponding energy efficiencies, a result of the irreversibilities of the process destroying some of the input exergy to the process.

Table 1
Comparison of energy (first law) efficiency and exergy (second law) efficiency for selected processes. (from Rosen and Dincer [65]).

Process	Efficiency, %	
	1 st Law	2 nd Law
Residential heater (fuel)	60	9
Domestic water heater (fuel)	40	2-3
High-pressure steam boiler	90	50
Tobacco dryer (fuel)	40	4
Coal gasification (high heat)	55	46
Petroleum refining	~90	10
Steam-heated reboiler	~100	40
Blast furnace	76	46

The energy utilization efficiency of a country can be studied using exergy analysis in order to achieve energy and hence financial savings. After its pioneering application by Reistad in 1975 to the US, several other countries have been similarly studied, e.g. for Canada by Rosen [66], for Finland, Japan and Sweden by Wall [67], and for Turkey by Rosen and Dincer [65] as earlier noted. Such studies of the major sectors of the Nigerian economy constitute part of the directions my current energy research.

Another direction of my current energy research, not too deviational, is the externalization of the environmental and social effects of energy utilization. This highly multidisciplinary research area came to prominence with the important work of Hohmeyer [68] in 1988 and his later publications [69–71]. The effects of interest are wide and cover such areas as economic, health, emissions to the air of NO_x , SO_x , CO, particulates, etc. and their impact on human and animal health, flora, fauna, buildings; emission of greenhouse gases CO_2 , N_2O , CFCs, methane CH_4 , tropospheric ozone O_3 , and water vapour H_2O , all of which impede the transmission of long wavelength radiation away from the earth; etc.

An aspect of the energy-exergy-environment interrelationships was considered by Fagbenle *et al.* [72] in their study of the technical implications for developing countries of the 1987 Montreal Protocol which restricted the production and consumption of chlorinated and brominated substances — the ozone-depleting substances — such as the fully halogenated chlorofluorocarbons (CFCs) and the halon compounds. The study, published in the International Journal of Environment and Pollution, advocated the introduction of, and education on, appliance efficiency indexing in developing countries in step with the developed countries, otherwise inefficient and discarded domestic and commercial appliances from the developed countries will be dumped in the developing countries, worsening their energy and environment problems. This warning has largely gone unheeded.

Energy and the Future

In the abstract to a 1975 paper on a survey of world energy resources, that great research geophysicist, M. King Hubbert [73] succinctly focused the world's attention to the exhaustibility time frame of fossil fuels - principally coal, crude oil and natural gas thus: *"The present large-scale use of energy and power by human species represents a unique event in the billions of years of geologic history. Furthermore, in magnitude, most of the development has occurred during the present century. In the United States, the peak in the rate of petroleum production occurred in 1970 and that for natural gas is imminent. The peak in the world production of crude oil is expected to occur at about the year 2000 and that for coal production at about 2150 or 2200. For other sources of energy and power, waterpower, geothermal power and tidal power are inadequate to replace power from fossil fuels. Nuclear power, based on the breeder reactor and utilizing low-grade deposits of uranium and thorium, has a larger potential than the fossil fuels, but it also constitutes a large perpetual hazard. The largest source of energy available to the earth is solar radiation. This source has a life-expectancy of a geologic time scale, is non-polluting and is larger in magnitude than any likely requirements by the human species...."*

Hubbert's assertion came from an application of the fundamental principle of exploitation of any exhaustible resource, namely that its exploitation rate must begin at zero, undergo a period of more or less continuous increase, reach a culmination or peak, and then decline, eventually to a zero rate of production, as shown in figure 6 below. On a cumulative production curve, this would be the logistic distribution. Thus, if from geological or other data the producible

magnitude of the resource initially present can be estimated, then, any curve drawn to represent the complete cycle of production must be consistent with that estimate. This implies that the area under the curve must equal the estimated magnitude of that resource. The principle therefore affords a powerful method to estimate the time scale for the complete production cycle of an exhaustible resource in any given region or for the whole world. In the case of the world estimates, Hubbert used "the absolute magnitude of the world's original supply fossil fuels recoverable under present technological and economic conditions" to conclude that for coal and petroleum, the time required for the exhaustion of the middle 80% of the ultimate cumulative production is of the order of one or two centuries.

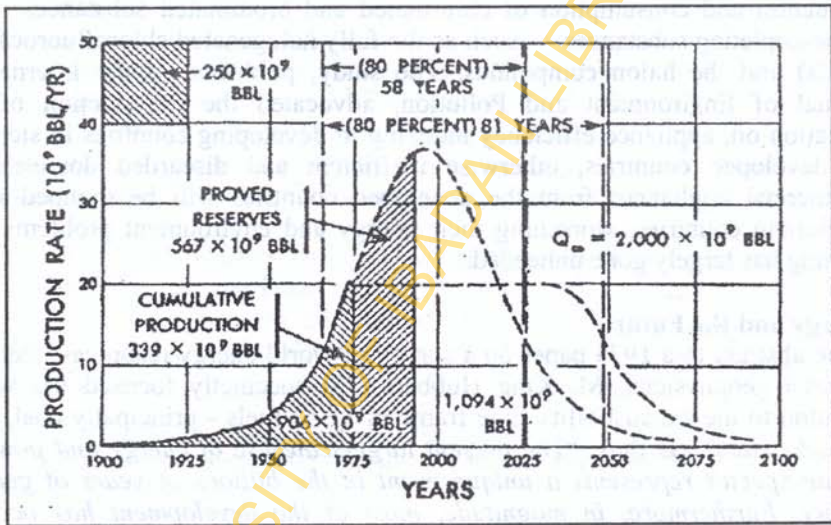


Fig. 6 Alternative complete cycles of world crude oil production.
(From Energy: For ourselves and our posterity [74], P.88.)

Hubbert also dramatically presented the brevity of the "epoch of fossil fuels" in terms of the longer span of human history. In the graph, shown in figure 7, the historical epoch of the exploitation of fossil fuels is plotted on a time scale extending from 5000 years in the past to 5000 years in the future. It is seen therefore that on such a time scale, the epoch of fossil fuels "can be only a transitory or ephemeral event" as Hubert put it, although it is a momentous event in the terms of the drastic influence it has had on the human species and civilization during its entire biological history.

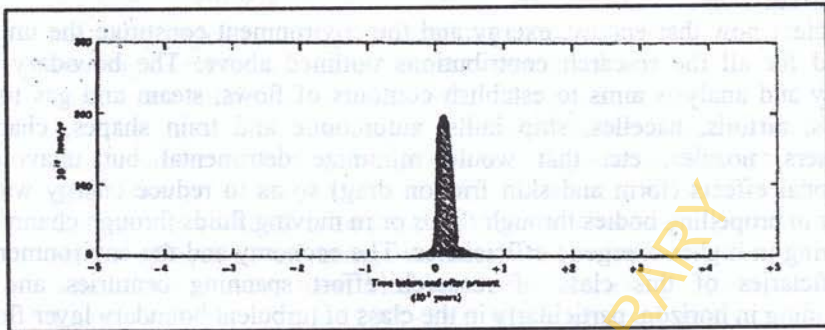


Fig. 7. Epoch of fossil fuels in a longer span of human history.
(From Energy: For ourselves and our posterity [74], p. 90).

A possible future for mankind has been suggested to rest on what is termed the Hydrogen Economy. This is the future of exhausted finite fossil energy resources of the world and yet with the lifestyle that the developed world is used to and to which the developing world aspires. The hydrogen economy rests on the huge water resource of the world wherein two-thirds of the earth's surface is covered by water. Thus electrolysis of this water with solar electricity will produce hydrogen fuel and oxygen with little or no negative environmental effects. Hydrogen is the fuel of the future, it is easily stored and can be used in either the gaseous or liquid form. The storage factor is the main reason solar electricity would need to be used for electrolyzing water rather than using electrical transmission lines. Hydrogen can be distributed on a large scale through gas pipelines.

In the domestic, commercial and industrial sectors, hydrogen can be recombined with oxygen in what is known as the fuel cell to produce electricity. In the transportation sector, hydrogen can be used as fuel in an internal combustion engines (ICE) as has been demonstrated in government sponsored research in the USA, Germany and Japan over the past two decades. Hydrogen vehicles have very close to zero tailpipe emissions, emitting only trace amounts of CO and HC originating from the lubricating oil and of nitrogen oxides resulting from burning any fuel in air. Alternatively, the electricity required by an electric vehicle can come from either a fuel cell (FCEV) or the conventional electric vehicle batteries (EV). For the fuel cell vehicle, the platinum-catalyzed polymer electrolyte membrane (PEM) fuel cell is the prime candidate.

In the hydrogen economy, the hydrogen, could also be obtained in any number of processes and from several sources — steam and plasma reforming as well as pyrolysis of natural gas, partial oxidation of heavy petroleum oils at refineries, coal gasification, etc., but the renewable source would be the vast water resource of the earth. Thus, the Biblical beginnings of the world in Genesis 1:2 would have contained the end point also, wherein the waters covering the earth would become its prime source of primary energy.

Energy, Exergy and the Environment: The Unifying Thread from Boundary Layer Theory through Nuclear Reactor Research to Renewable Energy Research.

It is clear now that energy, exergy and the environment constitute the unifying thread for all the research contributions outlined above. The boundary layer theory and analysis aims to establish contours of flows, steam and gas turbine blades, airfoils, nacelles, ship hulls, automobile and train shapes, channels, diffusers, nozzles, etc. that would minimize detrimental but unavoidable frictional effects (form and skin friction drag) so as to reduce energy wastage either in propelling bodies through fluids or in moving fluids through channels — resulting in higher exergetic efficiencies. The economy and the environment are beneficiaries of this class of research effort spanning centuries and still expanding in horizon, particularly in the class of turbulent boundary layer flows.

Nuclear reactor accident analysis research surely has the environment as its main focus, the prevention of coolant flow loss resulting in choking conditions and reactor meltdown. Energy is of course the fundamental *raison d'être* of nuclear reactors, the controlled release of the enormous energy locked up by nature in the nucleus for power generation. Nuclear reactor coolant flow dynamics benefits from the exergy gains of boundary layer research through optimized pump impeller and turbine blades design, etc.

Finally, the energy-environment relationship of the renewable energy research contributions discussed in this lecture is patently clear. Renewable energy resources, unlike the primary fossil energy resources, are generally far more environmentally benign than any primary fossil energy source. Of all the various renewable energy resources, only solar energy has the potential to meet the world's energy needs within any conceivable time spectrum of human habitation on this planet earth.

Energy, Exergy, the Environment and the Future

To ensure that the energy future, indeed the future, of Nigeria is not compromised, I humbly put forward the following recommendations emanating from the various issues covered in this lecture:

1. An urgent stakeholder-wide review of the National Energy Policy of the early 1980's, revisiting its objectives and priorities in the light of national, regional and international developments in energy and its interaction with the environment, particularly the United Nations Framework Convention on Climate Change (UNFCCC) process.
2. Establishment of a separate Ministry of Energy and constitution of a National Advisory Committee on Energy, reporting to The President through the Minister, and consisting of all the main stakeholders of the energy sector, to reflect the crucial importance of energy to national development through the accepted linkage of economic growth to energy and energy intensity. The Steel sub-sector of the present Ministry of Power and Steel actually fits in very well into the Ministry of Mines upon creation of a Ministry of Energy. Neither the Energy

sector nor the Steel sector is well under the present set up. Energy deserves a hundred percent attention to be able to drive the nation's economy positively. No one is happy with the status quo of the energy sector in Nigeria of today. Indeed the name "Power" given to it is too limiting of the broad range of energy options available and may tend to narrow our collective vision on wider energy issues.

The importance of energy as a separate sector is underscored by the establishment of both sub-regional and regional energy commissions. The Energy Commission of the Southern Africa Development Community (SADC) is in Luanda, Angola, coordinating all the energy issues of SADC, including the Southern Africa Power Pool (SAPP) which interconnects most Member States' electricity utilities. A SADC Energy Activity Plan for 2000-2005 was completed as my tour of duty in Botswana ended in 2001. The African Energy Commission (AEC) has also been agreed by the OAU to be established and sited at Algiers, Algeria and should commence operation hopefully this year. Nigeria should be interested in the top management of that Commission.

Indeed, all talk of e-learning and long-distance education, amounts to no more than a pipe dream and throwing good money down the drain given the unreliable energy base that currently plagues Nigeria. Information Technology with such unreliable energy base is mere frustration and it is next to worthless. We must get the energy base right first, for energy is the foundation of Information Technology. It must be a solid, diversified, reliable and futuristic energy base that can only come out of a purposefully restructured public energy sector.

3. Establishment of a National Centre for Clean Energy Technologies for the demonstration of all energy technologies that promote a sustainable environment, proven and prototype, new, renewable or conventional. In this regard, mention could be made of such technologies as the fuel cells, hydrogen technology, large-scale solar photovoltaic and solar thermal power generation technologies, clean coal technologies such as fluidized and air-circulating fluidized combustion technology, biomass integrated gasification/steam-injected gas turbine (BIG/STIG cycle) technology, etc. The Centre will also disseminate and diffuse these technologies and would therefore have a strong Extension Division.
4. Instituting clear rural electrification policies that incorporate both off-grid and grid-connected electrification systems through renewable energy technologies into the overall national energy strategy, but particularly into the mainstream poverty alleviation/eradication and rural development programmes.
5. According very high priority to Energy Research and Development in the annual budget and national rolling plans by creating an Energy Research and Development Agency (ERDA). That energy and economic development are strongly linked has been established through

the energy intensity, economic growth and degree of industrialization interrelationships. Many developed and some developing countries have long-established National Energy Programmes that are indispensable to their economic and social well-being. The following programmes for the ERDA, are a necessity for 21st century Nigeria in my considered opinion:

- (a) *National New and Renewable Energy Programme* on solar, on- and off-shore wind, biomass, energy crops, municipal and industrial wastes digesters, bio-fuels, landfill gas, sewage gas, mini- and micro-hydro, pumped hydro, wave, tidal, hydrogen, fuel cells, energy efficiency and conservation — Demand Side Management (DSM) of energy, etc. All developed and many developing countries have had such programmes in place for decades. If we have to live with NEPA unreliability, then at least measures should be put in place for affordable and easy access to environmentally friendly decentralized renewable energy systems such as solar PV panels instead of those noisy fume-laden generators in every other Nigerian urban dwelling.
 - (b) *National Programme on Clean Coal Technology* to seek environmentally benign ways of utilizing this significant national resource and to benefit from useful international research on clean coal technologies.
 - (c) *National Programme on Nuclear Reactors for power generation* to seek the safest options among the several nuclear technologies for the long term energy needs of the nation, particularly when the fossil energy resources get depleted as they are sure to be at current rates of exploitation. A second's thought of Nigeria of the end of even this century – 2100 – is enough to get anyone 'to begin to give this vast energy source a serious consideration. Successful nuclear technologies include the boiling water reactor (BWR), pressurized water reactors (PWR), the advanced gas reactor (AGR), or the modular pebble-bed reactor technology under consideration by South Africa.
 - (d) *National Programme on Petroleum and Natural Gas Resources* to include tar sands and oil shale. The research programmes here would also include the optimal use of these energy resources in appliances and equipment in the domestic, commercial, industrial and transportation sectors.
6. Improvement of the national capacity for energy research by adequate funding of Research and Development under the ERDA. The process must be open, transparent, result-oriented, well-monitored and accountable. ERDA must ensure sustained public education and awareness in energy-environment-economy inter-relationships.

7. Encouragement of collaboration of Nigerian energy researchers with their international counterparts through government bilateral agreements with other governments and regional and international energy bodies. In particular, facilitation of the full use of environmental funding mechanisms for energy projects, such as the GEF/UNDP and the CDM/JI arising from the UNFCCC.
8. According high premium to the fulfillment of fiscal obligations of national institutions to regional and international bodies through which collaborative research work and academic exchanges are facilitated.
9. Facilitation by government of access by local researchers to Information Technology gains through agreement, on behalf of Nigerian universities, with international libraries online such as the US Library of Congress, the British Library, the various other national and international libraries on line; Only such a level of support can give the Nigerian researcher any hope of surmounting the financial hurdle in the way of access to online research facilities.
10. Encouragement of the development of local capacity to manufacture renewable energy technologies through special incentives. For example, the capacity for local manufacture of solar water heaters, solar cookers, solar PV modules, panels and cells, inverters, wind turbines, gasifiers, etc. should be developed sufficiently to enable international competitiveness in this multi-billion dollar world renewable energy market. This can happen only by government enunciating clear policies encouraging the large-scale use of renewable energy thereby creating a renewable energy market in which private sector funds can be invested.

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