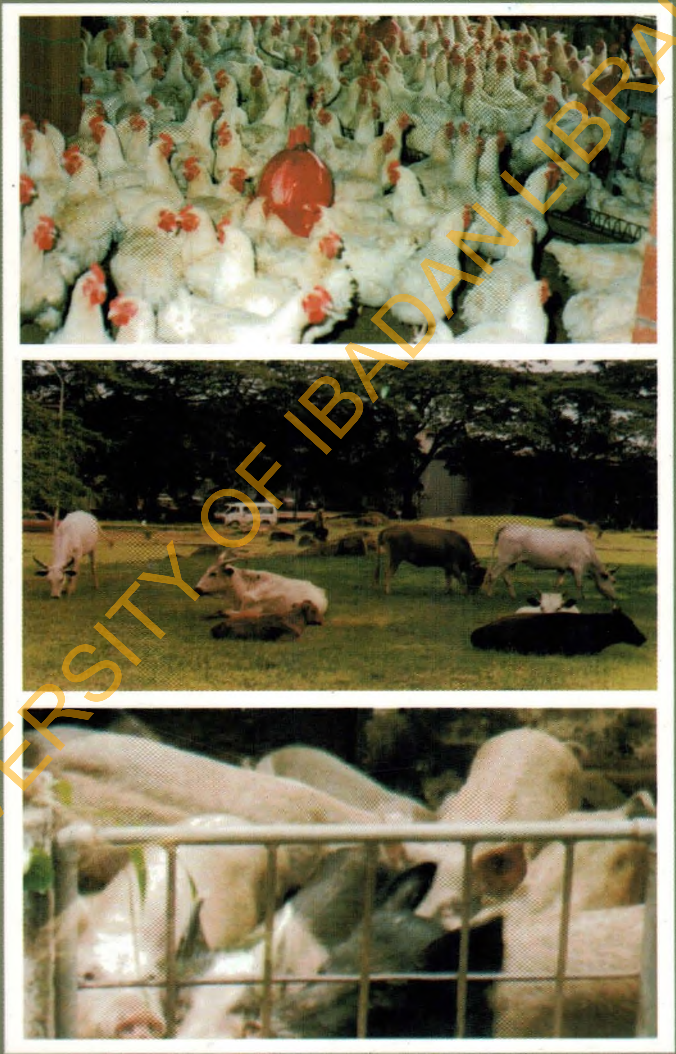
INTRODUCTORY EPIZOOTIOLOGY

Second Edition



ESURUOSO, G. O.
IJAGBONE, I. F.
OLUGASA, B. O.

VetAcademic Resource Foundation (VARF)

INTRODUCTORY EPIZOOTIOLOGY

= Second Edition =
(2005)

By

Professor Gabriel Oluwole ESURUOSO,
Distinguished AGSOBA (D.A.), B.V.M.S. (Glasgow), M.Sc. Immun. (Birmingham), PhD. (Ibadan), M.R.C.V.S. (U.K.), F.C.V.S.N.

Dr. Ighodalo Folorunso IJAGBONE,
FISLT, Cert. Immonology (Lond), M.Sc. (Parasit.), M.Sc. (Epizoot.), Ph.D. (Ibadan)

Dr. Babasola Oluseyi OLUGASA,
D.V.M. (Ibadan), M.Sc. (Epizoot.) (Ibadan)

INTRODUCTORY
EPIZOOTIOLOGY

= Second Edition =

(2005)

By

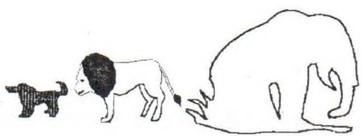
Professor Gabriel Oluwole ESURUOSO, Distinguished AGSOBA (D.A.), B.V.M.S. (Glasgow), M.Sc. Immun. (Birmingham), PhD. (Ibadan), M.R.C.V.S. (U.K.), F.C.V.S.N.
Ag. President, College of Veterinary Surgeons, Nigeria
President, Veterinary Council of Nigeria (1998-2003),
Academic and Animal Health Consultant,
Executive Director of Academic Consultancy Services (ACS),
Founder and President, VetAcademic Resource Foundation (VARF),
Former Dean of Veterinary Medicine, University of Ibadan (1977-1979),
Foundation Head of Department of Veterinary Public Health and Preventive Medicine, University of Ibadan (1976-1987),
Foundation Fellow of the College of Veterinary Surgeons Nigeria
Professor of Veterinary Public Health and Preventive Medicine,
University of Ibadan, IBADAN. Oyo State Nigeria (1976-2001)

Dr. Ighodalo Folorunso IJAGBONE, FISLT, Cert. Immonology (Lond), M.Sc. (Parasit.), M.Sc. (Epizoot.), Ph.D. (Ibadan)
Lecturer, Epizootiology and Preventive Veterinary Medicine,
Department of Veterinary Public Health and Preventive Medicine,
University of Ibadan, IBADAN. Oyo State Nigeria

Dr. Babasola Oluseyi OLUGASA, D.V.M. (Ibadan), M.Sc. (Epizoot.) (Ibadan),
Lecturer, Veterinary Public Health and Biostatistics
Department of Veterinary Public Health and Preventive Medicine,
University of Ibadan, IBADAN. Oyo State Nigeria

A Publication of VetAcademic Resource Foundation (VARF): *Published by VetAcademic Resource Publishers and Consultants*® U.I. P. O. Box 14400, IBADAN. Oyo State, Nigeria
[*Telephone*: **(02) 810 3164**. *GSM*: **0803 410 0566 & 0803 418 1811**
E-mail gomesuruoso@yahoo.com & *ProfGOEsuruoso@aol.com*





Introductory Epizootiology by Esuruoso, G.O., Ijagbone, I. F. and Olugasa, B. O. (Second Edition) 2005

All processing from data input to typesetting and graphics integration are by: -
VETACADEMIC RESOURCE PUBLISHERS AND CONSULTANTS*
[The Documentation and Desktop Publishing Division of Academic Consultancy Services (ACS) of VetAcademic Resource Foundation (VARF)]. U.I. P. O. Box 14400, IBADAN. Oyo State, Nigeria [Telephone Ibadan (02) 810 3164,
e-mail: gomesuruoso@yahoo.com & *ProfGOEsuruoso@aol.com*

ISBN 978-075-395-8

Previous Titles and Editions are: -

1. Esuruoso, G. O. (1976 ff) *Lecture Notes on Epizootiology53 pp.* for **Undergraduate** (*DVM*) and **Postgraduate** (*Certificate Courses in Epizootiology and Meat Hygiene and for MPVM, MVPH & M.Sc. Epizootiology*) **Students** of the Faculty of Veterinary Medicine, University of Ibadan, Nigeria:

2. Esuruoso, G. O. (1992) *Lecture Notes on Epizootiology* [Ref. GOE / 2OTS.IB / 250392. 93 pp. which was produced specially for the penultimate year and first set of final year DVM students of the Faculty of Veterinary Sciences, Department of Public Health and Animal Production, Usmanu Danfodiyo University Sokoto (UDUS), Nigeria. It was then mass reproduced and provided as the foundation text for the teaching of *Veterinary Epidemiology and Preventive Medicine* (i. e. Epizootiology), which was a major course in the DVM curriculum of that University (i.e. UDUS in 1992).

3. Esuruoso, G. O. (1993) *Fundamentals of Epizootiology*, 129pp. [Published by the Documentation and Desktop Publishing Division of Academic Consultancy Services (ACS), U.I. P. O. Box 14400, Ibadan, Nigeria] [Ref. GOE / 2OTS.IB / 250393; 93 pp. Being then the 1993 update of the 1976 1992 editions.

Printed in Nigeria by GLJ Press, Ibadan. ✆08033251140

DEDICATION

This book is dedicated to the glory of God, especially for the lives of all true Epizootiologists who believe in the gospel of being 'biomedically literate, statistically numerate and socio-economically cost-conscious in the development and practice of *Veterinary Public Health* and *Preventive Medicine*.

These are the transparent scientists, professionals and managers of human and material resources in timely order, who revere the holistic system and socially healthy approaches of *socio-economic jurisprudence* (sej), and will always prefer living by the dictates of positive (*psej*) rather than negative (*nsej*) socio-economic jurisprudence, towards the achievement and enthronement of total well-being through God's grace.

G. O. Esuruoso
23rd January 2005

ACKNOWLEDGEMENT

The authors gratefully acknowledge the cooperation of their undergraduate and postgraduate students who are now our colleagues being gainfully employed in the various Faculties of Veterinary Medicine in Nigeria, in the Institute of Virology, University College Hospital, (U.C.H.) College of Medicine, Ibadan, Nigeria and in other places at home, including the National Veterinary Research Institute (N.V.R.I) and the Nigerian Institute of Science Technology (N.I.S.T) and also abroad. We also acknowledge other academic and professional colleagues worldwide, who are committed to the cause and development of Veterinary Public Health and Preventive Medicine through the healthy realization that *Epizootiology* and its closest alternative '*Veterinary Epidemiology and Economics*' as designed and canvassed, are the major composite scientific disciplines providing the soundest basis for cognitive and holistic understanding and practices of preventive veterinary medicine (pvm), which is preventive medicine/measure (pm) in its widest, most comprehensive and naturally most meaningful sense, thus meeting the *social*, *economic*, *financial* and *environmental* health needs of man, our planet mother Earth and the concepts of *total well being* (Esuruoso, 1984 ff.).

In particular we wish to recognize the following individuals, who at one time or the other were and still are students or/and teachers of the science of Epizootiology. They include Professors S. A. Agbede, G.A.T. Ogundipe and Arunsi Kalu, Drs. Sunday E. Uhiene, Ikwe Ajogi, Tayo Babalobi, Mohammed Ardo, 'Deji Olarinmoye, Tunde Adeitan, Dele Oluro, Gbenga Adewale and Ronke Ogunwale. These are some of those who carried out specific projects on epizootiology, veterinary public health and/or preventive veterinary medicine in our school and who have since been applying epizootiological wisdom base to their teaching, research, professional practices and healthy living, in accordance with the principles of '*Non scholae sed vitae discimus*' (*ibid.*) with dedication.

We give special thanks to the pre-publication reviewers of this book, including especially Professors Oyewale Tomori, world renowned veterinary virologist and Vice Chancellor of the Redeemer's University, Nigeria, Samuel A. Agbede, achiever specialist in Aquatic Veterinary Medicine, Professor and current Head of the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan (U.I.), Arunsi

Kalu, Professor and current Head of Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri (UNIMAID), Gabriel A. T. Ogundipe incumbent Dean of Veterinary Medicine, Professor and former Head of the Department of Veterinary Public Head and Preventive Medicine, U.I. We also here record our appreciation to our many editorial advisers and proofreaders, especially Stephen O. Akpavie Professor and Head of Veterinary Pathology, U.I. and Dr. Ayodeji O. Olarinmoye, Director of Veterinary Services, Seventh Day Adventist Hospital, Jengre, Plateau State, Nigeria.

We are indeed deeply grateful and would like to register our special thanks to the author of the foreword to this book Chief Benjamin Ekundayo Olufemi, Professor of Veterinary Medicine and Dean of the Faculty, U.I. (2003-2005 AD). We recognize the inestimable contributions and cooperation of and we are therefore thankful to Mrs. Florence Ijagbone for her support during this effort and Mrs. V.W. Esuruoso, the Administrative Director of *VetAcademic Resource Foundation* (VARF) for her active input into the success of this project. Most of our grownup children, especially 'Funmi, Gbolahan, 'Sola and 'Lola made significant inputs into the acquisition of the equipment, other resources and encouragement that made the electronic production of this book possible, and so we thank them.

We also thank Miss Temilola Olatunji for her support by subtle encouragement to Dr. Babasola O. Olugasa. And to John D. and Catherine T. MacArthur Foundation for supporting Dr. 'Sola Olugasa to Iowa State University as visiting scientist, while the final stages of the work on this book was going on, and for the resulting indirect enhancement of 'Sola's input into this book, the authors are grateful.

Finally we give thanks and all the glory to God, the Father of our Lord and Saviour Jesus Christ for His immeasurable mercies in seeing us through this project, and in blessing the product. We recognize these as part of the spiritual dimension clearly reflected in the substance of the book, under the principles of *socio-economic jurisprudence* (sej), the nature of advocated *social health* and *the pie chart of human wisdom* (*ibid.*), which all true epizootiologists will find useful all the time.

Esuruoso, G.O., Ijagbone, I.F. and Olugasa, B.O.
Ibadan, Nigeria 23rd January 2005

FOREWORD

The second edition of this book has come at a time when there seems to be a dearth of qualified indigenous Nigerian authors in such a special area as Epizootiology. This book written by a guru and two of his disciples in the scientific discipline is an invaluable compendium of facts, ideas, figures and tables that provide a sequential introduction into the essential aspects of Epizootiology which is one of the necessary preludes to the understanding and practice of preventive veterinary medicine.

Of particular importance in this respect is the presentation of Epizootiology as the scientific discipline that is concerned with the study, control, eradication and prevention of epizootics. Of no less importance is the understanding of the tripod of epizootiology, which is one of the points of development of veterinary concern for problems of human populations. The aim of this text has been to ensure that such basics are available in an easily readable book. I am glad to note that the book contains sufficient material for a wide target readership.

I recommend this treatise to epizootiologists throughout the world. I am proud that one of the authors (GOE) had taught in the Faculty of Veterinary Medicine, University of Ibadan, Nigeria for nearly four decades (1965-2001) and had trained many Nigerian and foreign students in the various aspects of veterinary public health and preventive medicine. The other two authors (IFI & BOO) are still in active service. I wish them well in their contribution to man's effort in the understanding, management and control of epizootics in animal and human populations worldwide.

Professor B. Ekundayo Olufemi, JP, FCVSN
Dean, Faculty of Veterinary Medicine,
University of Ibadan, Ibadan, Nigeria

PREFACE

The first edition of this book came as "*Fundamentals of Epizootiology*", being a 1993 update of mimeographed text for both (DVM) undergraduate and postgraduate students at the University of Ibadan (U.I.). The earliest versions were used by students pursuing courses leading to the degree of Doctor of Veterinary Medicine (D.V.M) from the 1976/77 academic session. From 1977 to 1979 an upgraded version was used by candidates for the certificate programmes in Epizootiology and Food Hygiene, also at U.I. And from 1978/79 session and thereafter, students pursuing Masters of Veterinary Public Health (MVPH), Masters of Preventive Veterinary Medicine (MPVM), M.Sc., M.Phil and Ph.D Epizootiology used various upgraded versions with other textbooks from abroad when available. The course in Epizootiology was also later being attended by candidates pursuing the Masters of Science (M.Sc.) Virology degree of the College of Medicine, University College Hospital (U.C.H.), Ibadan, an arrangement that has survived to this day. The text of "*Fundamentals of Epizootiology*" was in fact based on the approved course PVM 701 of the University.

In 1992, when one of the authors acted as a visiting professor to the Usumanu Danfodiyo University in Sokoto (UDUS), he had to prepare a much simplified version of the text for Epizootiology for the first final year (and penultimate year) DVM students of the University, as there was no suitable textbook for their courses in epidemiology, veterinary public health and preventive medicine. This version was mass-produced as a special arrangement for the DVM students under the title "Lecture Notes on Epizootiology (Esuruoso, G. O., 1992)". One of the lecturers in Ibadan later found the text to be more acceptable to the DVM undergraduate class in the university, and therefore decided to adopt and use it.

This second edition is an upgraded and updated form of the existing texts in use at both and other universities. In addition, this second edition contains more extensive model practical exercises that go with each section and chapter of the book. The practical exercises are provided in model settings known to exist or are in the process of being established for the faculties. The practical exercises are meant to achieve the objectives of the teaching and learning processes in an enhanced mode. In the glossary provided, relevant key terms are defined, explained and illustrated. The idea is to aid both students and teachers in comprehending the substance of the text and what the authors mean. Figures and tables are now generously included. The appendices supplement the text. This is to ensure that the students appreciate the important role of epizootiology as providing the soundest basis for the practice of preventive medicine / measures in its / their most comprehensive sense.

In *Introductory Epizootiology,* the target readership has been enlarged, by making more glaring provisions for students in other disciplines. It is thus meant to provide materials for a baseline and bridge-makers' course for students in allied disciplines. Hence the book is meant to be useful for the *scientific* development and *positive socio-economic jurisprudential* (psej) orientation of students and teachers of Biology, Zoology, Agriculture, Agricultural systems Agricultural Economics, Animal Science, Environmental Health, Animal Health, Animal Husbandry, Livestock Production Economics, Geography, Biostatistics, Community Medicine, Veterinary Medicine, and *Scientific Thinking* generally

Also built into the text are systems of natural relationships, inter-relationships, inter-dependence, points of integration and coordination for achieving global views and bridge-building objectives for ultimate systems' success stories in scientific thinking and actions towards possible achievement of *total well-being (Esuruoso, G. O., 1993 ff)*.

LIST OF CONTENTS

APPENDICES:

List of Tables

List of Figures

Gist Presentation of
The Simplest Definition of Epizootiology

"Epizootiology is the study of epizootics".
It covers the study and vetting of 'whatever may befall' animal groups (herds, flocks, etc) and *human populations* and *communities.*

Veterinary concern for problems **in** and **of** *human populations* (i.e. groups of people) is most obvious in the control of **zoonoses**, the promotion of food (including meat and fish) **hygiene** and **sanitation of** animal, especially **livestock's external environment,** which is inevitably shared by man directly and indirectly. And all of these and more are traditionally covered under the discipline of **veterinary public health** (vph) **practice, research and administration**, which in turn is a branch of **preventive veterinary medicine** (pvm). That tradition is worthy of retention and development, not destruction or derogation. And the inculcation of *socio-economic jurisprudence (sej),* deriving from being *socio-economically cost-conscious* (see tripod of epizootiology, *ibid.*) as a component of epizootiology is in fact one of the cardinal development points of veterinary concern for problems **of** people and the need for them to be *socially healthy*. To be *socially healthy* is to be so mentally, morally, educationally, spiritually, law-abidingly, peace loving and peace promotingly and security consciously, thus living in harmony with nature.

***Epizootiology* remains in active service:**
Those who say in 1994 that the word Epizootiology is redundant may wish to have a rethink now in 2005 (over ten years after); the European Union (EU) is currently actively supporting the **P**an-**A**frican (**P**rogramme for the) **C**ontrol of **E**pizootics (PACE). If what **the programme is all about** are ***epizootics***, it should be obvious that *Epizootiologists sensu stricto* should, among other scientists, be in good position to apply the soundest cognitive knowledge, understanding and wisdom to the scientific study, control and prevention of the 5 major *epizootics* (and other problems) being so actively supported in 32 African countries.

Moreover, Appendix II to this text shows more than twenty one thousand (> 21,000) epizootiology titles from one single web search. Obviously epizootiology remains in active service worldwide.

Or, are the 32 countries and the whole of the European Union using redundant words such as '*epizootics*' in the title of a programme they are actively supporting with such heavy resources?

Obviously and most naturally, ***epidemiology*** should be seen as **a sub-discipline of Epizootiology**. To try to replace the whole with a part (through etymological inexactitude) may set future generations wondering what the science of our age was all about in matters of etymology. Therefore, no one should have problems in agreeing that *Epizootiology* should be retained as the holistic scientific discipline that should be concerned with 'the study', control, eradication and prevention of '*epizootics*'. Such can never be a matter of fashion. Epizootiology as presented in this book should remain the soundest and most holistic basis for 'the control of epizootics' as in PACE. And care should be taken of the sej component, insisting on psej, while disapproving, deprecating and discouraging nsej. For, most of the apparently intractable problems of nations great and small, highly developed or just developing, are largely the results of adopting, or not being able to control the practices of negative socio-economic jurisprudence (nsej).

GOE/VARF/112004

Chapter 1

INTRODUCTION

1.1 Policy Statements on the Place of Epizootiology in Education

1.1 (a) *Basic purpose of university education*

The first purpose of a university system is to provide higher *education* (at tertiary level) to the candidates admitted thereto. The word education in this context is used in its fundamental, broadly based and functional sense. It is also used to indicate the provision of adequate understanding of the basis for the management and control of problems that may interfere with the well being of people, animals, plants, the common environment and its content. It is meant to provide sound working knowledge and basis for acquiring skills. These would be useful for identifying roles, quantifying needs, determining and taking systematic actions that would favourably affect the fate of modern man. This is viewed in the contexts of natural relationships of man with the other components (plants, animals and other animate and inanimate objects) with which man inevitably shares his external environment. Such education is in turn expected to provide man with the basis for continuing survival through conscious adaptation to and effective control of the vicissitudes of social, economic and natural pressures and stresses throughout man's life. By these, the modern man can truly meet the dictates of the wise old saying '*Congruenta naturae vivendum est*' meaning '*One should live agreeably to nature*' / '*Man should be living in harmony with nature*' in order to continue to survive and prosper.

1.1 (b) Non scholae sed vitae discimus

Deriving from that basic purpose then, is the obvious need to ensure that our teaching is meant to provide learning, 'not just for school, but also for life'. Hence, '*Non scholae sed vitae discimus*' means 'we learn, not just for school, but for life'. This means that the knowledge and skills that a truly educated person should graduate with from our universities, and thereafter should prepare him for good living. To benefit from that key statement, a wise reader should stop and meditate on it for a while before moving on, as that exercise would take the reader beyond the stage of learning by *echolalia* and rote. Everyone needs some basic knowledge of epizootiology in order to live well and continue to contribute to *total well-being*. It is an important component of university education.

1.1 *(c) University education as a system*

Now, universities are usually divided into systems of colleges, faculties, departments and other units and sub-units. Naturally for the system to survive, the objectives of the component faculties, etc should never run counter to those of the main university system itself. Therefore, as the faculties diverge to focus on their special disciplines, they are in fact contributing their quota towards the achievement of the main system's objectives. Also, in a way that is not generally readily appreciated without scientific thinking, the natural, physical, social and applied sciences and disciplines, as well as the Arts and the Humanities, are of essence related to one another in the system of education being provided in our universities. This is a fact that must be fully understood by well-educated individuals within the system, so that they can often be part of the solutions, rather than being part of the problems of society. Now, epizootiology (as a branch of *epi'scientology*[6.1]) is meant to provide the common knowledge base and unifying logic paths for all scientific disciplines in any educational system. That is a key statement.

Our immediate example here is to trace the intricate inter-relationships (and inter-dependence) of the agricultural, veterinary, and the other (including human and environmental) health sciences to one another on the one hand. And on the other hand, one should try to establish the social, economic and cultural health implications of these natural relationships first for the survival and next for the prosperity of modern man and the health of the common external environment. We are assuming here that the word 'modern' as used can be interchanged with 'civilized'. Our reader should try and meditate on that assumption, before either accepting or rejecting it democratically.

1.1 (d) Branches of education in the context of relationships

There should be no problem at all in appreciating that the objectives of the biological, agricultural and biomedical (including the veterinary) faculties do overlap so intricately that there must be some consciously created meeting points, at least at the grassroots, for the individual disciplines to remain relevant to the overall system of living things and the world in which they all live. Now, epizootiology is meant to provide a model example of such meeting points in the formal education of their principal actors and exponents, since the interests of man are eventually the basis for all his efforts. And ultimate failure awaits an anthropocentric discipline that ignores the common knowledge base, the role-playing and fate sharing patterns with the lower animal and plant components, or even those of the microbes and the inanimate contents of the common external environment.

Epizootiology should be recognised as one of the three basic multidisciplinary and inter-related subjects that provide models for scientific approaches to the study of living and non-living systems in the same biosphere. The other two are *Epiphytology** and *Epi'inanimatology*[6.1]. All three form the components of '*Epi'scientology*'. *Epizootiology* (like each of the other two components in their individual rights) is in turn a multi-disciplinary science. It may be noted here that *Epiphany* (meaning 'What happened to (*befell*) the *Magi*, as celebrated by Christians worldwide on 6th of January each year) will be found by believers to be the metaphysical example that fits into *epi'scientological* logic paths[6.1].

1.1 (e) A matter of deliberate policy

Thus, it is a matter of deliberate policy, that the subject 'Epizootiology' will be presented in the manner of systems approach and will be treated as a multidisciplinary science[6.1], providing suitable materials for the basic education of students of Biology, Agriculture, Veterinary and Human Medicine, Geography, Economics, other social sciences, Mathematics, Physics, Electronics and computer science. For they all have something to contribute to and usually much more to gain from the philosophy, logic paths and scientific thinking methods of *Epi'scientology* here modelled by *Epizootiology*. That may be seen as a holistic and wholesome system approach to scientific thinking.

1.1 (f) Epizootiology and epidemiology

It should not be surprising therefore that such rival titles exist as *Epizoology*[6.1] (in one sense), Epizootology[6.1] (in another sense and culture) and *Epizootiology* (in the original sense). Now, *Epidemiology*, *Veterinary*

Epidemiology (an apparent compromise title), *Epidemiology of Animal Diseases* (an explanatory title made necessary for obvious reasons) and *Veterinary Epidemiology and Economics* (VEE) a spelling out of some of its major components, have all been used in the process of 'thought, need and coverage development'. Each of the terms makes good sense in the context in which they were developed and used. They provide choice. But what seems to be most important in this matter is that adherents of each school (teachers and learners alike) should be clear in their own minds, on what basis they have come to prefer one title to the other, since most of the methods are similar in many respects. It is also known that each of them has a distinct area of focus and those of differences in some essential details and coverage. This should be seen in the same sense as sheep, goat, dog, fowl and even man, each has two eyes mounted on one skull, etc, but they are yet quite different from one another in very important physical and functional respects. This is to the extent that to call a sheep a goat may sound silly. To call a dog a cat may be plain ignorance. To call a woman a cow or a bitch is obviously rude. Surely, a word should be enough.

1.1 (g) Intended coverage of Epizootiology

Today, there are accomplished and great men of science who prefer that '**Epidemiology**' should be concerned with the study of *diseases* in human populations (with a little greater foresight '*problems*' should replace diseases[6.1]). Hence, other scientists of equal distinction, be that so or not in contradistinction, would prefer the term '**Veterinary Epidemiology**' when covering the study of group problems amongst veterinary patients, which are mostly vertebrate animals lower than man on the evolutionary scale. Whereas in this book, **Epizootiology** is meant to cover patterns of problems in groups, herds, flocks and populations and amongst the various species that make up the *biological animal kingdom*' (as opposed to the kingdom of plants, which is studied under **Epiphytology**. Thus, the *de facto* branches of Epizootiology should naturally include *Epidemiology*', *Ep'ornithology*[6.1] *(or Ep'ornithics*[6.1]*)*, *Epi'equinology*[6.1], *Epi'bovidology*[6.1], *et hoc genus omne.*

(See the distinction made by the Royal commission on public understanding of science and the value of specific terms (scientific jargons) being used when scientists are communicating amongst themselves as opposed to when targeting the general public readers. Ref. The Royal Society (1985) The Public Understanding of Science, Report of a Royal Society *ad hoc* Group endorsed by the Council of the Royal Society, 41p. ISBN 0 85403 2576 The Royal Society, Carlton House Terrace, London SW1Y 5AG).

For those who prefer the term Epidemiology for the study of group problems in animals and people, they would always have the cause not to confuse the term with 'Epistemology'. We have observed on at least one important occasion, the case of a highly learned faculty and professional man writing on the board 'Epidermiology' (instead of Epidemiology), at a public seminar. Whereas, there is little to be confused with Epizootiology which cannot also by extension or as a matter of thesaurus be regarded as its potential synonym or being in the same group or family of words, depending on the user's discipline, school, culture, language or intended meaning. Hence, our University Senate in its wisdom approved for our school the original choice that was made. And hence also, it could be said that for our school, 'A word is enough...' And that word is *EPIZOOTIOLOGY*. For further reading and elucidation, scholars should see "Increasing role of and importance of veterinary epidemiology and economics in veterinary education, practice and development[6.2] presented as Appendix I in this book (*ibid.*).

Therefore, the reader should appreciate the fact that while some people think that there are these apparently competing titles, the first real question is not 'Which choice?', but 'How related?' are such titles as ***Epizootiology***, ***Epidemiology***, ***Veterinary Epidemiology***, ***Epidemiology of Animal Diseases***, ***Veterinary Epidemiology & Economics*** (VEE) *and other cognate conceptions / disciplines*[6.2]. Our presentation in this book is meant to reflect very clearly that naturally ***Epizootiology*** includes what others, for their own good reasons, present under the cognate titles *Epidemiology*, *Veterinary Epidemiology*, *Epidemiology of Animal Diseases* and *Veterinary Epidemiology & Economics* (VEE), all of which (and more) do exist in literature as matters of deliberate choice. And that the last named (i.e. VEE) is the closest in content, coverage and philosophy to Epizootiology as defined and presented in this book, and as taught and researched into at our University since 1975. VEE is thus the most acceptable alternative title whose content is nearest to, but not as comprehensive as what we teach in Epizootiology[6.2, 6.3]. Maybe a summary presentation of a review on the subject will be useful at this point. That summary is presented as *Section 1.2* below.

1.2 Concepts and Definitions of Epidemiology and Epizootiology: The Gist

1.2 (a) Introducing the gist

In the last three quarters of the twentieth century, concepts and definitions of ***Epidemiology*** and ***Epizootiology*** have been evolving. Below is a summary presentation of a review of the evolving concepts and definitions in prose and tables. While the review is not exhaustive, enough has been presented to show samples of the various considerations of the cognate disciplines (***Epidemiology*** and ***Epizootiology***), and how the various reputed scientists have projected their individual and group philosophies on the choice of one or the other of the two. The classified list and the sources that now follow will show how the various definitions reflect differences in coverage, while the principles and methods are similar to the extent to which the scope permits.

1.2 (b) Introducing the definitions

(i) Of *Epidemiology*

Over the years, and according to the scope chosen by the various authors, each apparently seeking to convey approximately the same general idea of the study of 'whatever befalls or may befall groups of people and/or animals', the various definitions have evolved as shown below. What is particularly noteworthy is that some significant variations were reflected from one definition or group of definitions to the others. Some constructed definitions that cover the study of **'infectious/communicable diseases'**. Others wrote in terms of the study of '**diseases, conditions, laws and circumstances'**. Others still interpret epidemiology as 'the study of **health, ill health and disease'**. Some define epidemiology as the discipline of '**preventive and community medicine'**. There are also those who consider epidemiology in terms of '**disease and/or physiological condition'**. Some see it as **'a science'.** Others believe that epidemiology is '**a philosophy'**. With a much greater scope are those who see epidemiology in terms of '**observation methods, total established facts and reasoning** (or **philosophy**) **thereof and related social factors'**.

(ii) Of *Epizootiology*

Whereas, there are those who see epizootiology as inclusive of empirical, scientific, observational, philosophical and rational **study of problems** (not just diseases alone) **that may befall** the various classes of animals as **biological groups of species**, the idea being to provide enough information for proffering and choosing from potential solution options for the control / management and prevention of the various problems cost-effectively in social, economic and financial terms. This we found to be particularly relevant to the mandate of veterinary surgeons, who must consider the financial, economic, social and environmental impacts or implications of animal group problems in real terms.

Hence, when we say that 'a modern veterinarian has need to be biomedically literate, statistically numerate and socio-economically cost-conscious (as being 'the tripod of epizootiology'[6.1]), we are reflecting the fundamental knowledge base requirements for the clinical, preventive, economic and social[6.4] aspects of the mandate of veterinary surgeons in **economic and commercial animal production** (ecap), **livestock development** (lid), **veterinary public health** (vph), **preventive veterinary medicine** (pvm), **veterinary environmental health** (veh), **veterinary extension services** (ves) and zoo-sanitary measures (zsm). In all these, we have made provisions for the adoption of **resource management approach**[6.5] (rma). Those then were the tools that provided the basis for our design, teaching, practice, application and promotion of the discipline of epizootiology as espoused in this book.

1.2 (c) Reflecting the uneasy feeling

In any case, it should be obvious that what a veterinary surgeon usually needs to know and would always consider is much more than the study of infectious / communicable diseases in people. Hence, while some chose to teach ***Epidemiology*** to veterinary students, others prefer to make the distinction by choosing the term ***Veterinary Epidemiology.*** Yet others made it even more distinctive by choosing ***Epidemiology of Animal Diseases.*** An even more emphatic distinction was the wisdom of choosing to teach ***Veterinary Epidemiology and Economics*** (VEE), thus indicating the multi-dimensional nature of the needs of the .more usual veterinary mandate in real life. These distinctions may probably have arisen from uneasy feelings about equating the problems of people in exact terms to those of animals of lower state in evolutionary terms and in reality.

1.2 (d) Not just the economic, but also the social health implications

And when one observes the stresses and distresses of *economic buoyancy* in great and small nations of modern men, it would be found that the usual bug or leaven, often hidden until the bubble bursts is social ill-health resulting from *negative socio-economic jurisprudence* (nsej), which is a branch of *socio-economic jurisprudence* (sej), according to Esuruoso and Abdulkadir, 1984[6.6]. A veterinary surgeon concerning himself only with the 'study of infectious diseases in people' is obviously also making a case for the need for him to explain his limitations to what physicians and others would rightly lay greater *species specialist* claim. Whereas a noble profession that we are, must see beyond economic buoyancy, considering that our social (moral, mental, ethical and the other components of social well being[6.2, 6.6] health would remain intact whenever we have delivered the products of our professional services. And it should always be made obvious that veterinary contribution to people's health is essentially preventive, and requires a detailed epizootiological wisdom, that could provide sound basis for *positive socio-economic jurisprudence* (psej).

1.2 (e) Classified summary presentation of the definitions in tables

The various classes of definitions include the following:

(i) Definitions of **epidemiology** in terms of infectious/communicable diseases (Table 1.1)

(ii) Definitions of **epidemiology** in terms of diseases, conditions, laws and circumstances (Table 1.2)

(iii) Definitions of **epidemiology** in terms of health, ill health, disease and or physiological condition (Table 1.3)

(iv) One definition of **epidemiology** in terms of preventive and community medicine (Table 1.4)

(v) Definitions of **epidemiology** in terms of observation methods, total established facts and reasoning (or philosophy) thereof and related social factors (Table 1.5)

(vi) Definitions of **veterinary epidemiology/epidemiology** according to context, and reflecting the interest and thinking of the author/s (Table 1.6)

(vii) Definitions of **epizootiology** in terms of the classification of living organisms being either plants, animals, or others, with explanations (Table 1.7)

It should be noted that this list is not exhaustive; there are so many definitions of epidemiology.

TABLE 1.1: DEFINITIONS OF EPIDEMIOLOGY IN TERMS OF INFECTIOUS/COMMUNICABLE DISEASES

S/No	Definitions of Epidemiology	Source
1.	"The science of the mass-phenomena of infectious diseases or as the natural history of infectious diseases concerned not merely with describing the distribution of disease, but equally or more fitting it into a consistent philosophy".	FROST, 1927[6.7]
2.	"The science of the infective diseases their prime causes, propagation and prevention".	STALLYBRASS, 1931[6.8]
3.	"That field of medical science which is concerned with the relationships of the various factors and conditions which determine frequencies and distributions of an infectious process, a disease, or a physiological state in a human community	MAXCY, 1951[6.9]
4.	"The study of the Ecology of infectious diseases"	COCKBURN, 1963[6.10]
5.	"The study of the spread and decline of communicable diseases in human populations and the prophylaxis and control of those diseases"	(p1) LOWE C.R. & KOSTREZEWSKI J., 1975[6.11]

N.B. Each of these definitions and related statements reflect the *'wisdom'** of the age, which cannot be ignored, especially when meditated upon in the right context and with clear conscience. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.2: DEFINITIONS OF EPIDEMIOLOGYIN TERMS OF DISEASES AND/OR CONDITIONS,"LAWS", AND CIRCUMSTANCES

S/No	Definitions of Epidemiology	Source
1.	"The study of disease as a mass-phenomenon"	GREENWOOD, 1935[6.12]
2.	"Concerned with circumstances where disease is prone to develop"	PAUL, 1938[6.13]
3.	"Epidemiology must understand disease, not so much as it affects the individual, or as it behaves under the eye of the observer at any one time or in any one place, but as it imposes itself on groups of people, *even if they extend across boundaries set by men for economic, political and social purposes"	AYCOCK, 1943[6.14]
4.	"The study of disease in populations"	STAMLER, 1958[6.15]
5.	"The study of distribution of a disease or condition in a population of those factors which influence their distribution"	LILIENFELD, 1958/78[6.16]
6.	"Deals with the characteristic behaviour of such diseases within the complex matrix of human populations"	REID, 1961[6.17]

7.	"The study of the laws governing the distribution of diseases in the community"	PEMBERTON, 1952[6.1]
8.	"The study of disease as it occurs in nature"	GORDON, 1964[6.1]
9.	"The study of factors determining the occurrence of diseases in populations"	FOX *et al.* 1970[6.2]
10.	"The study of the distribution and determinants of disease frequency in man"	MACMAHON & PUGH, 1970[6.2]
11.	"The study of the distribution and dynamics of disease in human population"	SARTWELL, 1973[6.2]
12	"The study of the factors determining the frequency and distribution of disease in human populations"	LOWE & KOSTREZEWSKI, 1975[6.1]
13.	"The study of the distribution and determinants of disease and injuries in human populations"	MAUSNER & BAHN, 1974[6.2]
14.	"The study of disease occurrence in human populations"	
15.	"The science* dealing with the incidence, spread and control of disease"	FRIEDMAN1974[6.2]
16.	"Concerned with mass outbreak of disease"	
17.	(a) "The study of the patterns of disease is known as Epidemiology"	LASAGNA, 1975[6.2]
(b)	"Epidemiology of animal diseases (formerly called epizootiology by linguistic purists)..."	SINNECKER, 1976[6.2]
(c)	The study of animal epidemics was at one time called epizootiology, as distinct from the term epidemiology, which was reserved for human studies'. "It is clear that there are not 2 separate sciences, but one epidemiology with two aspects, one dealing with diseases usually seen in man, and the other with those seen more commonly in animals (Mulvihill, 1972[6.27])"	Brendan HALPIN, 1975[6.28]
18.	"Epidemiology is the study of diseases in groups"	BLOOD, 1985[6.2]
19.	"Epidemiology is the study of diseases in populations"	SCHWABE *et al.*, 977[6.30]
20.	Alternative Definition: *"the study of the health status of populations"	SCHWABE *et al.*, 1977[6.3]
21.	"Epidemiology has been defined as the study of the distribution, the determinants, and the deterrents of disease"	BENNETT, 1985[6.31]

N.B. Each of these definitions and related statements reflect the '*wisdom*'* of the age, which cannot be ignored, especially when meditated upon in the right context and with clear conscience. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.3: DEFINITIONS OF EPIDEMIOLOGY IN TERMS OF HEALTH, ILL-HEALTH, DISEASE AND/OR PHYSIOLOGICAL CONDITION

S/No	Definitions of Epidemiology	Source
1.	"The study of health or ill-health in a defined population"	TAYLOR, 1967[6.32]
2.	"The study of the distribution of a disease or a physiological condition in human populations and of the factors that influence this distribution"	LILIENFELD, 1978[6.1]

N.B. These definitions reflect the '*wisdom*'* of the age, which cannot be ignored. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.4: ONE DEFINITION OF EPIDEMIOLOGY IN TERMS OF PREVENTIVE AND COMMUNITY MEDICINE

S/No	Definitions of Epidemiology	Source
1.	"The basic science of preventive and community medicine"	MORRIS, 1975[6.33]

N.B. This definition reflects the '*wisdom*'* of the age, which cannot be ignored. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.5: DEFINITIONS OF EPIDEMIOLOGY IN TERMS OF OBSERVATION, METHODS OF REASONING (OR PHILOSOPHY), TOTAL ESTABLISHED FACTS AND RELATED SOCIAL FACTORS

S/No	Definitions of Epidemiology	Source
1.	"Hence epidemiology is a method of reasoning about disease that deals with biological inferences derived from observations of disease phenomena in population / groups"	LILIENFELD., 1978[6.1]
2.	"Epidemiology at any given time is something more than the total of its established facts. It includes their orderly arrangement into chains of inference which extends more or less beyond the bounds of direct observation".	Ibid. (P.90)
3.	"Epidemiology is the science of that which is on the people"	WHITE. and HENDERSON, M.M, 1976[6.34]
4.	"Epidemiology is the study of the distribution and determinants of health and disease in populations, and part of its province is the study of the related social factors. Indeed, every epidemiological variable is in some sense a sociological variable. The factors affecting the distribution of disease in populations may be	HOBSON, 1975[6.35]

N.B. Each of these definitions and related statements reflect the '*wisdom*'* of the age, which cannot be ignored, especially when meditated upon in the right context and with clear conscience. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.6: DEFINITIONS OF VETERINARY EPIDEMIOLOGY/SIMPLY EPIDEMIOLOGY ACCORDING TO CONTEXT AND REFLECTING THE INTEREST AND THINKING OF THE AUTHOR/S

S/No	Definitions of Epidemiology	Source
1.	"Veterinary Epidemiology is a study of variable material (the recorded observations about disease) in variable hosts (the population) living in an environment in which climate, topography and nutrition define other main groups of variables. Results of such a study contribute to a "natural history of disease	LEECH & SELLERS, (1979)[6.3]
2.	"Veterinary Epidemiology is the study of disease within livestock populations and its effect on their demography and productivity" (Livestock demography?)	NDIRITU, 1994[6.37]
3.	"Epidemiology is the study of systems of problems of sub-optimal productivity"	ELLIS, (1985)[6.3]
4.	"Epidemiology is the study of disease in populations, and the factors that determine its occurrence, the keyword being populations". "Veterinary Epidemiology involves observing animal populations and making inferences from the observations". "The 4 approaches are descriptive, analytical, experimental and theoretical"	THURSFIELD. (1986)[6.3]

N.B. Each of these definitions and related statements reflect the '*wisdom*'* of the age, which cannot be ignored, especially when meditated upon in the right context and with clear conscience. Knowledge is neutral; but wisdom is supreme. (**See 'The pie chart of human wisdom', ibid.*)

TABLE 1.7: DEFINITIONS OF EPIZOOTIOLOGY

In terms of animal herd problems, basis for their elucidation, control, liquidation and prevention, and of veterinary public health (vph) practice

S/No	Definitions of Epidemiology	Source
1.	Epizootiology is the study of epizootics.	Esuruoso, G. O. (1994)[6.2]
2.	Epizootiology is the study of epizootic problems including diseases, with a view to establishing basis for their sound and cost-effective prevention, control/management practices, zoo-sanitary measures and extermination of the problems.	Esuruoso., *G. O.* (1994)[6.2]
3.	"Epizootiology is the comprehensive (holistic and peripheral) study of the variable factors, events, forces and circumstances that contribute to the occurrence, distribution, control and prevention of ill-health, diseases and other problems in animal groups, herds, flocks ... or populations, as well as the valuation, quantification and analysis of the variable factors, their effects, relationships,	Esuruoso, G. O. 1993)[6.1]

	interactions and the implications and contribution to the problems in each instance. This is a working definition*.	
4.	Epizootiology is a study of systems and relationships on which models of scientific thinking in operational research methodologies may be fruitfully based, for solving general and specific problems of animal groups / herds / flocks / human populations and of their environment. This is another working definition*	Esuruoso , G. O. (1993)[6.1]
5.	Epizootiology is the qualitative and quantitative study of the factors, events, forces, circumstances and relationships that contribute to the occurrence, distribution, effects, limitations, control and prevention of whatever problems may befall an animal group / herd, *et hoc genus omne* or human populations in a given location or geographical area, over a specific period of time. This is another working definition*	Esuruoso, G. O. (1993)[6.1]

N.B. (a)* A working definition* is the one that a diligent investigator would put before himself, and systematically plough through, obtaining relevant accurate and adequate data of facts and figures on all of the variables before subjecting them to collation, processing, summary (i. e. descriptive statistics) presentation, analysis and interpretation that could aid decision making.

N.B. (b) Each of the definitions above and related statements reflect the '*wisdom*'* of the age, which cannot be ignored, especially when meditated upon in the right context and with clear conscience. Knowledge is neutral; but *wisdom* is supreme. (**See 'The pie chart of human wisdom'*, *ibid.*)

In summary of the points so far, the following statements by Brendan Halpin, 1975[6.28], are particularly worthy of note in the context of relationships amongst the various alternative titles, as between ***Epizootiology*** and *Epidemiology*, also between *Veterinary Epidemiology* and *Epidemiology of Animal Diseases*, and finally between *Veterinary Epidemiology and Economics* (VEE) and ***Epizootiology***.

Hear what he says: -

(a) "***Epidemiology of animal diseases*** (formerly called ***Epizootiology*** by linguistic purists)..."

(b) "The study of ***animal epidemics*** was at one time called ***Epizootiology***, as distinct from the term epidemiology, which was reserved for human studies". We happen to believe that the former distinction mentioned here should be retained. Moreover, we wonder whether when an author uses the term 'animal epidemic' he is trying to distinguish whatever he means from 'human epidemic'. Or in what context would it be necessary to use the term 'human epidemic' instead of 'epidemic'? Why not reserve '***epidemic***' for outbreak of human problem and '***epizootic***' for outbreak of problem among lower animals, as in **PACE**[6.40] (**P**an **A**frican **C**ontrol of **E**pizootics)?

(c) "It is clear that there are **not two separate sciences**, but one epidemiology with two aspects, one dealing with diseases usually seen in man, and the other with those seen more commonly in animals (Mulvihill, 1972[6.27]". It is worthy of note, and for the avoidance of doubt, worthy of focus of attention, that the authors of '*Introductory Epizootiology*' also believe that 'there are not two separate sciences', but that **Epidemiology is a branch of Epizootiology**. And so, it must be obvious to reason that, in the systematics of whatever may befall group members of the ***animal kingdom***, all the other alternative titles used can naturally be regarded as branches of Epizootiology, and never *vice versa*.

It is also noteworthy what one of the greatest pioneers and his respectable colleagues in the field, namely Schwabe et al., 1977[6.30] did write as follows: -

(i) "Epidemiology is the study of diseases in populations".

This we do accept. But we also consider that "Epizootiology should be defined as the study of diseases and other problems in animal groups such as herds, flocks and other groups of animals, as in groups of men, that is in people or human populations (*See the Glossary, ibid.*).

They also wrote as follows: -

(ii) "Strict etymological considerations **may not always be** the best guide to word usage. **If they were, epidemiology would have to be considered a special branch of epizootiology**; and such other generally used terms as population and demography would apply only to a single animal species, man".

Now, because we agree with the truism in '**may not always be'**, we consider that from the point of view of systematics, the more embracing term Epizootiology should provide the framework for accommodating all the various species of animals that are *group* members, *orders*, *families*, *genera* and *species* belonging naturally to membership of the animal kingdom.

Again they wrote: -

(iii) "Epidemiology is a **more commonly used** and understood word than is epizootiology, and there is no need to use different words for the study of diseases in populations of men versus populations of other animals any more than there would be to use two different words for pathology. In summary, epizootiology is not only unwieldy and often mispronounced, but also redundant"

On the point that Epidemiology is being '**more commonly used**', we do feel that progress is shown when a more commonly misapplied word is put in its right place and a basic and non-controversial one is adopted instead.

In any case, many of the definitions of Epidemiology cited in tables 1.1 to 1.8 above cannot by a stretch of imagination be construed to tally with the universal meaning of *Veterinary Epidemiology* or *Epidemiology for Animals* or even *Epidemiology of Animal Diseases*.

There are simply those so many definitions that refer to such meanings as relating to '*human communities*', '*human populations*', '*groups of people*', or simply '*man*' as shown in the tables, with source and date in each case. Are they all wrong? Or have no choice and no right to determine and express the meaning they attach to what they were talking about? It would therefore be rather farfetched to apply the same definition to the study of problems of cattle herds, sheep or poultry flocks, if farfetched explanations then become necessary.

And with regards to the forbidden usage of different words for pathology, apart from the fact that that analogy appears to us to be a different kettle fish, *morbid anatomy* is being used for *pathology*, and we do have Departments of '*Veterinary Pathology*' and '*Plant Pathology*'. In any case, those who choose to qualify the noun must be accorded their rights to do so, for a number of reasons.

Now with regard to which of Epidemiology or Epizootiology is more readily understood, we dare say that the mere inclusion of the etymon 'zoo' should indicate to even infants that one is dealing with animals other than humans. And as if making the point that simplicity is a virtue, the Lord Jesus said, "Verily I say unto you, except ye be converted, and become as little children, ye shall not enter into the kingdom of heaven[6.41]." This is an example of the spiritual dimension in *social health* as in *psej,* which believers should remember. Moreover, as indicated earlier, I have seen a senior faculty member writing on the board at a seminar the word '*epidermiology*' when what he meant was epidemiology. The message should be clear. Again, when presented with the 'words' epidemiology, 'epidermiology?' and 'epistemology', some faculty members had considered that the last named is a branch of one or the other of the first two. These were in real time situations, especially in these days where every veterinarian who in his own rights is a specialist in other disciplines readily claims to be an epidemiologist, especially where this is convenient for grabbing jobs meant for preferred individuals. This is often a matter of *negative socio-economic jurisprudence*[6.1, 6.4, and 6.6] (nsej).

And finally, to say that the word epizootiology is redundant is globally debatable. When on one single trial, one of the authors went on the internet with the word 'Epizootiology' twenty-one thousand five hundred (21,500) articles came up from a single website. Another trial at another website (in 2004), produced 17, 300 articles under the title 'Epizootiology'. The printouts are provided as Appendix II (*ibid.*). So, how redundant is redundant? Only a few years ago, the announcement came that a new edition of the Oxford dictionary was being compiled, and it was to come out in sixteen volumes. If the word Epizootiology is not there, it would be surprising as the editors may not be happy. "Truth crushed to earth shall surely rise again." Natural reality can never be suppressed for aye. Epizootiology is such a natural reality, that future generations of conscientious scientists will earnestly look for and avidly make use of the term in the context of systematics. Details are given in a previous publication here provided as Appendix I to this book (*ibid.*).

1.3 Objectives of Epizootiology

1.3 (a) Main Objectives of Epizootiology

The main objectives of this multi-disciplinary course are: -

(i) To provide sound basis for scientific thinking and a framework for relevant studies in systematics. This should include scientific promotion, practices and evaluation of preventive measures (pm) relating to problems in animal groups or populations in ecological communities from many interest angles:

(ii) To promote the idea of conscious study of relationships of resource inputs, black box processes, product outputs, impact and fate of the external environment and cost-effectiveness in resource management. This would impact on choices to be made from model options. It would also impact on the effects of chosen models over time thus facilitating triangulation to sound decision-making tools:

(iii) To provide comprehensive basis for understanding problems associated with economic livestock (and general animal) production systems:

(iv) To provide foundation knowledge for teaching, research, practices and promotion of veterinary public health (vph) as a branch of preventive veterinary medicine (pvm):

(v) To provide sound materials and logic paths for the education for life of professional men and women in all sectors of the national economy. This would be particularly relevant to those in the scientific institutions, health and agriculture sub-sectors in psej mode for total well-being objectives.

1.3 (b) Other objectives would include

(vi) The provision of a utility framework for a model in relevant scientific thinking. This will fit into the concept that epizootiology is a scientific discipline with basic principles applicable across the practices of most professions:

(vii) The establishment of an interdisciplinary bridge approach to the study, analysis and sound interpretation of systems' problems, associated risks and possible solutions. This is particularly important as most problems always fit into some systems, and only holistic approach would provide the best solution:

(viii) The provision of enabling wisdom-base for the development of relevant model skills. Such skills would include capabilities in appropriate data collection and processing, risk identification, classification, evaluation and management, computer-based presentation, production of project design, management, implementation, monitoring, analysis, appraisal and re-appraisal. They would also include skills for study, control and prevention of problems in biological *animal groups* including *human populations*:

(ix) The provision of wisdom-base for systems' thinking, linking the arts and the sciences for total well-being. A wisdom-base will not only illustrate the usefulness of systems' thinking, but will also provide linkages between the arts and the sciences, the humanities and sociology, etc. Thus, the comprehensive approach in relevant systems and sub-systems can readily lead to *total well-being*[6.2]

(x) Finally, the provision of epizootiological procedures for systematic recognition and study of groups and *species* of animals, their material and functional nature and their relationships with one another and with the common external environment (including its contents) will have been met. Pathways to cognitive understanding of the dynamics in the health status of *discrete* and *diffuse* systems would have been established. Also, the relevance and significance of interactions and other events in the *black box* of the *natural BIOS*[6.2] would have been made obvious.

1.4 Conclusion

1.4 (a) *Understanding and Relevance of Epizootiology*

No one should try to fully understand the total relevance and importance of this group of ten objectives until he/she has gone through all the (theoretical, practical, tutorial and seminar) aspects of the course; not until he/she has studied the glossary, and has actively and fruitfully engaged himself/herself in relevant *scientific thinking,* such as the one going through recommended '*exercises in the identification of relevant issues, relationships, points of integration and coordination for system's success*'[6.41, 6.42, 6.43]. The key phrase there is '*system's success*'. And to identify the relevant and applicable system/s one could adopt the *OPST* approach* and *logic path*[6.1, 6.42].

It should be noted that in our teaching of this and related subjects, we would often prefer to start by providing the appropriate tools of thought, introducing some logic paths, guiding the student on scientific thinking, providing examples, demonstrating relevant processes and procedural details, and holding tutorials for essential clarification.

At the end, the candidate should be able to recount and list those objectives, which he/she has achieved. Full realization of many of the objectives is expected at the end of the postgraduate course on *Advanced (Systematic) Epizootiology*[6.3], which was designed and taught since 1979 in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan. The greatest beneficiaries however, are those who continue to find the model thinking methods, logic paths and approaches of systematic Epizootiology applicable (with necessary adaptation and innovations) to most aspects and types of lifestyle and life's problems of man, lower animals, plants and substances, even matter, energy and forces throughout their lives. These are loaded statements. Yet appreciating their relevance should not be beyond the capacity of students of veterinary medicine or diligent individuals of average intelligence in other disciplines. They should be regarded as tools of thought, materials for meditation and for heuristic learning, that the man of science may develop appropriate level of cognition that would sustain him to the greatest heights possible in his time and age. *Non scholae, sed vitae discimus.*

1.4 (b) *For students of Biology*, a course in Epizootiology will ensure that their knowledge of the lives and problems of living things is enhanced. The problems can then be classified, solution options visualized in terms of temporal and spatial implications, cost-effectiveness, statistical sensibility, causal relationships, global effects and basis for contribution to their control and design for their prevention.

1.4 (c) *For students of Agriculture*, *Epizootiology* will reveal amazingly similar approaches in *Epiphytology* and the kinetics of the natural interdependence of plants and animals in *agricultural*, as in *biological systems*, vis-à-vis the requirements for and implications of optimum productivity. The animal aspects of studies of ecological communities' will be illustrated. A fuller understanding of environmental health hazards and problems will be readily achieved.

1.4 (d) ***For students of human and veterinary medicine,*** it will be clear that Epi'scientology'[6.1] is an approach **that can provide the soundest basis for the study, simplification, understanding and practices of preventive medicine in its widest sense.**

1.4 (e) *For students of agricultural economics*, *geography, biometrics, computer sciences* and most of the other aspects of technology, it would be obvious that they have much to contribute to and much more to gain from their involvement in studies in Epizootiology. No longer would one attempt to roost in one's own cocoon, or put on one's usual professional blinkers, which often unfortunately has the effects of leading to embarrassingly narrow perspectives, even in the performance of otherwise acclaimed professionals. With all that challenge in mind, we wish our readers effective introduction to the path of wholesome education.

1.4 (f) For students of environmental problem management and prevention

The holistic and integrative system approaches of epizootiology should prepare their minds and way for recognising the natural facts that recirculation through recycling (rather than dumping) is one the first principles for naturally creating and maintaining healthy external environment for the ultimate good of the system itself.

1.5 Teaching of Epizootiology

1.5 (a) As a multi-disciplinary, inter-disciplinary and multifaceted subject, with multiple objectives, people who contribute to and benefit from Epizootiology often come from various backgrounds, as just indicated. Also variable are their purposes and objectives (*vide supra*), as well as the uses to which they would apply their epizootiological knowledge, skills and wisdom. The first major point to realize therefore is that students of Epizootiology will often have some important background knowledge of some of the aspects of the subject and some specific goals, the achievement of which will be facilitated by a fundamentally holistic working knowledge of system approach to the subject (*Epizootiology*). It would enhance ready adoption of its cost-effectively productive logic paths and regular application of its examples in *scientific thinking*, if readers appreciate the fact that there are always many aspects to the teaching and learning of the subject. Here we can start by mentioning the authoritative (*didactic*), *participative* and *heuristic* aspects of the teaching and learning of the subject.

1.5 (b) Adopting participative teaching-and-learning processes is therefore often in vogue. The procedures enable the Epizootiologist *sensu stricto* to decide on which models, which illustrations and which examples would be most appropriate and most readily apprehended by the candidates or at least for the majority of them. Even for students of veterinary medicine to whom the subject is being taught during the penultimate and finals of the 6 yearlong programmes leading to the degree of Doctor of Veterinary Medicine (DVM), the ultimate application of the knowledge, skills and the potential wisdom deriving will be variable. Therefore, previous relevant knowledge of teachers and students of Epizootiology in certain subjects have to be assumed or called to their memory through the participative teaching sessions. The subjects could include any or many of the following, namely: - Geography, Economics, other social sciences, General Biology, Physics, Chemistry, Mathematics (especially Arithmetic, Universal Arithmetic, Calculus and Statistics), Modern English usage, Information Technology and Effective Communication skills, Anatomy, Physiology, Biochemistry, Pathology, Microbiology, Parasitology, Immunology, Clinical and other diagnostic procedures and Basic Computer Science.

1.5 (c) Recognizing the relevance of knowledge of General Biology, Basic and Universal Arithmetic, Statistics, Anatomy, Physiology, Biochemistry, Pathology, Microbiology, Parasitology, Immunology and even that of economics, bionomics, social and environmental well-being issues have to be assumed or called to their memory through the participative teaching of Epizootiology. And where such knowledge is considered inadequate, the teacher of Epizootiology should give additional lectures in the basic subject before beginning the full-fledged teaching of Epizootiology. Such remedial lectures should enable the students to see the relevance of their contribution to and potential benefits from the principles and methods of Epizootiology.

Obviously, it would be unrealistic to expect any individual (alone) to have in-depth knowledge of all those subjects. But every aspiring or established epizootiologist must first have an in-depth knowledge of some discipline in which he can conduct, at some level, relevant didactic (authoritative) teaching or contribution to knowledge of the problem in hand. He must then be able to work out his 'relevance' in the matter. He must be able to identify other relevant disciplines and issues, before considering the 'relationships, points of integration and coordination for achieving the objectives' of his group interest and/or mandate or mission [6.1.]

[44]. That is a key statement that can open the gate to the philosophy of participative teaching and learning in Epizootiology.

1.5 (d) Adopting didactic, participative and heuristic teaching methods

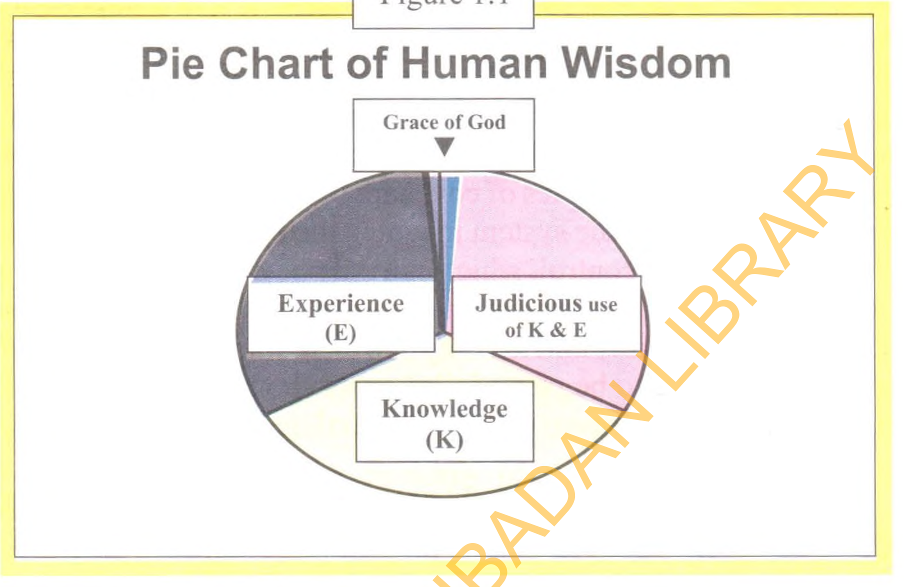
Hence, it should be obvious that both didactic and participative teaching procedures are relevant in Epizootiology. The heuristic component is mandatory. For, if all the necessary teachings were to be participative all the way, the whole effect would better be called discussions rather than teaching. Authoritative (or didactic) teaching should therefore be recognized deliberately in Epizootiology. These will cover the principles and methods of Epizootiology, identification and quantification of risks, 'epizootiological intelligence' activities and models, and the more esoteric and relevant aspect of basic and applied immunology, the clinical sciences, their social relevance and available technological leverages for their apprehension. Without the heuristic component, the learner's initiatives may not be adequately stimulated to the point of being self-dependent in thoughts development and decisions all being functions of cognition.

1.5 (e) In summary

In summary the presentation of **the course in Epizootiology will include lectures, tutorials, field practical, laboratory practical, bench** (i.e. writing up and computational/data processing) **practical**', as well as the concluding seminar presentation (which requires some skills in both technical report writing and presentation) at the end of each set of exercises. Each set of **practical exercises** will be partly **in the field;** and this will usually be followed up with those **in the laboratory**. Findings in the field and the laboratory will then be followed by appropriate write-up, summary presentation in descriptive and analytical **bench computation** (**data processing**) to obtain the results from both the field and the laboratory data and their interpretation in the context of the system objectives. A **brain-storming tutorial** will always precede both the **planning for the practical** and the **writing-up for the seminar presentation** at every level. Only those who take active part in all those aspects will eventually achieve optimum benefits from the course of studies in Epizootiology. That also is a key statement that is worthy of note for both teachers and students at their various levels.

1.6 The wisdom nugget: Studying Epizootiology can be quite exciting for the diligent, intelligent and *wise*. Hence we here present the pie chart of human wisdom[6,45].

Figure 1:1



1.6 (a) The pie chart of human wisdom[6,45]

Whatever is the subject in hand, you will always find that,

(i) Some people or protagonists in the system would have the knowledge but no experience, or at best limited and inadequate experience:

(ii) Others may have both the relevant knowledge and adequate experience, but are incapable of judicious use or application of both:

(iii) Others still may simply lack the grace of God to participate effectively / efficiently; and it may or may not be their fault:

(iv)Yet, others may just not have the essence or presence of the Spirit of light in their life and in their immediate environment.

And so, whatever is the deficiency in any scenario of life and living, ultimate wisdom may never manifest in the activities of those involved, whatever the level of their knowledge. Therefore, whenever we say that '*knowledge is power*', we must then also realize that '*wisdom is super power*', especially that wisdom that relates to '*natural systems of relationships*' such as *epizootiology* and '*socio-economic jurisprudence*'. The immediate answer lies in righteousness.

1.6 (b) Imparting and acquiring the knowledge

Now, knowledge is neutral: it can be used for positive or negative purposes. Acquiring experience requires intelligence (which is given only by the Creator), diligence, patience, persistence, systems approach and respect for timeliness, which is man's part of the covenant. Judicious use requires the right values, attitudes, cultural development and healthy socio-political environment. Obtaining the grace of God[6.45, 6.46] is the prerogative of the Almighty whose nature may include some elements of democracy and some principles of covenant between Him and the person. The essence depends on the system in which the individual has a role and faith, but never the full control, which can only be achieved by all playing their roles and sharing the system's fate righteously. Hence, it is wise to play one's role honourably and to comply with requirements of the system an individual chooses to be part of. Believers should meditate on this as part of the social health dimension of epizootiological issues.

As role players and stakeholders in the multi-disciplinary, inter-disciplinary and multifaceted subject of Epizootiology, the authors of this book intend to bring the good news of realizable success to all interested in scientific and healthy living. This we intend to do by building the system of imparting the knowledge, training to gain experience and exerting effort to develop skills to the point of achieving competence to appropriate levels of confidence[6.47], appreciating the grace of God and seeking earnestly to dwell in an environment full of His essence or in his presence which again is the spiritual dimension for those who must righteously achieve true success. *Non scholae, sed vitae discimus*.

Figure 1. 2: Depicting how one may achieve veritable wisdom in six stages

Stage 1: Obtaining the knowledge

Stage 2: Gaining the experience

Stage 3: Developing the skill

Stage 4: Achieving competence

Stage 5: Applying all judiciously

Stage 6: Having the grace of God in an atmosphere filled with His essence

True / veritable wisdom can only be achieved by going through those stages with God's grace, and in an environment filled with His essence. Unfortunately, some have knowledge but no experience: Some have inadequate and inappropriate knowledge and experience, but cannot apply them judiciously i.e. in *positive socio-economic jurisprudential* (*psej*) mode. Others try to achieve all the above without the grace and essence of God. Yet all strive to be leaders or achievers. No wonder, there are so many cases of failure and qualified success.

1.6 (c) Gaining relevant experience:

Hence, we can now triangulate to the fact that in the study of *Epizootiology*, the first set of **abilities to establish,** and **experiences to gain** should start with the **making** of *qualitative* and *quantitative* **observations on *factors*, *events*, *forces*** and ***circumstances* that cause** or contribute to **problems** and their aggravation or remission **in *groups*** or *systems* **of** objects (especially **animals and people** with the plants, minerals in their environment) **in the specific** types of geographical, **ecological** and meteorological **locations** and the immediate environment. This should be accompanied by recording and processing of the observations thus made in the right formats and with the right (*descriptive* and *analytical*) tools, following appropriate scientific procedures. These are loaded statements that should be discussed in great detail (explained and exemplified) in classes, tutorials and seminars, by the tutors with their students and amongst the students themselves, until every interested, attentive and right-thinking learner has understood the relevant meaning and import of every word used in the current context.

Students should ask simple questions, and their tutors should give crisp answers and *vice versa*. Subsequent comments and discussion should lead to the processes of summary *interpretation* and *triangulation*[6.47], which should then be recorded for every set of observations and exercises in the logical sequence here recommended. Reasoned examination of objects, processes, systems and time (OPST) approach should provide answers for sources of the *factors*, *events*, *forces* and *circumstances* mentioned above and in the working definition of *Epizootiology* (and especially those of

Veterinary Epidemiology and Economics and other cognate disciplines known to the science of '*whatever befalls groups of things* or *objects*', i.e. *Epi'scientology*.

Figure 1.3: Groups of animals and people forming relationships in diverse situations in which group problems may arise, and epizootiological approach may be the answer

OBJECTS (people, animals, plants and minerals), their inter-relationships and inter-dependence in **PLACES** (in terms of location, geography and the eco**system** types), producing results of interactions over **TIME**. These are in summary, items of factors, events forces and circumstances for qualitative and quantitative observations in epizootiology. These are then subjected to descriptive and analytical **PROCESSES**, interpretation of the findings/results and their presentation in such a way as to aid reasonable decisions and actions towards the control and prevention of the type of group and environmental problems under study. Those who carefully follow this OPST logic path are not likely to be far from the truth, be they '*Epizootiologists*', '*epidemiologists*', '*veterinary epidemiologists*' or '*epidemiologists for animals*', semantics notwithstanding.

1.6 (d) Developing appropriate skills

Now is the time to remember again that '*Skill means practised ability*'. Then the facts should be obvious that without commitment, diligence and application of people's intelligence, little can be achieved in whatever endeavour one takes part.

Figure 1.4: Depicting what may lead from demonstration of ability to development of skill

(*Skill* means '*practiced ability*')

1.6 (e) Achieving functional level of competence

If the ability established in carrying out the processes described above is **practised** diligently, intelligently and sensibly (i.e. epizootiologically, which incorporates *socio-economic jurisprudence mode*[6.48], practitioners in science and professional services are more likely to achieve appropriate **skills,** with reasonable level of **competence** and confidence in minimum time. The roadmap and the landmarks carefully laid out in the key statements above should lead on to the next steps without misgivings or doubt in the minds of Epizootiologists *sensu stricto*.

Figure 1.5: Depicting stage-by-stage approach to building up competence and confidence:


Sign posts


the road


Thinking


Up-bringing


Systematic Building up


Celebrating competence with confidence

1.6 (f) Applying the knowledge, experience and competence judiciously

All that is then necessary is the ability to deal wisely during the data collection, processing, interpretation, and triangulation, as in the decision and action processes across borders. This is where the maximum effects of positive and negative socio-economic jurisprudence (psej and nsej) will apply. Both the technocrats and the politicians must be healthy socially, which means mentally, morally, educationally, spiritually, law-abidingly, peace-lovingly and peace-promotingly and security-consciously. That spells out what has been repeatedly described as meaning *positive socio-economic jurisprudence*[6.4, 6.48]. It is when the system falls short of maintaining reasonable level of social health in the terms described in *sej*, that failure occurs and persists as it has been in many sectors of the Nigerian polity. An epizootiologist should not be part of the problem, but prominently part of the solution eventually in all aspects of problem preventive measures beyond financial wealth and economic buoyancy. What has been said so far spells out much of the substance of the pie chart of human wisdom illustrated in Fig. 1 above. What is left will now follow.

1.6 (g) Having the grace of God in an atmosphere filled with His essence

In spite of all the problems of development and the great number of people operating at the level of nsej, there are still many in every nation who fulfils most of the requirements for being wise socially and economically. But they fall short of the grace of God, and are operating in environment not conducive to being receptive to the essence or presence of God. They have breached some essential laws of nature. Little or much, the weak link became the strength of the tug-of-war chain. And when it breaks, all pulling at it fall on their hind part. And only those who have healthy conscience would usually admit what went wrong. The less endowed would continue to deceive themselves in perpetuity or until they find themselves out of the way. These are the spiritual aspects of our science that forms the basis for *preventive measures* in their widest and deepest sense.

Public morality is often at the root of most of the problems of society. So that where the science is right, the art and skills are there, and the technology is reasonably developed, but because the socio-economic jurisprudence is negative, failure is intractably ensured. The answer is, whatever our science, art or technology, we need to take good care of the social health component. The solution is that we should all work, watch and pray, always in psej mode. And that should start from our application of epizootiology to the prevention and control of our biological, agricultural, financial, economic and social problems. As products of nature, try as he may, man can ill-afford to breach some essential laws of nature with impunity.

Figure 1.6: Depicting what may lead to ultimate success:

WORK!

WATCH!!
MEDITATE and

PRAY!!!

For, even **INSECTS** do 'pray'

1.6 (h) *Conclusion: True or veritable wisdom is from God.*

Access to it is in our fear and love of Him. *'If you love me, keep my commandments'*[6.41]. Any human law that contradicts the laws of nature, of God, will sooner or later be the source of human problems, from the ***social***, through the ***economic***, and right to the ***financial*** **problems**, that will often appear to be and remain intractable. And that is part of the principles of *positive* and *negative socio-economic jurisprudence*. The solution lies in righteousness. The fact that my brothers do not agree with this declaration would not in any way negate its veracity.

1.7 GUIDELINES FOR MODEL PRACTICAL EXERCISES

1.7 (a) Introduction to the practical exercises

"Epizootiology is the comprehensive (holistic and peripheral) study of the factors, events, forces and circumstances that may contribute to the occurrence, distribution, control and prevention of problems (including diseases) in groups (herds, flocks etc.) or systems (or 'populations') of biological animals in a given geographical area over time"[6.1, 6.2]: this is called a working definition[6.2]. Therefore, if it is to serve truly as a working definition, it must be considered relevant when planning any epizootiological practical or real-time investigation or other relevant, productive and scientific activity. This definition must be constantly at the back of our mind when planning relevant inquiry or practical training of students.

(i) Write or print it out and place it before you as you plan and implement your valued epizootiological projects and programmes.

(ii) Derive your tools of thought and logic paths from that working definition, 'giving every word its weight and every unit of expression its ultimate meaning'[6.45].

(iii) Now, peruse and then meditate on that;

(iv) Then read on.

1.7 (b) Usual Structure of Model Practical Epizootiological Exercises

Practical training in Epizootiology should be seen as a system of well-planned and properly integrated sets of activities in eight or more logical algorithmic, flow-chartable and flow-charted steps or stages, consisting of the following components and structure:

Step I:
(i) The first step should be the identification and definition of a clear and un-ambiguous *title of the exercise*: (ii) the holding of a *discussion* on it with potential participants, consisting of both academic and technical support **staff** and **students**. (iii) It is at this instance that careful thought should be given to and agreement should be reached on what to do. WHERE TO DO IT, who is to do what and what is needed to do them, and (iv) *preparation for the next stage* and OTHER SUBSEQUENT STAGES. Such preparation can only be realistic if all participants are agreeable (i.e. interested, willing, able, capable, committed and determined to be available and perform in *system mode* and in *timely order*). (v) All the requirements must have been actually listed (in logical sequence), assembled and ticked as seen as suitable **before moving to the very next stage.**

Step II:
(i) The next stage should be the actual **Field visits** aspect of the practical. The location or *place*, *time*, means of *transport and transportation arrangements*, and *equipment* for collecting field materials, and **forms** in appropriate formats **for on the spot and time saving recording of field findings** should be secured in advance. These forms should be discussed and taken along to the field.

(ii) *In the field*, one should again carefully consider the working definition of Epizootiology. One should also remind all concerned of *epizootiological logic paths* covering the (animal and human) systems, groups (or populations) concerned. The geography (including the ecology, topography, meteorology and other climatic factors) of the place or area to be visited and the time and date for the practical should also be discussed in advance of the undertaking.

(iii) These needs and factors should have been structured and integrated in a database frame ready for use in the field, during the exercise. See subsequent chapters and the appendices for examples of recommended forms for data collection.

Please note that: -
iv) It is not wise to be keeping records in long hand writing on the field; you should be recording numerical and non-numerical data on pre-prepared forms or tables.

v) Inter-relationships (in ecology) should be recorded among other things. Formats for recording the inter-relationships should accompany the team.

vi) Specimens of plants, animals, their remains and parasites should be collected into suitable containers prepared in advance of the visit and brought along for the purpose.

vii) The names, quantities and state of such specimens should be recorded on suitable forms brought from home base; the records should be in such organized form as would be convenient for the next (laboratory) stage of the practical exercises.

Step III:
(i) **The next stage is the Laboratory aspect** of the Practical exercise / training.
(ii) This should start with a recording in a bound laboratory notebook or in duplicate book of what was brought from the field, how they are preserved, where they are kept in the laboratory,

(iii) What tests are to be done on them and when or how soon they should be processed? What possible results to anticipate. And

(iv) How such results are intended to be presented in *statistical summary*, *analyzed form* and *interpreted* either way, in order to shed light on the problems in terms of *ecological epizootiology*.

Step IV:
Reagents and equipment for the laboratory tests should be logically listed, obtained and ticked as correct, complete and ready for use before commencing the exercise.

Step V:
(i) The tests should be performed.
(ii) The results should be recorded in a pre-determined format, to facilitate the (word and statistical) processing of such records of findings in the next stage of the practical. See subsequent chapters and the appendices for examples of formats for recording laboratory findings.

Step VI:
(i) This is the stage of data processing, on both the field and the laboratory findings. This processing should include non-numerical (*facts*) and numerical (*figures*) obtained:
(ii) Both should cover descriptive and analytical processes:
(iii) The non-numerical (i.e. words and graphics) processing should entail placement of the various variable factors into appropriate organized forms, tables, logic paths, algorithmic and flow-charting forms, statistical summary presentation and interpretation, suitable for decision processes by real-time and potential end users, as earlier planned for.

All these should fit into a modern database management format. Modern database pre-supposes electronic/computer management. It makes recording and reporting uniformly and dependably informative and available for different uses and users. This is because, once you have a reasonable database format in a computer storage system, you can retrieve the materials in any of the many possible forms desirable for your need on each occasion. For example, a table of database material can be promptly retrieved as a chart, histogram or graph form, by using the appropriate computer *application software* (such as Excel, Lotus Freelance Graphics, Microsoft PowerPoint and several others). Thought should be given to possible adaptation of such records for reliably and adequately informative geographic information systems (GIS)[6,49]. This provides for necessary interactive systems environment and functionality in advance. Records of findings at this stage should be made suitable for ready application at the next stage of the practical training.

Step VII:

Next is the stage of **SEMINAR** presentation. All the (staff and student) participants, other staff in the Department, as well as those in other departments in the entire Faculty should be invited to the Departmental/ Clinical seminar presentation forum. The idea is to present what we have done, what we have found and how we have interpreted them, for questions, comments and contributions, so that we can learn from others for our own improvement and edification. Also that the others may become aware of our efforts and findings for the edification of the entire Faculty. A department does not exist in a vacuum. It will always be an integral part of a Faculty. And that has system's implications. In fact, it will be wise for all the various departments, disciplines and interests to be actively involved and informed in all epizootiological exercises in the Faculty. **Thereby all will appreciate their inter-related roles in preparing the basis for preventive veterinary medicine** (*pvm*). This is a key statement, the implications of which will keep recurring in all matters relating to **Veterinary Degree Programmes** worldwide.

Step VIII:

The final stage of an epizootiological practical (exercise or training) is the write-up and an appraisal of the benefits over costs, in terms of knowledge gained, financial involvement, justification for owning or using a vehicle, other forms of transportation and other equipment and reagents for epizootiological practical training and/or investigations. Necessary justification should also consider the involvement of various other academic, technical and secretarial staff **at the inter-phase with realities on the ground and imaginable.** That write-up should provide material for the departmental annual report, for comparison year after year, for further teaching in subsequent years and for publications as contribution to knowledge in the field.

1.7 (c) Conclusion: Efficient Resource Management Approach

Adopting scientific, efficient resource management approach and positive socio-economic jurisprudence (psej) [6.6] is the only way to ensure justification, sustainable survival and prosperity through the study of group and environmental problems and the application of the findings to the management and prevention of such problems.

1.8 An Appraisal of Performance in Relation to Objectives:

1.8(a) Need for project appraisal

At the end of each lecture, practical and the entire course, there shall be an appraisal of the level of achievement of the objectives stated at the beginning. Appraising what is achieved must of necessity be carried out by the lecturer, as part of the mandatory continuous assessment of the students' performance[6,50]. Before then and even after that, wise, otherwise and clever students should have reviewed their own performance at the end of each practical exercise, in the field, in the laboratory, at the documentation level and in the seminar presentation. For what would be the need for stating the objectives of the course if at the end it is not considered which of the aims have been achieved? In any case, it should be realized that continual self-appraisal should be seen as a wise recurrent step by scientific thinkers, more so for *Systematic Epizootiologists*. But who is an *Epizootiologist*? See the *glossary of terms* at the end of the book.

1.8(b) Recommended procedure for the appraisal

Preferably, the lecturer/s should draw up a questionnaire for the students to complete at the end of the course; and this may be assessed as part of the continuous assessment, giving marks that would reward attentive students in their continuous assessment grading and marks. The questionnaire should include such questions as:

1. Students Names (SURNAME first and in upper case letters).

2. Matriculation Number.

3. Year / Stage of Study (e.g. Year Five / DVM IV).

4. Summarize what you learnt in Epizootiology in not more than fifty (50) words.

5. What is the relationship between the course you took in Epizootiology and the one in Preventive Medicine?

6. What is the relationship between the course you took in Epizootiology and the one in Public Health?

7. What other courses that you have taken in the Department bear some relationship to some parts of Epizootiology?

8. What other courses that you have taken in other Department of the Faculty bear some relationship to some parts of Epizootiology?

9. How could you apply epizootiological knowledge base in named aspects of veterinary practice, research, livestock development and livestock production?

10. What are the relationships and differences between Epizootiology and other cognate disciplines such as Epidemiology, Veterinary Epidemiology, and Epidemiology of Animal Diseases?

Signature .... Date ....

Ref. ....

1.8(c) Conclusion

True and properly conducted appraisal should always be regarded as a good source of dependable knowledge for continuing improvement in the delivery of the course in subsequent years. Therefore, a careful analysis should always be carried out, and records of the findings should be kept and referred to when planning subsequent practical exercises in order to achieve improvement year after year. An in-built self-appraisal like this has a lot of value in ensuring sustained in-house development. Remember the saying: - "*Civilization began when man started keeping records of his activities.*" (S.I.t.m.)

Chapter 2

EPIZOOTIOLOGY AND ITS COMPONENTS

In this chapter, we shall consider what Epizootiology is all about; and in so doing we shall start by answering relevant question and then go on to consider relevant issues.

2.1 Between the Simplest and a Working Definition of Epizootiology

2.1 (a) Simplest definition

Epizootiology is the study of epizootics

2.1 (b) A working definition

Epizootiology is the comprehensive (holistic and peripheral) study of the variable factors, events, forces and circumstances that may contribute to the occurrence, distribution, control and prevention of **ill-health, diseases** and **other problems in groups** (herds, flocks or populations) **of animals**, as well as the valuation and quantification of their contributions to evolving effects by each of the variable factors resulting in the problem in each instance[6.1]. The factors often considered include those of hosts, agents/parasites and the environment; they also include the *nature* of the relationships, events, interactions between the hosts and the agents and those of both with the common external environment and its other contents. There are many other definitions[6.2] of the subject according to the context, objectives of the moment and the perspectives of those involved. For immediate further reading appendix I (*ibid.*) should be consulted. What is given here should be considered an example of a working definition.

WHAT ARE THOSE PROBLEMS* OTHER THAN DISEASES AND **ILL-HEALTH, IN GROUPS** (HERDS, FLOCKS OR POPULATIONS) **OF ANIMALS' WITH WHICH EPIZOOTIOLOGISTS ARE CONCERNED?**

THE GIST

The problems which epizootiology is designed to study, in order to provide basis for their determination, control and prevention at herd, zonal, national, international and global levels include: -

infirmities, deformities, other enormities, vices in people and animals, inclement weather, other environmental hardships, physical trauma, irritations of skin, mucous membranes and nerves, pressures, stresses, distresses, mental depressions, oppressions and/or torture, destabilization, disorientation, reduced capacities, incapacitations, training in wickedness, over stimulation, excitements, headaches, toothaches, joint aches, stomachaches, indigestion, herd malnutrition, starvation, water deprivation, reduced productivity, cessation of productive capacity, infertility, affections, infections, infestations, intoxications, other real and potential causes of diseases, morbidities and mortalities in groups, herds, or populations of animals and people (as in the case of *zoonoses*), vices in animals and man and negative socio-economic jurisprudence (nsej) an indication of social ill health in man, with repercussions on animals, other members of the biotic community, the environment and the ecosystem.

Therefore, it is the '*factors*, *events*, *forces* and *circumstances*' that contribute to the occurrence, distribution, control and prevention of **those problems** that epizootiology is designed to cover. The cognitive learner should immediately see the relationships of those variables to one another and how they impact on the well-being, value and integrity of whatever *species* of biological animal the learner is interested in.

Unless the reader appreciates what is explained here, he/she would be limiting him/herself to only the '*study of infectious diseases*', an error that was once prevalent worldwide. *See Appendix I* in this book. It is that holistic view of the variety of problems, their nature and the common denominators that would lead epizootiologists *sensu stricto* to be able to say, with confidence, based on required competence that, '*Non scholae, sed vitae discimus*'. And we regard that as one of the marks of an educated man.

2.1 (c) Study of relationships

In any case, Epizootiology may be regarded as a science of *natural* relationships between groups (or populations) of biological animals, the plants around them and some of which they depend on (in the food and energy chain), their common external environment and its contents, which they share inevitably with other living things, and some of which provide them with shelter. Epizootiology also deals, essentially and by default, with the problems associated with the nature of animals as individuals and in groups. It includes considerations of their mass and volume, the dynamics of their life's activities, the internal environment of the individuals and *species*, causal factors leading to rises and falls in their fortunes, the types and shapes of their biorhythms and the temporal and spatial coefficients appertaining to the patterns and effects of their problems. Such details as are now concentrated in this short paragraph are the usual subjects of detailed explanations and discussions during lecture and tutorial periods in the proper teaching of the subject.

2.1 (d) Study of natural and evolving systems

Eventually, students of Epizootiology are meant to get the firm idea that Epizootiology is the study of systems and relationships (including those in natural networking). By default the physical and functional nature of the systems have to be defined and simplified for adequate understanding in qualitative, quantitative and probabilistic terms. The nature, structure, roles and fate of the components and solution options have to be explained in a way that the basis of both cyclical and erratic changes in the systems can always be readily visualized and appreciated as matters of *cognition* and common sense. Such understanding should provide meaningful basis for the control and prevention of real, evolving and potential problems in the identified system. Some elaboration on each of these terms and *tools of thought* will now follow.

2.2 Study of Relationships in Epizootiology

2.2 (a) *Why do we study Relationships?*

We study relationships in Epizootiology (and in fact in many other affairs and circumstances of life) because such studies provide orderly ways of leading us to really understand the problem at hand. In fact, and in the first place, living things do not usually exist in a vacuum. 'Nature abhors a vacuum'. And that means that for everything created there will always naturally be an environment, an external environment, the contents of which will include the object of our immediate concern among many other objects, animate and inanimate (*See OPST approach, page 25*). And when objects exist together, the usual chances are that they will likely interact (physically and functionally) in a significant way, and if kept together long enough to a significant extent. They could interact directly or indirectly, closely or remotely, physically and/or functionally, with a further chance of influencing one another, positively or negatively, lightly or intensely, thus generating actions and reactions, which may or may not be equal and opposite, *et cetera*. These realities should never be taken for granted when assessing systems' problems.

One of the factors may act as *stimulus*, while the other would represent a *response*; one may be *causal* / stimulus while the other may be the *effect* / response. One may be *independent*, while the other may be *dependent*. The force of one may be great enough to deform the other, or to make the other one move in one or several directions and over some variable distances, over time, first breaking the *inertia of rest* and causing some energy changes in the system. Food chain, energy chain, disease/problem chain, transformation of matter and its mass, over space and time, and the concepts of vector and scalar quantities are all results of actions and interactions in relationships within and amongst *discrete*' and *diffuse*' systems[6.1].

2.2 (b) Physical and functional relationships

The associated physical and functional relationships within a defined *diffuse* system may often be scientifically examined in detail according to the procedures of 'OPST' approach, see page 25.

In general, however, the first natural model equation goes thus: -

$A + B \Rightarrow C$ (i); this represents a reversible state of the (building up or breaking down) process:

$A + B \Leftarrow C$ (ii); this is a breakdown process; the outcome is the breakdown of C into A and B:

$A + B \Rightarrow C$ (iii); this is a building up process, the outcome being the build-up of A and B to form C.

The above are natural equations for *catabolic* (breaking down) and *anabolic* (building up) processes in a system. An epizootiologist should be familiar with good examples of these in nature.

Changes associated with relevant model reactions and represented by the natural equations may evolve from modifications (deformation or remoulding), structural rearrangement of the constituent components, transformation of energy content, etc. Some or all of these may be considered desirable, while others may be undesirable, depending on the needs of the system and as perceived and judged by human intellect, immediate needs and desire. And in any case, man will always wish to be in control of the situation (as the good Lord allowed him[6.46] ... Genesis 1:26, 28) for better, for worse. For the intelligence given to man has by default put man's fate in man's own hands to the extent to which man is able to observe the various *natural laws*, first of the systematics and also of *symmetric* and *asymmetric*[6.50] relationships, *ceteris paribus*. '*Congruenta naturae vivendum est*', as earlier mentioned, is again relevant here. It means 'It *is wise for one to live in harmony with nature.*'

2.2 (c) Living agreeably to nature or *'in harmony with nature'*

But how can this be if man has no sound scientific knowledge of '*nature*'? Hence it could never be a sin for mortal man to go in search of the knowledge (e.g. especially of the systems) that would enable man to control the other components of his environment, including knowledge of the close / immediate and remote forces that affect his survival and shape his destiny, or even determine his destination, provided he follows the natural rules of the systems and does not consistently seek to be destructive either directly of himself or of the system of which he is a part and parcel.

This trend will be found relevant in the enforcement of environmental quality of natural resources and their management[6.5], as well as in acquiring adequately sound working knowledge of systems. The study of relationships will ever remain relevant to all natural approaches to the acquisition of ultimate knowledge, as in *Epi'zootiology, Epi'phytology* and

Epi'inanimatology, all being the usual components of *Epi'scientology*[6.1]. And even in *Epistemology* and other philosophical approaches to cognition, the thinking must always be in accord with what is natural. For unless we start by recognizing what is natural, we may never be certain that we are honourably living in harmony with nature and in tune with natural relationships, thus readily avoiding intractable problems.

2.3 Types of Relationships (Rr)

Relationships may be classified according to how they come about, the nature of their components and according to the resultant effects.

2.3 (a) Type 1 Naturally occurring relationships and how they come to exist:

Below is how some naturally occurring relationships result from *physical forces, e.g.*

(i) By local winds (unstable and variable in direction) or hurricanes:
(ii) By prevailing (regularly recurring in the same direction and seasonal) winds:
(iii) By moving water (torrents, streams, rivers, melting ice):
(iv) By lava of molten rock or avalanche:
(v) By magnetic field effects (positive and negative forces):
(vi) By gravitational force:
(vii) By universal body movement e.g. of the earth around the sun, and of other celestial bodies in the orbits of one or the other or as meteors and meteorites.

In general, the variable factors, events and forces that cause steady, seasonal, predictable and random movements and relationships influence the movements of dry and moistureladen winds, precipitation (leading to dews and rains), flooding, over-flooding and ebbing of rivers and lakes, rising and falling of ocean tides all causing many types of relationships that in their intricate ways produce significant effects on the *diffuse* and *discrete* systems of communities of men, groups of animals, plants and substances in the common environment.

2.3 (b) Type 2 - Natural perspective relationships

These are natural relationships, brought about consciously and sub-consciously by living things for their own needs or as consequences of their survival activities.

At sub-conscious levels, the following examples may be considered: -
(i) Epithelial cells Rr
(ii) Rr between layers of tissue that form organs (such as heart, liver, kidneys)
(iii) Rr between Gonadial cell types (in male and female organisms)
(iv) Hair/head, head/neck, neck/shoulder, foot/hoof, toe/finger-nails Rr.

All these are typical examples of important relationships that determine the nature (including the functions) of well-known *discrete* and *diffuse systems* and subsystems and their components. The need to always consider the objectives of the individual, vis-à-vis those of the sub-systems and system to which the components belong, is one of the main concerns of the study of relationships within systems. The need also to find out how much of such objectives are achieved through coordination, and how they fail to materialize through lack of coordination will always be a lesson for the wise.

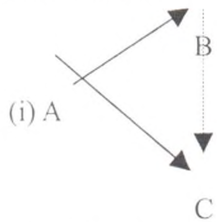
Relationships at conscious level (especially in vertebrate animals) may include coitus, which in lower vertebrates and humans is a good example of consciously established relationships that is relevant to epizootiology. There are conceivably other relationships in this group. These may include
(i) Regular cohabitation and marriage:
(ii) Establishment of an immediate family unit consisting of father, mother and off-springs:
(iii) Maintenance of extended family of uncles, aunts, nephews, nieces, immediate and remote/distant cousins, etc.:
(Iv) Rr within societies, organized communities, professional associations, villagers, townsmen, statesmen and countrymen, are important Rr that has some basic rules in common with all the others mentioned above.

2.3 (c) The scientific study of relationships within systems

The scientific study of relationships within systems, and the basic rules that maintain the relationships, provide examples of important model exercises in *scientific thinking*[6.1, 6.51] with which every civilized man has to be familiar, more so, for those who may be deciding the fate of others[6.5, 6.43.]

[6.52]. Community leaders, managers of all sorts, be they of livestock production or development systems, or of any of the four estates of a nation's government. **Those without the working knowledge of the rules of relationships within systems have often been the cause of national disasters**, such as Nigeria and other developing countries have experienced from 1983[6.51] until the present day in matters of social, political and monetary management systems of the nation. Through misplaced priorities, mistaken enthusiasm, based on good intentions, narrow perspectives, limited awareness, low morals, poor education in systems imperatives and poor spiritual health, and the whole nation was plunged deeper and deeper into chaos, landing all in dire straits, in avoidable national debt and apparently intractable economic strangulation due to social ill-health and *negative socio-economic jurisprudence*, practised by the authorities. The results amounted to unmitigated failure of relationships within systems. And until we return to dedicated practice of system imperatives, the nation may remain at sea and in the doldrums.

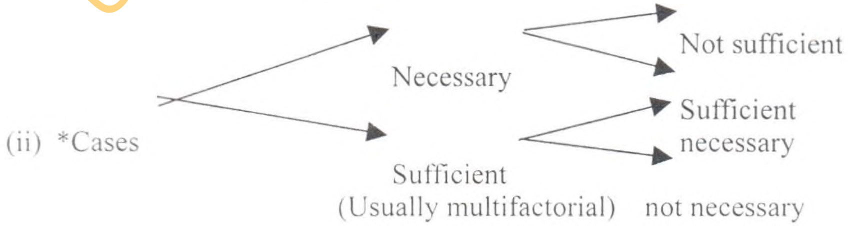
Figure 2.1: Relationships may be illustrated by methods of path diagrams as shown below:



A = causal variable factor
B = Effect/Effectors variable
C = Effect/Effectors variable

→ = Causal path

- - - - - - - → = Non-causal path



(iii) (A + B + C) ⇒ ⇒ ⇒ ⇒ (D)
(X) ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ (Y). ⇒ ⇒ ⇒ ⇒ (Z)

2.4 The Components of Epizootiology

By definition (*vide supra*), Epizootiology is the detailed study of the problems of animal groups (or populations), that is, in more specific terms, of groups of animals such as herds, flocks, drove, flights, *et hoc genus omne*. The usual objectives of such study is to provide information on problems associated with or arising from the various *living activities*[6.42] of the animals, their *interactions* with one another and with the common *external environment* (including its content). Therefore, there should always be a biomedical component. Since such studies will usually require a statistical analysis (sample statistics) from which conclusions may be drawn (on population parameters), there is also a biostatistical component, which in strict sense should be largely a mater of biometrics.

To be of societal use and value, the *socio-economic* implications of such effort (involving benefit/cost relationships) must be **explored and spelt out in social, economic and financial terms**[6.5, 6.52, 6.53, and 6.54]. Those were the lines of thought which led one of the authors to state more than two decades ago that

> "A modern veterinarian must be biomedically literate, biostatistically numerate and socio-economically cost-conscious."

The tripod of epizootiology

Those three components (i.e. biomedical literacy, biostatistical numeracy and socio-economic cost-consciousness) were thus described as the tripod of Epizootiology. These are the three pillars of knowledge, usage, experience and eventually wisdom, on which the study of Epizootiology as basis for preventive measures are best founded. Hence epizootiology is the basis for vph and pvm practices[6.1, 6.43, 6.44, 6.55, 6.56]. The understanding, ultimate knowledge, control and prevention of the zoonoses are best based on the systematic epizootiological approach[6.56]. A more detailed examination of the three components will now be presented.

2.4 (a) The biomedical component

Biomedical studies[6.30, 6.55] as a component of epizootiology is concerned with the study of the biology (i.e. forms, functions, life cycles and the habitat) of the hosts and the agents, as well as the study of the medical/disease implications of the relationships (or interactions) between the hosts and the agents/parasites, the parasite and its vector, and their common external environment/the habitat. In this way, full use is being made of the basic knowledge of biology, relationships (commensalism, symbiosis and parasitism) and the causes and courses of disease and other problems already covered in microbiology, immunology, parasitology and pathology, all now being integrated in a scientific (i.e. in a systematic and methodical) manner (*vide supra*).

Two examples should suffice to illustrate this application to the various diseases and other problems of animals. But even these examples will only be mentioned here in outline, as an over-detailed digression at this point may derail the establishment of the trail of thought by which the components of the tripod of Epizootiology are shown to make up the platform for preventive measures. Details of the two examples will be found in a later section of these notes. Such details, according to the experiences of the lecturer were of course usually given during the lectures. The examples in outline will be those of bovine brucellosis and trypanosomosis (otherwise known as *nagana*).

(i) In the Epizootiology of bovine brucellosis[6.57, 6.58, 6.59], the biomedical components will be concerned with the biology of cattle and of the various *brucella species* that have been known to cause identifiable and significant problems in the *bovine species*. Next the disease implications of the relationships between the hosts and the agents will be determined. Such determination pre-supposes, of course, that the type of relationship in diverse circumstances will have been established. Next will be the tracing of the natural history of *Brucella abortus* in the body of a cow, from the stage of mucous membrane contamination, through the establishment of infection, the transient bacteraemia that usually passes on to the intracellular sojourn, often disturbed by the chemo-attractant nature of erythritol, precipitating the subsequent migration to and proliferation of the *brucella* in the gravid uterus of the cow and in the foetal membranes

(See also Section 5.3 (b) (i) for the natural history of Bovine brucellosis). From this, battalions of the organisms eventually make their way to the exterior of the host's body, heavily contaminating the fomite contents of the environment and the appurtenances of the cowshed or byre. The usual outcome of all these events is ultimately a matter of probability, which will be dealt with under the next component. One important probability is the spread of the organisms to new animal and human hosts. Brucellosis is a zoonosis.

(ii) In the nagana example, again, the biology of the bovine host and that of the trypanosome parasites, are the main concern. But then the biology and even the biometrics of the various (cyclical and mechanical) vectors, including their peculiar habitat/environmental requirements, also have to be studied. Tsetse flies[6.60] (*Glossina species*), tabanids, stomoxys, their varieties and peculiar biological life styles[6.61], requirements and spectrum of their relationships with other components of the biosphere, present a formidable course of study, which has already been or should have been covered under *Entomology*. The keen Epizootiologist is not usually contented merely to assume the detailed knowledge required to make his own summation studies meaningful.

He asks his students some leading questions and if they seem to be fairly knowledgeable in the details, a measure of participative teaching-and-learning processes is established. Otherwise the teacher will, as a matter of necessity, resorts to a spell of digression, to establish the missing or forgotten knowledge, and to integrate it into his Epizootiological reasoning. Details of the nagana model will be presented in the appropriate section of the book. What is more important here is that the student/reader should note the wide scope of even the biomedical component of Epizootiology. The possibilities are not difficult to envisage; but the probabilities of the outcome in specific samples of cases is a matter of biostatistics, which will be considered under the second component (of the tripod of Epizootiology).

2.4 (b) The biostatistics component

Once again, a quick reference to the definition of Epizootiology will remind one that it is the study of problems in animal groups or populations. Very often the total population is not available for study. On other occasions, even when all the units may be available, it would not be an economically sound proposition to study the entire group. In most cases the ideal and practical solution is to study *samples* from the identified population. Such samples in turn, have to be representative, so that conclusions drawn from the results of the *sample statistics* may be applicable to the *population parameters* at large. All that these mean is that statistical methods[6,36] have to be applied. *Sample statistics* have to be referable to *population parameters*.

Already, the explanation has been given to show that Epizootiology is a science of relationships, and that some of the relationships can be shown to be of statistical significance, while others are the results of chance occurrences. Such distinctions are best made by the techniques and logics of probability, an important branch of statistics. And when we study the occurrence and distribution of a particular disease or problem in a given group (or population) of animals, we usually want to be able to extrapolate our findings to other populations in similar circumstances, and to be able to predict, not only the likelihood of similar occurrences in the future, but also the frequency and intensity of such predictable future events. It is only then that an appropriate preventive measure can be conceived, designed and implemented successfully. Biostatistics is therefore an inseparable/constituent component of Epizootiology as defined. This theme will be maintained throughout the book, and will in fact come up again for special mention with practical examples in the section on Mathematical Epizootiology (*quod vide*).

2.4 (c) Socio-Economic component (of Epizootiology)

Now that we are now on the *socio-economic* component of our subject, it may be the right time to explain that when we talked of the tripod of Epizootiology, the full "gospel" actually reads thus as stated earlier: -

> "*A modern veterinarian has need to be biomedically literate, biostatistically numerate and socio-economically cost conscious*".

That is a key statement. And what is good for the noble profession should also be good for all the other professions, disciplines and people earlier listed as having roles to play and a fate to share in the study and applications of our multi-disciplinary subject E*pizootiology*, as basis for the prevention of problems in systems, groups, populations or communities. **All the component members of the system must always be conscious of the social and economic implications**[6.38, 6.53] of their role in society. Even in the normal practice of their profession, the benefits and costs must always be weighed in both economic and social health terms.

So would any other person need to be, the moment he realizes that the ultimate goal of his total professional and/or scientific effort is to advance the well-being of man, the human race and all that is linked to its survival and the enjoyment of its being and brief sojourn on earth. The key words are '*being cost-conscious in both economic and social health terms*' and 'of the need to advance not just *human well-being*' but *total well being*[6.38, 6.52, 6.53].

Now, what is human well-being? There must be thousand-and-one theories on that alone. Our aim here however is practical. And so we would not shy away from the simplest approach, the simplest definition, and that which is readily apprehended and acceptable to common sense and the common man with a reasonable amount of that sense without which other senses are of limited value. The shortest meaning[6.62] of *well-being* is *good health, happiness and prosperity*[6.62]. A further analysis has led the authors to conclude that one could think of *financial, economic, bodily, educational, moral, mental and spiritual well-being*. Any vocation or profession that has nothing among all these to contribute in a positive manner must consciously or unconsciously be contributing to them negatively; and so, it is being part of the problem.

Moreover a morally, mentally and spiritually healthy man will naturally cherish the values of *honourable peace*, being educated, *being honourably law abiding and respective of the rights of other members of society*. He would therefore not contribute directly or indirectly to any violation of basic human rights in whatever circumstances that support the rule of sane laws and the security needs.

One of the purposes of this course is to engage in **a comprehensive study of the occurrence and distribution of problems in the biological animal systems and populations**, with a view to being part of the solution. We would in fact be doing better to be able to contribute positively to necessary preventive measures. These are some of the reasons for considering many kinds of relationships (Rr), so that we would be able to identify, foster and promote such Rr as would prevent or limit problems in populations. And socially speaking, lack of bodily, educational, moral, mental and spiritual well-being is always an important problem of human herds, if less so in animal communities the inversion will make sense when we come to consider *ecological communities* and their (systems) problems.

Yet another objective of this course is to provide sound basis for the study and practices of pm (preventive measures/preventive medicine) in its widest sense*. It is important to realize that when we say that

"Prevention is better than cure"

We would in fact be doing better if being cost-conscious and should therefore be saying

Prevention is better and cheaper than cure

And once we can say this from a firm belief in what we say, it should dawn on us that what we are doing is comparing the net benefits of cure with those of prevention and finding the latter better than the former. And once we go further to say that one is cheaper than the other, we must realize further that we are assuming a better benefit/cost ratio for preventive measure (pm) than for curative measure (cm). The key point therefore is that even pm has its own costs.

That those costs and benefits may be envisaged or/and measured in financial, economic and social, even in cultural development and political terms, is one of the key lessons in/of sociology and the understanding of national circumstances. A scientist or professional that shies away from such basic understanding, and he is contented with doing his thing in isolation of the nature and causes of societal problems, will sooner or later find himself irrelevant to society anywhere on our planet. And this cannot be our plan for the graduates of our universities, whatever their discipline, faculty or profession.

* See details in Glossary of terms

An epizootiologist should be able to envisage the *nature*, relevance and importance of the social costs and benefits of his scientific efforts, discoveries and their applications in the direct and indirect promotion of human well-being, the survival of the human race and the enjoyment of the products of his labour. Therefore, without apology, we would insist that *socio-economic cost-consciousness* shall be reflected in all aspects of this subject. This is an indication of the usual recognition of the role and importance of the economists and other social scientists that are '*de facto*' members of the multi-disciplinary team in livestock agriculture as in veterinary public health (vph). And as mentioned earlier, they all have a lot to contribute to and not a little to gain from scientific studies in the discipline of Epizootiology, its principles, logic paths, methods, techniques and their applications in diverse circumstances.

Direct applications of the philosophy of this component will be further expounded in the appropriate section of this book. The lessons are usually abundantly clarified during the didactic and participative lectures, tutorials, discussions, and seminars and even during the practical exercises, which are essential parts of courses in Epizootiology.

2.5 RECOMMENDED PRACTICAL EXERCISES

2.5 (a) Title of Practical: **Physical and Functional Relationship Study**

Physical and functional relationship studies are usually carried out on the University Teaching and Research Farm of the University of Ibadan (See Figures 2.2, 2.3, 4.15, 4.16, 4.27, 4.38, 4.39, 4.41, 4.43 and 4.44), which is used jointly and for cost-effectiveness by Faculties of Agriculture, Veterinary Medicine and related disciplines in other Natural Science and Technological Faculties of the same University.

Similar studies and field practical training in Epizootiology were initiated and also carried out at the Dabagi Dairy Farm of the Usumanu Danfodiyo University Sokoto (UDUS) during an intensive teaching and training of the first final year and penultimate year students of Veterinary Medicine of that University in 1992 (see Figures 4.51 and 4.52). The procedures usually carried out at U.I., Faculty of Veterinary Medicine (FVM) in Ibadan by one of the authors were followed at UDUS as part of the course in *Ecological Epizootiology*, for which a special set of notes were prepared for the students.

2.5 (b) Preparation for the study:
(i) Staff and students who are to participate in the practical exercise should meet, name and be tutored on the title / topic of the impending study and field training:

(ii) They should then discuss the *nature* of study title, and then the Teaching and Research Farm to be visited. The usual purpose of a teaching and research farm and the specific to be visited should next be presented to and thoroughly discussed with the students in the context of its geography, ecology, economics, and relevance in livestock production, veterinary public health (vph) potentials and preventive veterinary medicine (pvm) practice. Remember that **Epizootiology is meant to provide the soundest and most broad-based knowledge for the practices of vph, pvm and economic livestock production.** And that is **a key statement**, which should not be missed at any point during the course of studies by students of veterinary medicine.

N.B.
This occasion should be seen as presenting a good opportunity to engage deliberately in 'participative teaching'[6.1, 6.47, 6.50]. The fact that this text would be available to both staff and students in advance of the exercise should facilitate necessary meaningful participation by both staff and students who are diligent enough to consult and meditate on the *relevance*, *importance* and *substance* of the planned exercise before the date and time scheduled for the practical exercise. Epizootiology is of course meant for diligent and committed staff and students only. Half-hearted interests (or divided attention or allegiance) can hardly bring out good results to the participant at any level in any subject based on *system approach*.

(iii) Basis for 'Epizootiological definition of systems' problems, their descriptive prose and expository presentation, and their quantification, analysis, evaluation and benefit/cost consideration in relation to the Teaching and Research Farm under study and the problems of its contents should be taught to the students at this stage.

(iv) Expected contents of the Teaching and Research Farm should be listed and described following OPST approach[6.1, 6.43, 6.44]. Remember that OPST means **O**bject, **P**rocesses, **S**ystems and **T**ime factors. They provide *tools of thought* and *functional logic paths* in systematic epizootiological reasoning. They are useful in visualizing and presenting both the literary (i.e. the qualitative) and the statistical (i.e. the quantitative nature of the system under study. The nature, definition and description of potential problems, their indicators and how to identify and record them during data gathering at the farm should be explained to and discussed with the students at this stage. **A well-structured format** for real-time data recording will always facilitate the processing of the data later. This point should never be missed.

2.5 (c) Designed forms for field data collection and recording:

Forms to be used in the field for collecting data on objects, *et cetera* that would be observed on the farm must be constructed before going to the field.

(i) Remember that objects are to be classified into animate and inanimate:

(ii) *Animate* objects should include plants, animals and microbes:

(iii) *Plants* should include trees, shrubs, herbs, grasses and other species:

(iv) *Microbes* should include bacteria, fungi and their spores, helminth and protozoan eggs and larvae as well as nymphs of relevant species of insects, water-insects such as cyclops, schistosomes, larval stages of flukes, mosquitoes and tsetse flies, (dangerous and beneficial) bacteria:

(v) *Animals* (i.e. members of the biological kingdom so called) should include man, horse, cattle, sheep, goats, pigs, dogs, cats, insects, earthworm and others (recall studies in Biology and Zoology). They are all parts of the ecology of the study area when present.

(vi) *Inanimate objects should include:*

(via) *Edaphic* contents, soil, rock, mineral and micronutrient types.

(vib) *Meteorological* or atmospheric content including water vapour, mist, dust, lead and other particles, the various gases (such as oxygen, nitrogen, carbon dioxide, carbon monoxide, sulphur dioxide and other exhaust gases from automobiles and other sources).

(vic) Dust particles and micro droplets (as potential carriers of spores of fungi and bacteria, viral particles inside discarded cellular matter).

Provisions should also be made on the forms for recording all conceivable data types on usual and unusual contents of aquatic / hydrologic environment, gross matter, mud, sand, their contents, assorted minerals (members of the periodic table of elements in various forms and combinations, bland, active, reactive, toxic and useful).

What we have said so far should be seen as the body of the preparation imperatives. Next, we shall present the *soul* and *spirit* of the matter in a poster form, which now follows on the next page.

Theme:

PREPARATION FOR AN EPIZOOTIOLOGICAL FIELD STUDY / TRAINING: THE GIST, SOUL AND SPIRIT OF THE MATTER

IT SHOULD BE SEEN AS AN IMPORTANT PART OF THIS PRACTICAL EXERCISE TO DESIGN FORMS FOR RECORDING ALL THE ABOVE POTENTIAL DATA MATERIALS BEFORE LEAVING BASE AND GOING TO THE FIELD:

Figure 2.2: Effective preparation for a successful field study and/or training:

(a) Demonstrate what is to be done (b) Explain to all prospective participants (c) Draw up the forms for data collection in the field (d) Obtain appropriate vehicle (e) Discuss on arrival on the spot (f) Make observations and record them (g) Collect specimens (h) Record details of specimens collected (i) Study the epizootiological map of the area (j) Demonstrate the map to others (k) Collation of records from the field (l) Review of progress

How to complete the forms with facts and figures to be obtained on the field should also be exhaustively discussed during this planning stage:

Each participant should go to the field with necessary writing materials to complete the forms while on the field:

Envisaged adequate numbers of such forms should be carried with the team. The tutor should carry extra forms in case the students default:

Remember that every epizootiological field study or training visit consumes scarce resources: true epizootiologist should therefore make adequate provisions for counting the costs and presenting the benefit/cost analysis at the end of each visit. In fact related costs and envisaged benefits (in whatever terms) ought to have been estimated by a truly 'cost-conscious' tutor, as 'a modern veterinarian', which the gospel says 'must be socio-economically cost-conscious'.

2.5 (d) The field exercise

For the field exercise, participating students should be grouped into four each. In each group of four students, all must be observant, using their eyes, not just for seeing but for looking ... Two should be announcing their observations and findings independently / corroboratively, while the other two are recording them in two separate pre-designed forms. For example, recording data on a group of cattle on the farm should reflect logical structure of numbers of cows, bulls, yearlings, calves and castrate; this is known as *herd statistics* / structure. The same should be done for other animal species on the farm.

The various species of plants should be identified with estimates of their quantity or preponderance of one species over the others. Notes should be made of their physical relationships e.g. what plants or weeds or grasses or vegetables are growing under the canopy or shade of palm-tree, iroko tree or the paw-paw tree on the farm?

Functional relationships between plant-eating (grazing / browsing) animals may be established, and thereby show which animals are drinking from local body of water and which ones are sucking the blood of other named animals in the area.

Specimens to be collected for laboratory identification and processes should include samples of plants, remains of animals, insects and their excrements, ticks, flies etc for detailed identification in the laboratory.

Appropriate specimen containers some with and others without preservatives should have been brought to the farm. They should then be taken to the laboratory.

Laboratory practical should follow what has been discussed under chapter 1 of this book.

2.5 (e) Recording, Reporting and Write-up for Presentation:

Recording, reporting, seminar preparation, presentation and write-ups with analysis of findings should follow what has been described at the end of chapter 1. In doing this:

1. Candidates should be led on how to write up all the above briefly, qualitatively and quantitatively to make sense.
2. They should also write in such a way that slides for presentation can be made meaningfully.
3. They should be given examples to work on for analytical processes.
4. Analytical processes should start from the relationships established through measures of correlation coefficient (r). Possible establishment of causal relationships should follow it. This is the true beginning of *analytical phase* of *epizootiology* and *biostatistics*.

5. Students should be made aware of those facts without doubt. It is good to let the students know that such collections and processing of epizootiological data to obtain useful information can make important contribution to knowledge. When properly presented, they can result in useful and informative publications. As epizootiologists, all participants should have the moral and ethical configuration to publish together whatever was done together. Plans for such publications should actually be discussed. It is not good to publish without first presenting the material at a departmental and a faculty seminar. This is because the contributions of colleagues in the form of comments, questions and criticisms can lead the wise authors to improve on the quality of the write-up for publication. Finally, it should be remembered that VetAcademic Resource Foundation (VARF) has an outfit for publishing such high quality materials. Interested people should read the feature article with the title '*Value and integrity of scientific research and publications*' in the 2nd Special (inter-millennium) edition of VARF Bulletin of 31st December 2000[6,63].

Figure 2.3: Picture of one of the grazing areas at the University of Ibadan (U.I.) Teaching and Research Farm.

A section of the cultivated pasture at the U.I. Teaching and Research Farm Used in the teaching of ecological epizootiology

Figure 2.4: Picture of one of the animal buildings and its surrounding in the U.I. Teaching and Research Farm

Illustrating tropical cattle house type and the nearby pasture, being part of the facilities used in the teaching of Epizootiology. Flora and fauna contents of the ecosystem, the biomass and the stock carrying capacity of each hectare of the grounds are some of the parameters studied on this section of the teaching and research farm

Chapter 3

PHASES OF EPIZOOTIOLOGY

3.1 Why Phases?

The development of epizootiological knowledge of a particular problem (including diseases) should at best be achieved in logical stages; that is in phases. Problems themselves usually evolve in stages[6.1, 6.64, 6.65, 6.66]/phases; from whichever angle they are viewed. For example, from the points of view of extent, intensity, amount of change or damage done, the reversibility or otherwise of the outcome and the amount of the biological, social, economic and/or financial costs and the natural benefits negated (and opportunity costs), the evolution of any problem at all can be viewed in phases of continuous or continual changes whether the final outcome or the duration of the total change is acute, sub-acute or chronic.

Epizootiology is a science of animal group or population problems. Such problems often begin and evolve by involving varying proportions of the group or population (see Sections 5.3 and 5.4 (b)). Morbidity on day 10 may be 10%; whereas on day 15 it may have risen to 30%. Incidence per unit time is either increasing or decreasing within the limits of 0 100%; the sequence and direction of change in between times and landmarks are often characteristic of the particular problem at hand. And in particular, where/when animal groups or populations are involved, a knowledge (not only of the group/population dynamics but also) of the usual sequence of events and measures of the variable determinant factors and forces involved must be understood in a logical (and one may even say in an algorithmic) manner. If therefore, that is the natural way in which diseases and other animal population problems often develop, it stands to reason that any understanding of the problems would best be achieved in a logical sequence and in phases.

3.2 The Phases of Epizootiology

Now, the study of any problem or event can be divided into any suitable number of phases or stages. This will normally depend on the nature of the problem or the event and our conception of convenient points for making sensible statements about changes in its nature, extent and the amount of detectable damage done (see Section 5.4 (b)). In this case, the proportion of the population that have become patently affected or have died or have simply become more or less permanently changed or deformed will usually have to be determined.

In the scientific (systematic and methodical) study of problems in animal populations, three phases have been found convenient by pioneers in the field; and these are
(i) Descriptive, (ii) Analytical and (iii) Experimental phases. We shall now consider the subject in the following sequence, namely: -

3.2 (a) Descriptive Epizootiology

By definition or default, observation of the variable determinant factors of disease (and other problems, and measures of associated changes) is in essence the very first step in Epizootiology. The very next step is to think deliberately, at least on the relevance of what the observer is seeing or perceiving to the perceived problem or disease. The third step is to record, report, communicate, and in any case describe what has been observed. This approximately, is the import of Descriptive Epizootiology. To make sense, not only to the observer but also to his audience, the descriptive work has to be done systematically and methodically (that is scientifically). The appropriate language and sub-language/s[6.45, 6.66] of the discipline must provide the medium of communication. There is always a dictionary of Epidemiology[6.67] or at least a thesaurus of Epizootiological terms, and in this book, a glossary *quo vide*.

The acuity of the observation (and therefore the succinctness of the description) is of course a variable factor and function of the observer. Brightness, dullness, weakness, agility (alacrity or nimbleness) and similar states are the usual attributes whose descriptions may vary tremendously according to the observer's perception; such descriptions are highly subjective. Some people are in fact colour-blind. And yet for others, physical goodness and beauty 'are in the eyes of the observer'. Hence such terms are best avoided in Descriptive Epizootiology as in its branches such as Descriptive Epidemiology and Descriptive Epornithics. There is however an array of population/group and individual attributes that readily lend themselves to fairly standard descriptions whatever the state of the observer within the range of normality and around an average measure of common-sensibility.

3.2 (b) What then are the items usually described?

Traditionally, the three groups of attributes often considered for detailed descriptions (as may be relevant to each problem in hand) are those of (i) the group or population, (ii) the place, and (iii) the time of the events. Over a decade ago, however, one of the authors introduced the "OPST" approach, by which the usual variables that could be described can be grouped under Objects (O), Processes (P), Systems (S) and Time (T). The identification of the system to which the objects and processes belong should provide a distinct advantage to both the observer and the user of the resultant information, as well as for anyone who is aware of the advantages of systems approach in almost all spheres of natural phenomena and human activities. Candidates who are likely to proceed to postgraduate studies or to become independent investigators or researchers in any scientific outfit will be well advised to try and understand the OPST approach. The useful idea is the value of adopting it. Its adoption will often guarantee a comprehensive and systematic coverage in the study of most subjects. The researcher or even the decision maker is thus afforded maximum opportunity for carefully considering all possible options and the attendant implications. All of these may then be placed on the probability scale, thus enhancing the soundness and validity of the basis for relevant decisions and actions. At the primary/elementary or undergraduate level however, we shall stick to the old method of operating at the levels of groups of animals, population (of persons), description of places (often in geographical / ecological terms) and temporality in terms of 'When?' 'Since when?' 'For how long?' 'How often?' And, 'On what dates?'

3.2 (c) Description of Groups (or Populations)

A problem in a group of animals that is important enough to arouse the interests or to justify the engagement of the services of an Epizootiologist must first be identified on the following criteria: -

- What is the nature of the interest/problem?
- What would be the objectives of the enquiry or intervention?
- What are the nature, species, composition, size, other characteristics and other parameters of the group or population affected, at risk and/or exposed?

Knowing that a health problem is affecting a population of zero-grazing dairy cows must conjure up a trail of thought different from what will be relevant to a similar problem in a herd of beef cattle on a ranch. The breed of the cattle (e.g. N'Dama or Bunaji) will obviously be associated with thoughts of possibilities different in one case from the other. And even within the same breed, the ratio of male to female, and the various age groups (and in fact the entire series of data making up the "herd statistics") will present various scenarios of possibilities when infertility is apparently the matter with them.

In summary, the description of a group of animals or a population of human beings must include the type/s, species, age groups, numbers of each, proportions, ratios, sexes, performance records, genetic compositions, known inherited susceptibility or resistance to named diseases, nutritional status and such like things. Summary descriptions of the herd or the Descriptive statistics, including measures of central tendency and of variability of specific traits within the herd are essential conclusions that must be presented come what may, at the end of an exercise in Descriptive Epizootiology.

3.2 (d) Description of Place/Location

The **location** (in terms of **geography**, **ecosystem types** and **grid references**) of a group of animals in problem is always of significant relevance to the causes of the problem. For, not only do infectious agents and their vectors have *ecological preferences*[6,68], but also that *their abundance* is always associated with local climatic and other environmental factors, such as the actual vegetation, soil type and the fauna system. The vegetation zones of the continents have been known to be conducive to specific ***flora*** and ***fauna*** elements. The **tropical rain forest**, the **Guinea and Sudan savannah grasslands**, and **the arid regions** of Nigeria (See Figures 4.17, 4.18 and 4.21) for example, have their peculiar groups of *flora* and *fauna* and of problems in the groups of animals in each of the regions / belts.

The seasonal migration of ruminant animals from the northern parts southwards just before the height of the dry season, are the direct consequences of the changing ecological conditions in the various parts of the country (see Figures 4.11, 4.19, 4.20 and 4.57). The classification of tsetse flies (*Glossina species*) into forest, grassland and riverine *species*[6.60] is an indication that the types of problems they cause will naturally be associated with such places where the particular types of vector would readily survive and prosper to the detriment of their hosts[6.61]. And when everything else is approximately right in a place for the ***hosts***, the ***agents*** and the ***vectors*** to be there, then the close relationships and interactions occur, resulting in disease implications, the associated morbidities and mortalities[6.69, 6.70].

Even diseases and *other problems* caused by inanimate objects (see OPST, *ibid.*), such as lead or molybdenum poisoning, and those caused by plant poisoning[6.71, 6.72, 6.73] are often associated with the presence and abundance of such substances in the particular places. Living at high altitudes or in valleys or even on the slopes of hills and mountains is often associated with the peculiar problems of such places. 'Mountain vegetation' has its own peculiar problems reflected in the nature of the ecosystem, the role (*niché*) and fate of the flora and fauna components.

So, it is usually not only the vegetation and the climate of a place but also the organic and inorganic contents of the soil that would determine the type of animal health problems, their volume and the usual outcome in a place. In addition, the animate and inanimate contents of the environment, as well as the topography of the place will often contribute to the presence or absence of particular diseases or health problems. The nature and extent, and even the usual outcome of diseases and other problems in groups of animals (and plants) and the population of human beings and their activities in a place are determinant factors of their survival and prosperity. Where a population is located, where it derives its sustenance (including the drinking and bathing water), where its remains eventually settle (dumped or in the chain of natural recirculation or recycling), the size of the uniform area, the expanse of the regular edaphic characteristics of the place, are all important variable factors that together determine the type, nature and volume of the problems in the local populations. Environmental factors may in fact contribute to the aggravation and remission of such problems. The "place" variable determinant factor should always be considered when studying the occurrence and distribution of problems in groups of animals over a temporal (time) scale.

3.2 (e) Description of Time (Temporality)

Whenever a problem or disease is identified in a group of animals, the natural questions of time that come to mind will always include (i) 'When did it start?[6.51]' (ii) 'For how long has it been going on?' (iii) 'Has it been continuous or was it ever interrupted?' (iv) Has it manifested itself in a cycle of occurrence and disappearance (biorhythm)?' (v) 'How long are the identified phases of the cycle?' (vi) 'How long are the intervals?' (vii) 'On what day or in which month/s, season or year/s?' (viii) 'At what time or hour of the day or night does the problem usually start or stop, or increase, or decrease?' In summary, the description of time in relation to the occurrence, distribution, persistence and disappearance of epizootiological problems should always be directed towards answering the questions when? Since when? For how long? How often? At what time intervals? Et cetera.

The usual idea is to find out what other determinant factors (*See* AND, OR; Boolean logic/algebra[6.51], in the *web of causation*[6.51] are associated with the time of the occurrence, aggravation, remission and or termination of the particular disease (or other problems) in the particular group of animals or human population (i.e. people) in which the investigator concerned is interested. The fact that temporality is the most important factor in causal relationships (John Stuart Mill cited by Susser, M., 1979 [6.51]) will be taken up in the appropriate section of these notes. But briefly here the major point that stands to reason is that, if we consider that a problem may have been caused by a determinant factor *A*, we must be able to show that in the scheme of things *A* occurred before *B*. A father existed before his son.

3.2 (f) Group / Population, Place and Time Relationships

As just concluded in the immediate past section of these notes, temporality is only one of the variable determinant factors that should always be considered when seeking to understand the nature of a problem in a group of animals (including human population) as in the uses of *alibi** and its proof in court cases.

What is most important however is the association of a particular time measure with the specific place (distribution in space) and our target herd, flock or population and how often (i.e. how frequently) such associations occur over the months, or years or seasons as may be appropriate in each particular place. Recall that it has been explained earlier that Epizootiology is a science of relationships (Rr). It is indeed with the establishment of the relationships of population, place and time[6.74, 6.75] on the scale of commonsense that the nature and role of a particular problem will be understood. Biological commonsense (otherwise known as '*biological plausibility*'[6.51]) will for example allow us to see **the absurdity of a seeming perfect relationship** of a group of bulls, in any place and over any period of time, **leading to a diagnosis of metritis in the bulls**. Common sense, it has been said, is that sense without which all the other senses are meaningless. Remember the issues of '*biological plausibility*' in the context of the prototype diagnostic computer called '*the Cambridge Box*' (s.i.t.m. 1952)!

3.2 (g) Socio-economic jurisprudence (sej) as a cardinal issue in Epizootiology

Even then, if all that Epizootiological approaches entail is the study of physical relationships of groups, populations, place and time with a touch of plausibility in the presentation mode, in the twinkling of an eye everyone of average intelligence, with minimum application to study, will soon become a doyen or doyennes Epizootiologist. And even on the philosophical scale, there is far much more to Epizootiology than all that have been said so far. For example, what one of the authors would like to refer to as the '*human factor*', with its positive and negative components, has a lot to do with the level of success that may be achieved in preventive medicine practice based on Epizootiological *knowledge*. Instead, we should always be interested in basing our judgment, decisions and actions on '*epizootiological wisdom*' (See 'the pie chart of human wisdom, Figure 1.1, ibid.).

* See details in Glossary of terms

Human interests and passions have the tendency to oscillate between such positive virtues as selflessness, honesty of purpose and diligence on the one hand, and selfishness, proclivity to fraudulence and other vices on the other hand. *Healthy passions* are sometimes replaced by *perverted passions* known as perversions. All men always mean well and aim for good. But while some aim for the good of the system, others have self and the good of self as priority number one. On such occasions, we may justify the saying that for such systems the road to disaster, even to hell, is usually paved with good intentions. The travellers on the road are selfishly well-meaning individuals, often aiding and abetting one another to turn the world upside down, eventually putting the system in distress, even with the abundance of necessary knowledge and skills to go otherwise notwithstanding. These are indications of the social dimension, whereby we are sure when we say that *being socially cost-conscious* can be the determinant factor for success or disaster when all else is right or wrong. We therefore recommend that *socio-economic jurisprudence* (sej)[6.6, 6.48, 6.52, 6.53, 6.54] should always be part of the cardinal issues in epizootiological studies for the practice of preventive medicine, as for livestock development and production to which *epizootiological wisdom* has a lot to offer.

Now, *socio-economic jurisprudence* (*sej*) has been defined in several non-contradictory ways according to the context in such references as just cited above and in many others else. Perhaps the cogent message here should be that sej means the wisdom of being conscious of the need to aspire to be socially (in addition to being economically) healthy in our epizootiological efforts and professional life. Then being socially healthy includes being mentally, morally, educationally, spiritually, law-abidingly, peace-lovingly and promotingly and security-consciously healthy. Those who are so healthy are said to be practitioners of *positive socio-economic jurisprudence* (*psej*). And those who are unhealthy in those seven respects are identified as practitioners of *negative socio-economic jurisprudence* (*nsej*). Without these traits, one can observe many otherwise diligent, intelligent and loving achievers perishing eventually on the altar of nsej. And so, the question is, "What does it profit a man to be a great achiever that nevertheless perishes because of his social ill-health?" Or, who does not know that failure in those seven respects never ends well? So, to ignore sej is to ignore the totality of ones efforts on which one would be eventually judged. The choice should be left to every individual. Democracy is all for the freedom of choice and acceptance of fate resulting from the deliberate choice made by each *discrete** or *diffuse system*[6.1].

3.3 Analytical Epizootiology

This section deals with the strictly mathematical aspects of Epizootiology. It is synonymous with the 'quantitative approach' and rests on the analytical branch of biostatistics, measures of probability and experience in interpretation of the results obtained from appropriate computations[6.36]. The candidate should recall that just as we have *Descriptive Epizootiology* we also have *Descriptive Statistics* (in another course). The interesting thing is that, the issues, events and variable factors and relationships being described in one are exactly the same as what is being measured in the other; namely the population parameters, the sample statistics, in addition to the attributes of animals in groups, the geography and ecology of places and times associated[6.74, 6.75, 6.76, 6.77, 6.78] with the problems in hand and events of immediate concern, all of which are important components in systems of *Descriptive statistics*, just as they are of *Descriptive Epizootiology*.

Now, the mathematical / statistical components are the bare bones of the matter; the attributes provide the flesh. And who would ever wait to associate with the skeleton of a man walking in the street in broad daylight. He is more likely to 'pick race' on first sighting. Man is skeleton covered with flesh, even as quantitative knowledge has to be dressed up in qualitative garments to make sense. The quantitative expression 'One thousand out of a million' will only make sense when the natural questions 'of what?' and 'which?' are answered. Think about that for a moment. And you would appreciate the relevance and importance of relating qualitative descriptions to the quantitative measures in order to make sense of the whole issue or the nature of the system that is the matter.

In *Analytical Epizootiology* however, we are concerned with the formation and testing of hypotheses[6.77], the construction of models[6.79, 6.80] and formulae, and their examination and application to issues at hand,

* See details in Glossary of terms

from which inferences are made on the probabilities, beyond the realms of our immediate observations. Relevant epizootiological data, which must be appropriate, accurate and adequate, must first be correlated to obtain the coefficient. They are then subjected to regression, with a view to catching a glimpse of the probable past in quantitative terms[6.79, 6.80]. Predictive mathematical models are also made and tested, to forecast the quantitative growth or waning of specific population parameters in the foreseeable future[6.81, 6.82]. The whole idea is to provide opportunities for better/greater understanding of the past and future behaviour of the modelled system/s, and to provide some quantitative basis for decision and planning[6.49, 6.83, 6.84, 6.85] for a better or preferred future state.

Planning is usually concerned with how to ensure that the future will be better[6.86] than the presents in whatever aspect of the animal population parameters, in which the planner may be interested, towards enhancing the various aspects of *human well-being*[6.43, 6.53, 6.56, 6.62, 6.86].

Important decision processes are often based on resultant predictions, having taken care of all the possible and operative variable factors or assuming that in addition to the key determinants all the other factors would remain constant or only varying within predictable limits. Otherwise our application of *Boolean logic/algebra* will have to be extended beyond the *true* or *false* operands, thus going into AND, OR, NOT logical functions[6.51] on our way to the truth of the matter; just as Revd. John Polkinghorne[6.87] has clearly pointed out that both science and religion are always 'searching for truth'. No contradiction.

Apart from the few basic points mentioned above, it may be taken for granted that Analytical Epizootiology should be considered in detail at the postgraduate level and as a special lecture and for a detailed chapter in *Systematic Epizootiology*, which one of the authors treats as synonymous with *Advanced Epizootiology*, as taught by him to postgraduate students working for the MPVM (Master of Preventive Veterinary Medicine), MVPH (Master of Veterinary Public Health) and M.Sc. (Epizootiology) degrees of the University of Ibadan, Nigeria[6.3]. To the extent to which the undergraduate candidates may be enthused to seek further knowledge of this branch of the subject, further details should be given during the lectures, tutorials and practical exercises of this course. The really enthusiastic student will eventually register for one or the other of the postgraduate courses in veterinary public health (vph), preventive veterinary medicine (pvm) or M.Sc. Epizootiology, for all of which Advanced (Systematic) Epizootiology is one of the core and compulsory courses.

3.4 Experimental Epizootiology

Experimental Epizootiology is essentially a prospective study, potentially involving the two components of Descriptive and Analytical Epizootiology. It affords the experimenter the greatest opportunities for detailed investigations of a particular system, constructed to taste for specific objectives, with well-thought-out sets of observations, test and control models, and envisaging some interpretation in one way or the other, depending on the qualitative and quantitative outcomes of the experiment and the analysis of the data.

In such empirical studies, the necessary inputs are so well controlled as to exclude undesirable interference, thus eliminating the chances of undesirable outputs such as *noise, smoke* or *heat* (See *Natural BIOS* and its black box in Figure 4.2). While activities in the black box are kept at a reasonable level of healthy relationships, and there are the chances of good (expected) overall performance, the resulting output (outcome) is thus kept fairly pure and predictably dependable. The indicators either way is usually clear even in the design of the experiment.

Experimental Epizootiology will often require a deep understanding and a fair knowledge of not only the basic system to be modelled, but also of the constituent components, and a clear open mind for reading just the observed outcome rather than the investigator's mental pre-occupation. An example of experimental epizootiology conducted in Ibadan, Nigeria was the investigation of quality and public health aspects of smoke preservation of meats in Nigeria by Alonge[6.88].

Experimental Epizootiology may be quite costly in terms of the material resources required. It will also demand a high level of discipline in keeping to the time scheduled in the original design and for the various sets of activities (protocols) that constitute the experimentation details.

Parallel experiments may often be designed with variations only in one or the other key variable determinant factors, thus having multiple scenario effects and results. All of these are meant to elaborate on any tedious or knotty points, which may still require clarification after reading recommended textual materials such as the students' lecture notes or this book.

Attendance at lectures will remain very important, even essential to achieve the appropriate level of learning or education earlier canvassed and recommended. Eye contacts between lecturer and students may reflect wistful responses, which should lead the lecturer to clarify any doubts in the students' understanding that would otherwise go undetected if students only learn by reading the hard copy of this book. Each has its own role to play in the teaching and learning processes. The wise would take advantage of both chances.

3.5 Summary and Conclusion

3.5 (a) *In summary,*

In summary, epizootiology may be conducted in three phases, namely, at descriptive, analytic and experimental levels. The descriptive study is associated with the presentation of the relevant findings in summary as in descriptive statistics, which involves measures of central tendencies (mean, mode, median), and measures of dispersion (such as variance, standard deviation and standard errors of the means), as well as correlation coefficient a summary of relationships between independent and dependent, cause and effect, stimulus and response and such like pairs of *associated variables*.

The analytical study is essentially mathematical, starting essentially with correlation of associated variables, measures of their symmetrical and asymmetrical relationships, and involving regression and predictive models and the inferential measures and interpretations beyond what could be deduced from direct observations. In an experimental study, both descriptive and analytical methods are usually relevant. The idea is to get as close as possible to the true present, past and future nature of the problem at hand. The final uses of such information include the provision of basis for planning[6,86], basis for decision processes and scientific basis for preventive measures (pm) in their widest sense relevant to both vph and pvm studies, while being an essential part of Epizootiology itself.

All such studies are best done in systematic manners, and using appropriate methods in each case. The outcome of such studies should not be seen as negating what may have been expected from the point of view of common-sensibility. An understanding of the positive and negative aspects of *human nature* will always be relevant to the interpretation of the various results. Knowledge and skills in the appropriate areas will usually be necessary to achieve real and meaningful results, and this would always include computer skills for data processing. Data here should include numerical (quantitative), non-numerical (qualitative), graphics (pictures) and sound.

3.5 (b) Universal applicability of epizootiological philosophy

Finally, all the methods and philosophy of Epizootiology are universally applicable to many other aspects of human endeavour. Just as one can study the Epizootiology of diseases (e.g. brucellosis, nagana, tuberculosis, cancer, etc) and conditions (e.g. coughing, sneezing, grunting/groaning), one can also study the Epidemiology of vices (such as lying, violence and gossiping). While the variable determinant factors may differ in each of the three groups (diseases, conditions and vices and other problems), the methods (i.e. descriptive, analytic (counting and accounting) and experimental models) are very similar. They entail the description, summary presentation and analysis of the attributes of the groups of animals or population, their location (spatial distribution), temporality (temporal distribution) of the events and their interpretation for decision making, action taking, towards solving identified and quantified problems.

And in real-life situations, Epizootiologists *sensu stricto* may have to study such vices as pecking, nibbling, paddling, etc, in animals. In man Epidemiologists and criminologists may have to study social vices and crimes (respectively), using similar methods and considering populations at risk/exposed/involved, distribution of occurrence, say in urban and rural areas, in schools or boarding houses, and even in family houses and in prisons, all over time. The similarities in the systematic approach and in methods are what make Epizootiology and allied disciplines good examples of models in *scientific thinking and methods of inquiry.

Hence a good understanding of systems approach and of Epizootiological methods will carry an educated person a long way in conducting scientific thinking and investigations on the various problems of life.

3.5 (c) Recommended practice

In order to build up epizootiological database infrastructure, a teaching department should each session plan to familiarise the students with the practical guidelines presented at the end of the various chapters in this book. They should also learn from other well-established programmes on community database development for the groups of students[6,90]. These groups should accurately keep record of qualitative and quantitative data, in specified formats, describing groups of plants, groups of animals, other groups such as of insects, extent of areas covered, people met, their population dynamics - all as part of their epizootiological studies and training.

3.6 Recommended Practical Exercises

3.6 (a) Preparation for the study

Before commencing a practical exercise, staff and students should meet to discuss the following:

(a) Title of the practical study

(b) The meaning of phases. Illustrate this with the various faces of a dice being cast. While it is the same object, it has six faces. It is when one knows what is on the face of each of the six faces that one can understand the true nature of the object dice.

(c) Illustration of phases: It is important to look at one after the other face of the dice, until one sees the characteristics of the dice that one wishes to explore in detail. One may however not see expected characteristics until all the phases have been examined one by one. Explain to the students that an epizootiological practical is similar in that it has many phases. The phases to be examined are descriptive, analytic and experimental.

(d) Importance of observation: To describe anything, one has to make observations. Such observations must answer the question what (and

* See details in Glossary of terms

what individuals and groups)? Where (located and how wide spread at any point in time)? And when (i.e. time when, since when, how often, for how long, at what intervals of time)?

3.6 (b) The field exercises

Students should start by observing and discussing the scene in the field during their practical Epizootiology. At this point photographs may be taken and video filming made. The more efficient observer will describe objects seen in the field more accurately than the casual observer. Deliberately looking at an object is often more informative than merely seeing an object. A good observer should use his eyes, not just for seeing, but also for looking.

Apart from describing the forms, sizes, shapes, etc, the numbers, groups and the relationships of the objects to one another, one should also describe the quality and relative quantity of each group of objects (that are not just seen but) observed, inspected and examined for their various characteristics (form, shape, symmetry, consistency, solid, fluid or gaseous). In this case one is already going through numerical description of the group of objects in the field, as would be later presented and considered in the classroom.

3.6 (c) Purpose of observational training

The idea is

1. To inculcate in the students the need to be keen, sharp, deliberate and comprehensive observers, in qualitative and quantitative terms during this exercise.

2. Plan for a group of students to accurately keep record of qualitative and quantitative data, and materials collected as samples, describing groups of plants, groups of animals, other groups such as of insects, extent of areas covered, people met ...

3. Finally, one group should look for evidence of the meteorological, hydrological and edaphic contents and circumstances of the place, at the time of visit. The colour of the soil should also be noted, as this is usually a reflection of the iron (and other mineral contents).

4. These groups should of course have been provided with tables and units of quantities in which to record the data to be collected before they go to the field.

5. When considering groups of animals, *herd statistics* should be recorded. Explain what *herd statistics* mean, show the students a sample table (e.g. of cattle herd statistics) and train them to design reasonable tables for recording flocks of poultry (layer and breeder), sheep and pig flock statistics.

6. Advise and instruct the students on how to make independent records while completing the data sheets for herd/flock statistics.

7. While in the field, Supervising Lecturers must also observe and make some notes and keep records on their own, in order to have basis for independent judgement when checking the students' reports and their data sheets.

8. Supervising Lecturers should encourage students on practical training to **record** their **data** and other findings **in duplicate**, even when they are using forms.

9. Remember that when back in the laboratory, you are going to process the data of *descriptive epizootiology* in terms of *descriptive statistics*. This would be difficult if the appropriate data is not collected. Also, if accurate and adequate data are not collected the outcome may be meaningless. It may defy sensible interpretation, or tempt the less upright to resort to guessing figures. These are key statements, and indications of what should be avoided.

3.6 (d) Laboratory Practical

A record of materials brought from the field must be kept immediately on arrival in the laboratory. Each group of the various materials and samples must be counted and the number recorded. Mode of preservation from the field must be stated. Mode of preservation and where kept in the laboratory must also be recorded in the bound notebooks kept for the purpose in the laboratory. What processes (e.g. haematology, serology, specimen identification, culture, histopathology, etc) which are to be carried out on each group of materials or samples should be recorded immediately on arrival in the laboratory.

The next day, there should be a presentation session in the laboratory (so that students can point to or demonstrate what they are talking about … and answer questions on them). In such an exercise it would be advisable to follow the following steps:

a) Get every group of students to present highlights of the data they collected variously from the field in descriptive epizootiological (veterinary epidemiological) language:

b) Get each individual or group of students to present their observations in descriptive statistics. And correct any mistakes in presentation:

(c) Explain to or remind them that *descriptive statistics* mean **summary presentation of the characteristics of the groups** of plants and animals or human population in the area: Sorting figures from the lowest to the highest order of magnitude and presenting them as such is the usual beginning of descriptive statistical procedures on collected data; it provides the range. From this, you can get other statistical measures (such as mean, median and mode) of the sample, group or population:

d) By calculation, you can get the variance and the standard deviation. Therefore, to present in descriptive statistics mode includes all the above. When a table is produced from the figures, it is part of *descriptive statistics*:

e) Although these things must have been taught during lectures, it is good to repeat to the students what they are doing when making this summary presentation:

f) Graphs and charts, they should be told, are the best ways for establishing and visualizing relationships or associations between *variables*. Therefore, correlation coefficient should be worked out from such charts as an example of measurement of relationships.

g) Now explain to the students how using the modern digital computer systems can facilitate such record keeping, data processing (including computations, report writing) illustrations, graphics integration, analysis of results and their interpretation for plans, decisions and action. Remember that Epizootiology is often a means to an end (and not an end in itself). Take them into the computer room and do the whole gamut of *descriptive statistics* with the qualitative and quantitative data available.

h) This is the point to emphasize how what we describe in descriptive epizootiology literally/qualitatively are the same things that we describe in descriptive statistics quantitatively and with measures of probability, ending with an interpretation of the results.

3.6 (e) Recording, reporting and write-up for presentation

a) Candidates should be led on how to write up all the above briefly and to make sense, in qualitative and quantitative terms.

b) They should also write in such a way that slides for meaningful presentation can be made from the write-up.

c) They should be given examples to work on for analytical processes.

d) Analytical processes should start from the relationships established through correlation coefficient determination. Possible establishment of causal (asymmetrical) relationships should follow. This is the true beginning of analytical phase of epizootiology and biometrics.

e) Students should be made aware of those facts without doubt. It is good to let the students know that such collections and processing of epizootiological data to obtain useful information can make important contribution to knowledge. When properly presented, they can result in useful and informative publications. As epizootiologists, all participants should have the moral and ethical configuration to publish together, whatever was done together. Plans for such publications should actually be discussed. It is not good to publish without first presenting the material at a departmental and a faculty seminar. This is because the contributions of colleagues in the form of comments, questions and criticisms can lead the wise authors to improve on the quality of the write-up for publication.

Finally, it should be remembered that VetAcademic Resource Foundation (VARF) is concerned with the promotion of veterinary research and human resource development for social responsibility and positive socio-economic jurisprudence. Its publications in the Maiden edition of its Quarterly Bulletin of March 1997[6,53] will always be of value in matters of resource management approaches, even in Epizootiology.

Chapter 4

EPIZOOTIOLOGICAL APPROACHES

4.1 General Introduction:

4.1(a) Merits of Epizootiological Approaches

MERITS OF EPIZOOTIOLOGICAL APPROACHES

It is important to note the following basic merits of epizootiological approach to the study and cost-effective resolution of herd/population problems.

1. **The approach is comprehensive**, providing holistic and scientifically sound basis for working towards the cost-effective achievement of total well-being in three dimensions *as defined*[6.52, 6.53]

2. **It is based on systems construct**, and takes care of all relevant systems and subsystems, qualitative and quantitative nature of relevant factors, forces, relationships, interrelationships and interactions, providing pigeonholes (or slots) for all real and potential implications in perspective, in real time and space distribution changes. **For example**, in a congress expositional paper presentation on the *Epizootiology of Bovine Trypanosomosis in Nigeria* in 1973[6.61], the body of the exposition included systematic treatment of the following issues, namely: -

(a) *'Human herds and/or animal populations'* usually affected by the disease in general and in particular cases, places and circumstances:

(b) A simplified, summarized and logical function definition of the problem and a summary assessment of the actual and foreseeable status of the problem over time:

(c) The host, parasite, vector, environmental (*geographical and ecological / ecosystematic*), economic (including bionomic), actual financial and *social health* (human factor) variables, through and over present, short time, long time, foreseeable (visualizable / envisionable) changes distribution over space and time and likelihood of effective control of any or all of the various determinant factors (in reality the entomological (vector), protozoological (parasite)) and vertebrate host aspects in relation to each other, one another and to the environment (the geography, ecology, ecosystems), as well as the immunobiological (susceptibility and resistance), all presented in perspective. In facts and figures, the actual financial prospects, the more embracing *socio-economic* implications and the scope of the problem were presented. Putting all the above in major systems perspectives, **the disease** was described as **a major biological problem** that had evolved over centuries and would therefore need well-coordinated epizootiological systems approach in order to make reasonable impact in minimum time and at minimum *expense* (in social, economic (including bioeconomic), financial and political terms.

3. **Expositions resulting from epizootiological approaches are usually of durable relevance, value and validity.**
For example, the work just cited, though it was presented in St. Louis Missouri in 1973, is still patently valid, valuable and relevant, thirty-three years later. The predictions remain fulfilled. The summary and conclusion made then are still tenable in spite of billions of Dollars, Pound sterling, Naira and other currencies spent in many research institutes worldwide. The scenes stated in the exposition remain a stark reality, simply because the stated well-coordinated epizootiological systems approach was never adopted.

4.1(b) Body of the General Introduction:

A scientific approach to the study of problems in animal groups or populations and their environment may be considered from the points of view of the various disciplines that may contribute to and benefit from the philosophy and techniques of epizootiology. As a result, there could well be a good number of approaches to the study. For example, there could be Agricultural, Biological, Environmental, Biomedical, Sociological, Socio-economics, Political, Cultural, Mathematical, Geographical, Ecological, Geological, Archaeological, and even Philosophical (in contra-distinction from practical/utility and pragmatic) approaches. In actual fact, the areas that have so far received significant attention in literature are branches and combinations of some of the disciplines and interests just listed.

The ecological approach (Pavlovsky, 1939[6.91] and others) may be considered a branch of the Biological approach (Ecology is a branch of Biology[6.68]. On the other hand Ecological Epizootiology has come to be accepted as synonymous with Landscape and Geographical Epizootiology, with significant contributions from matters and studies of the environment or "Environmental Epizootiology". By many, Mathematical Epizootiology is considered to be largely the same as Statistical Epizootiology (Statistics in turn being regarded as a utility branch of Mathematics). More correctly perhaps, all the "counting and accounting" and the associated computations, involving methods of Algebra, Calculus and the simple basic arithmetic processes (addition, subtraction, division, multiplication, exponential and factorial calculations) as applied to Epizootiology can well come under the discipline of Biostatistical Epizootiology. All these could not be the only possible combinations; the list may conceivably be quite extensive, especially in the context of '*non scholae, sed vitae discimus*', thus covering most aspects of human life.

For students, readers and teachers of Biology, Agriculture, Animal Science, the Health Sciences and the allied disciplines and professions, the combinations that would first come readily to mind would include the **Biomedical**, the **Ecological**, the **Biostatistical** and the **Socio-Economic** approaches. From these, the authors have decided to consider at some length the areas of knowledge that can be effectively pursued under the titles (i) Biomedical/Medical detection[6.30] approaches; (ii) Ecological approaches; (iii) Mathematical approaches; and (iv) Socio-economic[6.1] and Socio-cultural approaches.

4.2 Biomedical (Medical detection) Approach

Here we are dealing with objective signs and subjective symptoms of physical and/or functional abnormality. This approach is based on the nature of observable and detectable abnormal changes in the forms, functions and the life-cycles and habitat (biology) of the animals and the clinical manifestations (or indicators) or the medical/disease implications of the interactions between the animals and their parasites, with the obvious implications of the relationships between both and their external environment. Medical detection approach to the study of problems in herds of animals must of essence be based on the knowledge of the lives of those animals and at least some clear awareness of the pathological and clinical changes and manifestations that constitute the indicators of such problems.

Biologists (including Agricultural Biologists), Pathologists, other Biomedical and Animal Scientists (including Zoologists) have roles to play and some knowledge to share in the field of medical detection approach to Epizootiology. And depending on the goal of the principal actor and the home-base system, any of these disciplines may provide leadership or rallying point for the relevant approach to such studies. Agricultural Biologists for example have been known to shoulder effective leadership in *landscape Epi'scientology*.

When diseases and other health problems in the group of animals or human population are the main concern and mandate of the system (e.g. Animal (Veterinary) and Human (Public Health) systems, leadership is often best provided by the Biomedical professionals, with the necessary support from and collaboration with other professionals and scientists. When Agricultural Biology is the main thrust of the home-base system, the Agricultural Biologist will best provide leadership. When Economic Livestock production is the main interest of the system, Economists, Animal Husbandry/Animal Science specialists or Veterinarians are the likely groups from which the leadership of such system may be chosen. A team leader in each of these cases means a *bridge-builder* who, knowing and being capable enough in his own chosen discipline, is also able and willing to show practical appreciation, not only of the relevance and substance but also the importance of the other disciplines and their participation. He is capable of bringing them to work together as members of a system whose total effort can produce the successes, which the particular system has as its objectives.

Maintenance of animal health, human / public health, environmental sanitation, economic livestock production and the preservation of threatened species, are some of the distinct goals towards which teams of

Epizootiologists may cooperate to achieve success for the system. Such Epizootiologists will always have valuable roles to play in research, services and administration related to such systems.

In this respect, the leaders in biomedical detection approaches in the Epizootiology of animal diseases are Veterinarians, and for human diseases they are human Doctors or simply physicians. Recent parallel developments in Agricultural Biology have led to the specialization in Plant Pathology and in the opening of Plant clinics. Those knowledgeable in ecological community systems will at once be aware of the relevance of those specialist areas to the welfare of human and lower vertebrate animal populations, and of the importance of the work of Plant Doctors who must be knowledgeable, not only in *Epiphytology*, but also in Epizootiology. The reasons and relationships should be obvious. Animals and plants are connected by the universal environment, food and energy chains, and by extension, in the chain of the usual problems (including diseases). This is a major awareness readily appreciated through the studies of ecological communities, the interdependence and related advantages and disadvantages.

Problems are never really solved in strictly compartmentalized (parochial and blinker-applying) systems. The common baseline and relevance of the basic philosophies and techniques will be readily shared if all imbibe of the science and culture of Epizootiology, even as these relate to Medical Detection Approach.

Medical detection approach is concerned with the detection of signs, symptoms and other indicators of diseases and related health, survival and production problems. Veterinarians seek to detect such signs in their patients. Human Doctors have the advantages and disadvantages of having to deal with both signs and symptoms; the distinctions are dealt with under Diagnostic procedures *quod vide* (q.v.) in section 4.2a below.

4.2 (a) Indicators of diseases and other problems

In this sub-section, we shall consider the **detection** and **consideration** of **indicators** and other pieces of evidence of the presence **of diseases and other problems** in animal herds and human populations. Now, objective signs and subjective symptoms of physical and/or functional deviations from normality are the usual indicators of diseases and related problems in animals and men. Such aberrations are usually described in terms of *morbidity* and quantified in terms of *incidence* and *prevalence* and the related *rates* and *ratios*. And when the problems result in the death of some or many of the affected animals the outcome is quantified in terms of *mortality rate*, which is indication of the proportion of animals that have died in the group. Measurements of mortality rates and ratios and of *case fatality rates* are important in the determination of the amount and value of losses due to the disease or other problems under observation.

4.2 (b) Morbidity and mortality measurements

Morbidity is the number of animals that are detectably or observably ill. Morbidity rate is a comparison of the number that is ill with the total number exposed or at risk over a given period of time. A better term for morbidity is *incidence*. And incidence rate is the number of cases compared with the total number in the same group, herd or population at risk during a given period of time. Mathematically: (i.e. in terms of equations)

$$\text{Incidence Rate (IR)} = \frac{\text{Number of occurrences}}{\text{Total number in the group or population At risk/exposed during the given period}}$$

$$\text{Monthly IR} = \frac{\text{Number of cases that commenced during a month}}{\text{Total number of animals in the group or population at risk}}$$

Whereas

$$\text{Incidence Ratio (Ir)} = \frac{\text{The number of cases that are ill}}{\text{The number of animals that remain normal in the same herd/flock/population at risk during the given period}}$$

For example: -

If in a herd of 100 cattle 10 individuals are found to be showing the signs of Foot-and-Mouth Disease (FMD) during the month of January, for that month

(i) The Incidence Rate (IR) = 10/100 = 10%

Whereas
(ii) The incidence ratio (ir) = 10/90 = 11.11%

If during the month of February 35 more cases develop, then
The February IR = 35/90 = 38.89%

Whereas
(iii) The February ir = 35/55 = 63.64%

Now, if on a day in March, all animals showing various stages of the lesions of FMD or anti-body titres compatible with positive infection are counted and found to be 69 in the same herd, with no mortalities so far, then

(iv) The Prevalence Rate (PR) will be 69/100 = 69%

If however there have been 9 deaths made up mostly of young calves succumbing to the disease, then
(v) The Mortality rate
i.e. Number of deaths / Number of animals at risk/exposed (being the total number in the population) = 9/100 = 9%

However
(vi) The Case Fatality Rate (CFR)
i.e. number of deaths / Number of diseased animals = 9/69 = 13%

The distinction between Mortality Rate and Case Fatality Rate (CFR) should be carefully noted.

Incidence rate has been defined as a measure of the rate at which new events occur in the given population. It could also be defined as the number of occurrences commencing during the stated period of time, e.g. Monthly incidence is the number of cases commencing during the month in question; hence some authors use the term "the number of new cases".

Whereas prevalence may include previous cases that had occurred one or several months back, but which are still detectable by the usual methods of identifying affected animals. Prevalence is usually further categorized into point prevalence and period prevalence. *Period prevalence* usually refers to the number of cases known to have occurred during a given period of time. Whereas *point prevalence* is the number of cases known to have occurred at any point in time when the number was counted. When the terms rate and ratio are used, the mathematical presentation must include both the numerator and the denominator, as earlier exemplified in the cases of mortality rates and ratios.

The relationship between incidence and prevalence is represented mathematically by the formula

P I x D where P = prevalence
I = incidence and
D = duration

Table 4.1: HOW INCIDENCE AND PREVALENCE ARE RELATED

Definitions of **INCIDENCE**	Definitions of **PREVALENCE**	Author & Date
"The incidence of a disease is the number of cases of the disease which come into being during a specified period of time."	(i) "*Point Prevalence* is the frequency of the disease at a designated point in time (e.g. at the beginning of a period) "for a specified population at a specified time; point prevalence rate is the proportion of that population which exhibits the disease at that particular time all cases of the disease then, irrespective of when the signs or symptoms started the numerator.	MacMahon and Pugh (1970)[6.21]
The incidence rate is the number of cases per specified unit of population".		Halpin, B. (1975)[6.28]
"incidence is the frequency of events during a stated period of time". "It is often difficult to measure incidence directly since the exact time of onset of illness is often uncertain. Therefore occurrences used instead are: (i) onset of symptoms and signs; (ii) time of diagnosis; (iii) date of notification	The denominator is the total population at risk (affected and unaffected)".	
Attack Rates are special forms of incidence rates expressing total incidence of a disease for which the population is at risk only for a limited period of time, e.g. (i) neonatal diarrhoea of piglets; (ii) in an outbreak of foot and mouth disease which comes periodically and is limited in period (epidemic)	(ii) "*Period Prevalence* is a measure of the total number of case of a disease known to have existed at some time during a specified period". It is the sum of point prevalence and incidence. i.e. number of cases existing at the beginning of the period (period precedent) plus number of cases coming into existence during the period incidence.	

The attack rate is stated as a percentage without time, e.g. 25/50 = 50% attack rate. A secondary attack rate is based on known incubation period of a disease, since the primary case should have ended before the second attack occurred. "the incidence of a disease is the number of new cases happening within a specified period". 'incidence is the number of occurrences commencing during a given time in a specified population.	Prevalence is the number of cases prevailing at a point in time in a given population. Prevalence is 'the number of cases prevailing at a certain time'. "Point Prevalence" is the total number of cases existing at that point in time, whether new, old, or almost recovered"	

NB: TIME FACTOR relates to:

(i) Point in time at which observations are made (prevalence).

(ii) Period during which events are counted (incidence).

Hence the derivation of the formula

P I x D where P = prevalence
I = incidence and
D = duration

4.2 (c) Scope of medical detection

Medical detection includes the various methods available to the biomedical sciences and professions for the detection, definition, and quantification of the various forms of disease, ill health and other problems. It includes the clinical, microbiological, parasitological, biochemical, pathological, immunological and even surgical components. Indeed all the methods of diagnosis available to the biomedical disciplines are included. And that is why we have such terms as 'Clinical pathology', 'Clinical immunology', 'Clinical parasitology', 'Clinical microbiology' and 'Clinical epizootiology'. Therefore, further details will be resumed in Section 5.4 of this book, which deals with *Epizootiological diagnosis*. In the meantime, we shall now consider Ecological approaches or simply *Ecological Epizootiology*.

4.3 Ecological Approach / Ecological Epizootiology

4.3(a) Introduction:

Ecological approach to Epizootiology is the most comprehensive, most involved, most natural and most productive of holistic results of the four approaches discussed in this book. **It is a biological approach**, as ecology itself is a branch of Biology. As earlier defined, *Ecology* is the study of natural, physical and functional relationships ... between many groups of living organisms and their dynamic (though in places fairly uniform) environment (in cases of established ecosystems). Ecology can in fact also be defined as the study of *ecosystems*. And an ecosystem is a specific type of biological relationship between various species of plants, animals and other organisms. Among the animals it includes pray and predator relationships. Among others it includes producers and consumers, as well as saprobes and their common external environment, the dynamics of which eventually determine the nature, content, physical and functional structure of the system. **An ecosystem is a community system and its environment;** it is an example of a *diffuse* system[6.1]. And it is usually named according to its characteristics and the *nature* of its environmental components.

4.3 (b) Types of Ecosystem

Ecosystems can be classified in many ways. One of the ways is according to the nature of the environmental component. These are the various types of *terrestrial*, *aquatic / hydrologic* and *atmospheric* ecosystems, where the geosphere, the hydrosphere and the atmosphere respectively form major parts of the *biosphere* in which each system is based. These types can be further sub-divided, as for example in an aquatic ecosystem, the water medium may be fresh, saline or brackish. Again, the components and nature of an ecosystem on an oceanic bed, a few miles down, will be significantly different from those in the surface water. In summary, the world major ecosystems have been classified[6.92] as follows: -

World major ecosystems[6.92] are listed as

1. Boreal Forests
2. Desert Ecosystems
3. Freshwater Ecosystems
4. Marine Ecosystems
5. Grassland Ecosystems
6. Savannahs
7. Scrublands
8. Temperate forests
9. Tropical forests
10. Mountains
11. Polar lands

It should be noted that interface areas between adjacent types of ecosystems also exist. This is a point at which diligent students would go into the heuristic learning exercise on the physical and functional biological *nature* of the various types of ecosystem listed as 1 11 above, as well as some visualization of intermediate areas ad their contents in terms of prey and predators, consumer and producer, herbivores, carnivores and omnivores peculiar to each type of established ecosystem and mode of recycling. The tutors should lead and advise the learner on such effort.

Factors that determine and sustain the various ecosystems are those that affect the patterns of life of the various plants, animals and other organisms at various *trophic* levels, all of which constitute the *biotic* content. The *abiotic* content includes the edaphic, hydrologic / aquatic and the meteorologic / atmospheric / climatic factors. Thirdly, there are the complex webs of relationships, interactions and interdependence affecting the food/nutrient chains, energy flows, temperature range and continuing process of evolution and balance or imbalance that naturally lead to the survival, prosperity or disappearance of *species* over time and space. In many cases the interference of man constitutes major factors on the fate of many *species*.

Ecological Epizootiology: Gist Presentation I

The various environmental conditions that naturally determine the distribution of animals (hosts, parasites, vectors, carriers, reservoirs...) and their problems (including diseases) and their distribution over space and time can be found in the scientific study of the geography and the various types of ecosystem in every part of the world and in diverse climatic and meteorological conditions. This is a fundamental summary statement that can lead to reliable functional logic paths for cognitive and heuristic learning, resulting in holistic understanding of ecological approach to Epizootiology. Therefore, before reading any further, the wise learner would stop at this point now and meditate on the relevant meaning of every unit of expression and the weight and value in gold of every word in that small paragraph. Learning merely by rote at this point can be quite ineffective, seriously counter-productive and unnecessarily time wasting. For, of all the natural resources the good Lord gave graciously and freely to man, the most abused is time, often with dire and irreversible consequences, when all is already too late. So, let the reader, honestly (to himself) meditate now; to meditate is to think deeply and quietly on a specific issue/s.

Now, a brief reference to the glossary (*ibid.*), and a careful study of the figures that follow below should prepare a diligent reader's fertile mind for effective understanding and appreciation of the relevance and value of the knowledge base in the text of the paragraphs that follow hereafter. Wishing you, diligent scientific meditation and delightful results from a smooth and pleasant run through of the exposition that now follows.

Again, it should be noted that the **figures which illustrate the geography**, the **ecosystem types** and **their distribution** in Nigeria (as for any other country or region) should provide materials for heuristic learning and cognitive understanding during well-planned epizootiological tours of the various parts of the country. And this approach should be found quite applicable to similar studies in any other country in which the learner may be interested. To further aid such learning and equip the learner in a smooth transition to the level of 'Advanced (Systematic) Epizootiology', the adoption of the following wisdom nuggets, already mentioned and described elsewhere in this book; see index and glossary sections) is highly recommended. They include the following tools of thought and introductory approaches to *sound scientific logic paths* (sslp) to the necessary wisdom in the subject/s at hand. They are:

(i) OPST approach:

(ii) Natural BIOS:

(iii) 'Mental exercises in the identification of relevant issues, relationships, points of integration and coordination for achieving system success'[6.44].

(iv) Pie chart of human wisdom (that goes beyond merely acquiring knowledge).

Ecological Epizootiology: Gist Presentation II

As epizootiology is presented here in such a holistic manner as to provide the soundest basis for preventive measures (pm) in the widest sense, no one haven diligently and intelligently gone through the text and illustrations here provided will ever remain the same or unconvinced that being an epizootiologist should be an essential achievement in worthy living. He would have learned to join the happy group, who very early on in their career have clinched to the belief in adopting the wisdom in the saying,

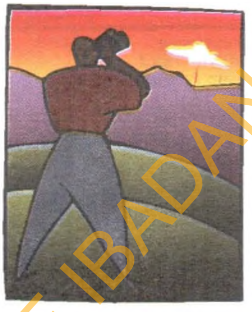
'Non scholae, sed vitae discimus' (*ibid.*).

This is because wisdom in Epizootiology as presented in this book should provide the soundest basis

(i) For the study and practices of '*preventive veterinary medicine*' (pvm):
(ii) For the appreciation, study and application of the concept and practices of 'veterinary *public health*' (vph):
(iii) For the articulation and practices of '*prevention and control measures*' (pcm) on many problems of natural living, survival and optimal prosperity earned by the grace of God and not through *nsej* measures.

NB: If and when in doubt about the import or meaning of any of the above, give us a shout and the authors will scientifically reason with you in *psej* mode.

And, as the spirit says:
Figure 4.1: Work! Watch!! and Pray!!!
Always seeking to be right and righteous and to remain so.

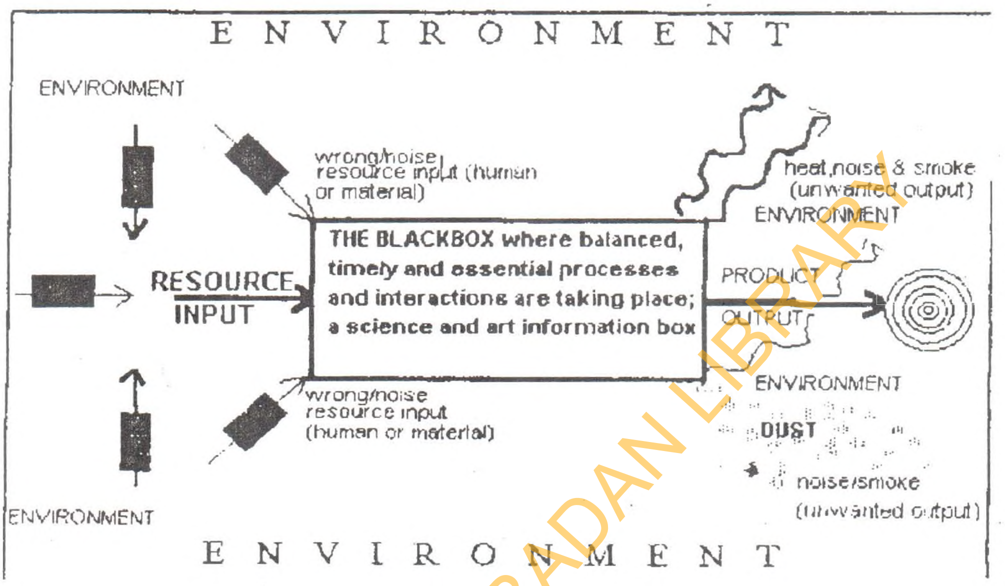

There is no law in any of the Holy books, nor from the writings of the holy prophets that goes against those simple injunctions, which are part of the wisdom nuggets for epizootiologists *sensu stricto*. Nor would a wise man ever ignore the spiritual dimensions of his being in serious matters as scientific learning and thinking. Being an epizootiologist is seeking to be a complete being in body, soul and spirit, neglecting nothing in the system.

The Nigeria Environment

Much of the teaching, learning, working, watching and praying on which the text and illustrations in this book are based could be found in other places than in Nigeria. But since it is often said that 'Charity begins at home', some aspects of the Nigeria scene relevant to the teachings of epizootiology will now be presented mostly in annotated graphics. But first we must remember, not only the '*pie chart of human wisdom*' (ibid.), but also the wisdom one could acquire from natural input/output relationships mediated in the *black box* (the usual custodian of most reliable information in and about a system). To illustrate this, we here present the Natural BIOS meaning '*Natural Basic Input and Output System*'[6.1], and which is universally applicable to the construct and study of most systems in nature.

Figure 4.2: The Natural BIOS :(Basic Input/Output System) in Principle

The lessons of the black box in a system:

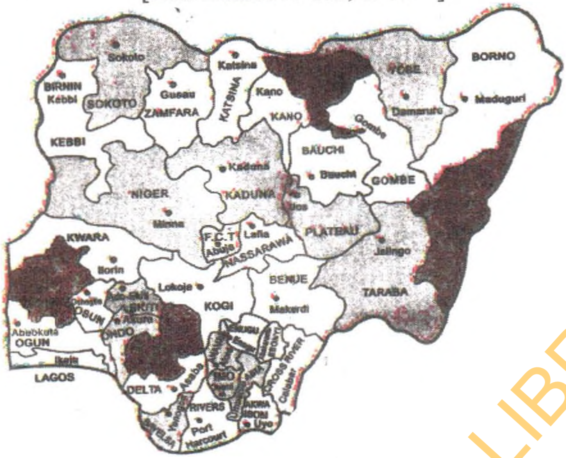


For the wise and diligent, there are lots of useful lessons to be learned from the nature of this illustration. Such lessons have earlier been listed in the original documen[6.1] ['*He knows enough, who knows how to learn*!' (S.i.t.m.1955)]

Geography of the Country

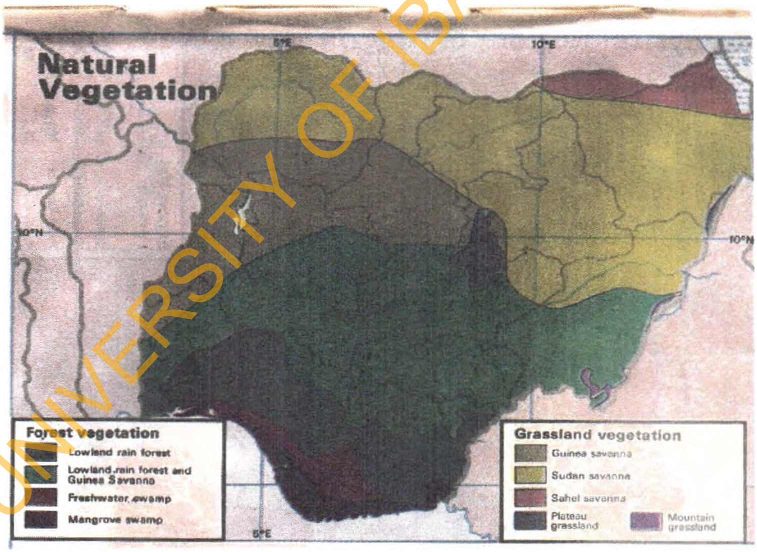
Without a thorough knowledge and comprehensive coverage of the various aspects of the geography of the area, ecological epizootiology may be difficult to appreciate. Therefore, we present maps of the country showing the physical, topographical, vegetation and other aspects of the country of our immediate concern. The grid references should be noted. The grid lines of latitudes and longitudes should be noted, as they are important in the exact location of specific places on the ground. In this context, one should learn to overlap the vegetation, physical and other maps with the political map in order to make sense of the relationship in human geography and political administration.

Figure 4.3: Political map of Nigeria showing the various states and their capitals
[Ref. Eunice J. Gill, 1979[6.93]]



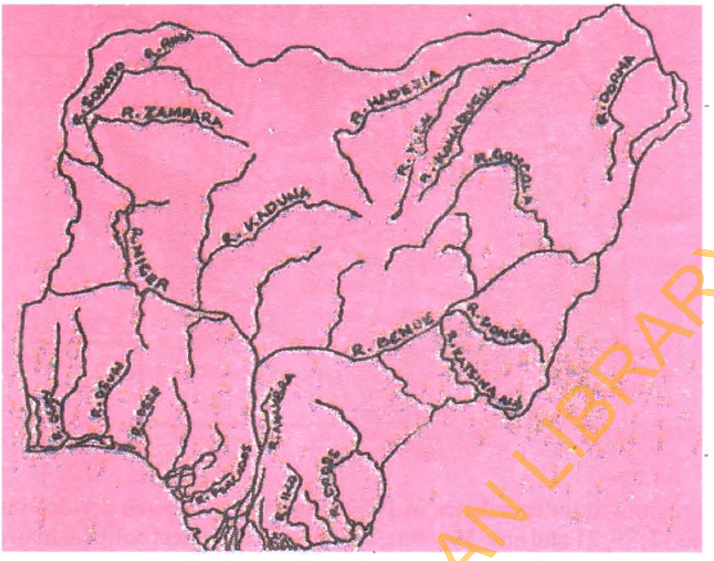
From three regions at independence in 1960, Nigeria has become divided into four regions, and later into 12, 19, 21 and now 36 states, as shown in this latest political map of the country.

Figure 4.4: Natural vegetation of Nigeria: Forest and grassland vegetation



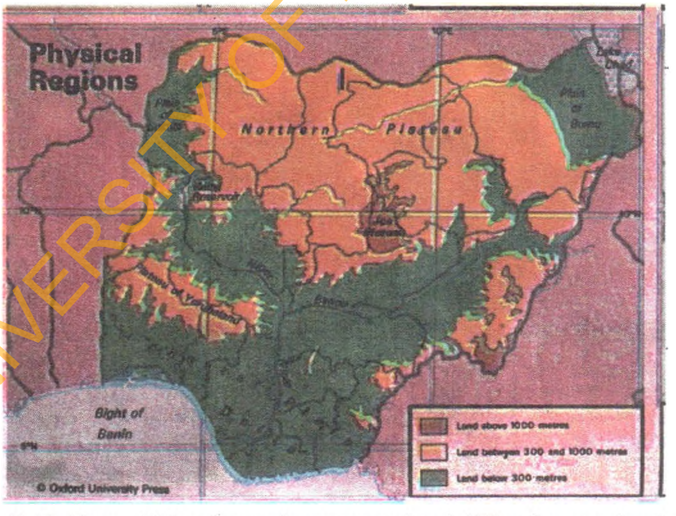
From the points of view of the ecosystem and natural resources for livestock production, all aspects of the natural vegetation of the country are important. Both the forest vegetation and the grassland vegetation are relevant. Details are discussed in the text of this book.

Figure 4.5: Rivers of Nigeria



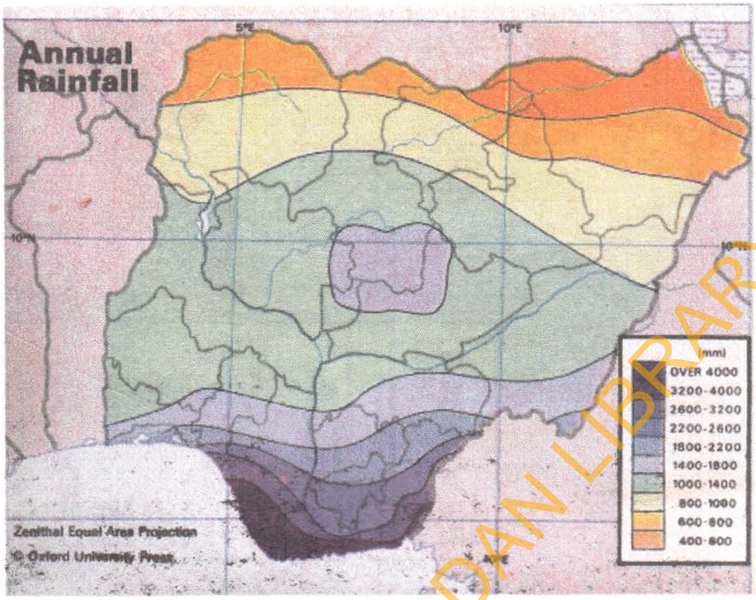
Many of the rivers in the country are tributaries of the two major ones, which are Rivers Niger and Benue. Their ecological significance are discussed in the text of this chapter

Figure 4.6: Physical Regions of Nigeria



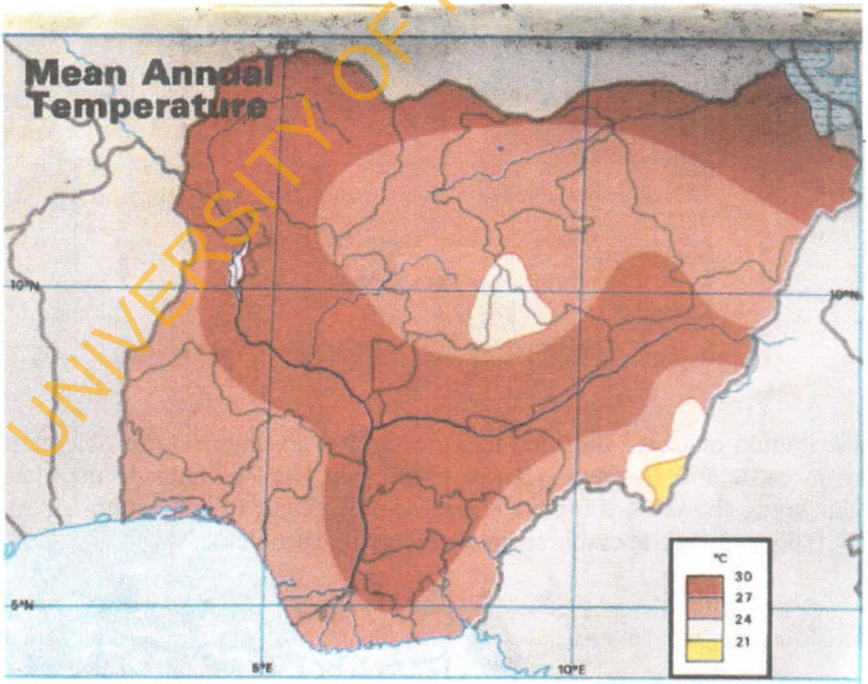
Physical regions divided into: - (a) Land areas that are more than 1,000m above sea level: (b) Land areas that are between 300 and 1000m above sea level: and (c) Land areas that are below 300m above sea level. The highest altitude in Nigeria is on the Jos plateau; it is the peak of *Shere Hill*, which is 1,781m (5,843 feet) above sea level and is not far from Kuru. The importance of altitude in types of conditions suffered by animals should always be considered.

Figure 4.7: Showing annual rainfall distribution in Nigeria



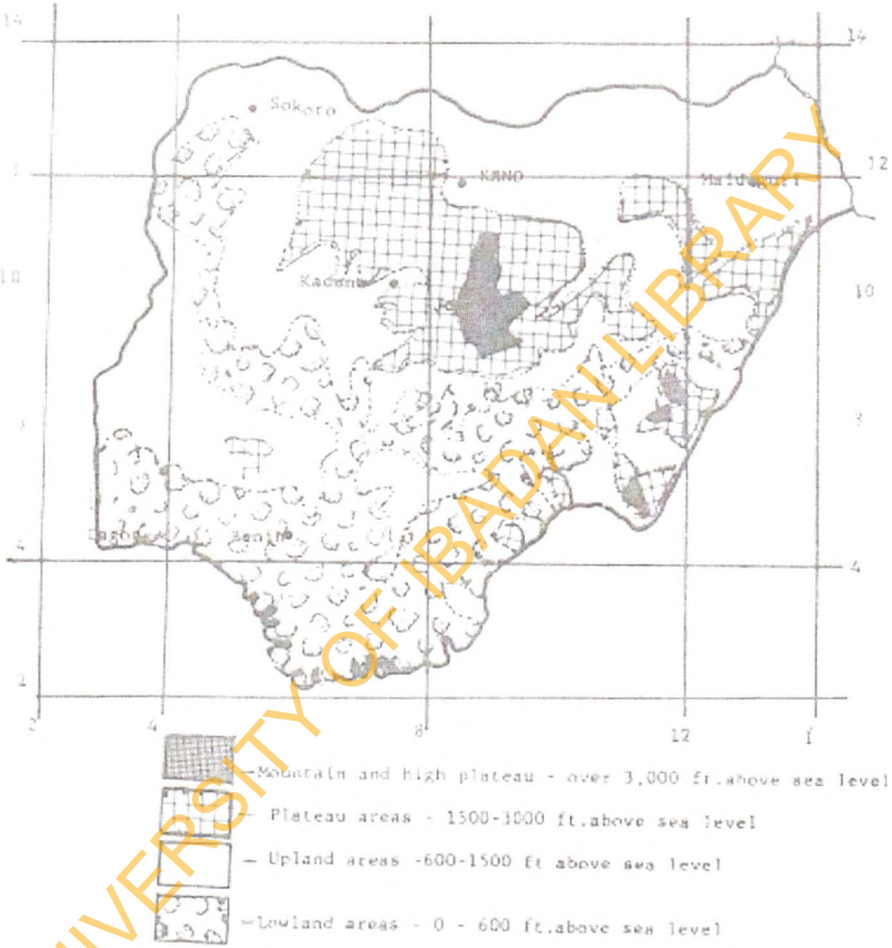
Rainfall in the country varies from 400 to over 4,000mm per annum

Figure 4.8: Mean annual temperature range between 21°C and 30°C



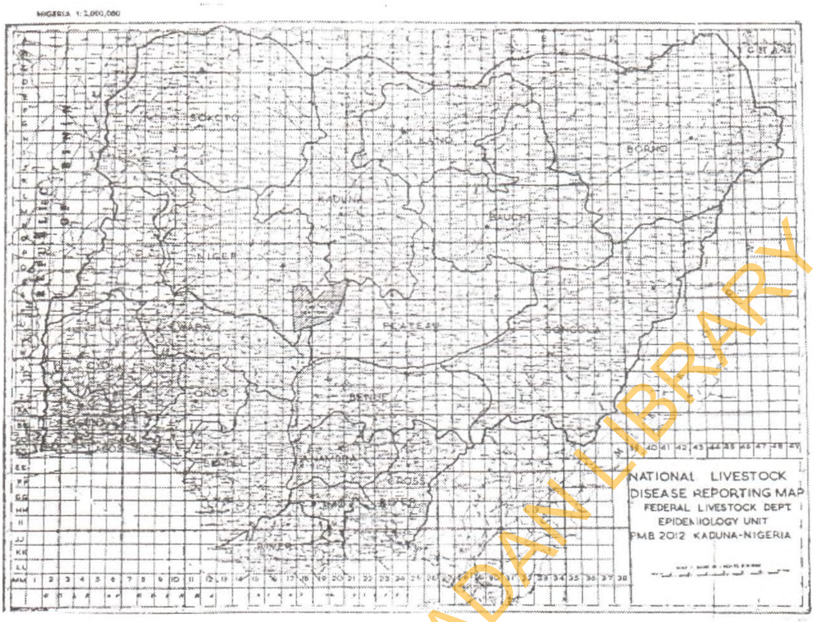
Temperature is a major determinant factor in describing the seasons in Nigeria

Figure 4.9: The physical map of Nigeria showing plateaus and mountain areas which are largely free from tsetse flies



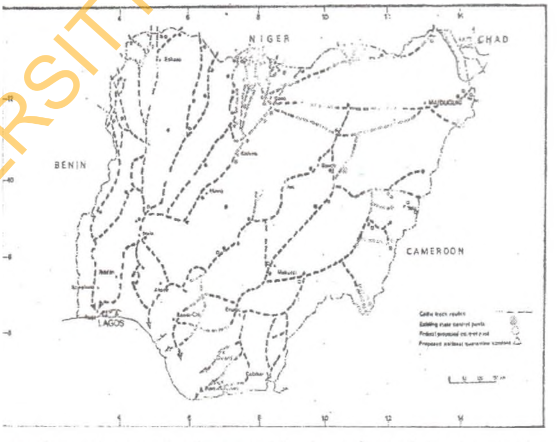
The distribution of tsetse flies and trypanosomosis are important problems (causing *nagana* in cattle and *sleeping sickness* in man) in Nigeria. Outside the plateau and mountain areas, the vectors and the diseases are widespread in most other parts of the country, representing intractable social and economic problems.

Figure 4.10: Epizootiological/Disease Reporting Map of Nigeria:



Provision of alphabetical and numerical landmarks for establishing grid references for various places is a significant feature of the map. It is useful in the description of places and locations of problems in epizootiology, now enhanced by the uses of GIS and GPS technology (*ibid.*).

Figure 4.11: Nigeria's trade cattle trek routes, along which control posts and quarantine stations are established



Plant and fly surveys along the trek routes often enable the epizootiologist to visualize the types of toxic plants and fly challenges to which the trade cattle are being exposed along the routes. *(Source: Epidemiology Unit, Federal Livestock Department (FLD), 1978)*

Figures 4.12 and 4.13: Photographs taken along Okene-Abuja road, Nigeria: Examples of shrubland and anthropurgic ecosystems

Shrubland ecosystem

Anthropurgic ecosystem (Roadside mechanic area)

Various views on a road running from southwest to northern Nigeria: Showing variations in the ecosystems that are issues in the Epizootiology of animal group problems in the country. [*Observation and photograph by Esuruoso, G.O., 1998*]

Figure 4.14: A watering point en route Southwest to Northern Nigeria

A liver fluke area observed and photographed by Esuruoso, G.O., *1998*

4.3 (d) Other methods of classification:

Another way of classifying ecosystems is according to their evolution and development. Hence we have such groups as *Autochthonous ecosystems, Anthropurgic ecosystems, Synanthropic ecosystems, etc.*

4.3 (e) ***Anthropurgic ecosystems***

An Anthropurgic Ecosystem on the other hand, is a man-made system. Cultivated farmlands, village environment, township areas and roadside extensions are some good examples of ecosystems created by man or influenced by various human activities that tend to modify the natural composition of the native land (See Figure 4.13, a roadside mechanic area, and Figures 4.15, 4.16, *Piggery Section of U.I. Teaching and Research Farm)*.

4.3 (f) ***Autochthonous Ecosystem***

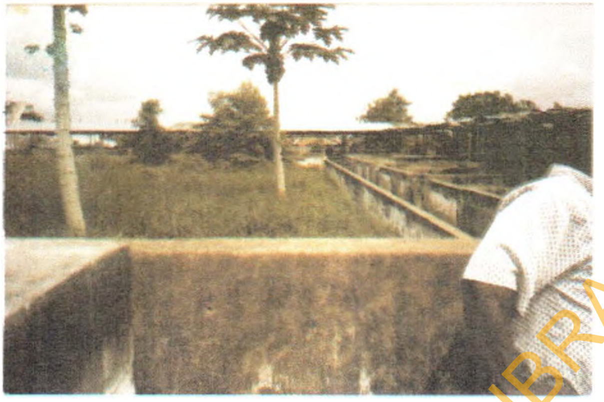
Autochthonous means native or indigenous. Hence an *Autochthonous ecosystem* is the indigenous system as found in nature, haven evolved in the natural processes of chance, selection, survival of the fittest, fitting into the nutrient and energy chains, etc, until the conditions and contents have become stable in type and in proportions of the various species and classes of flora and fauna in a *dynamic equilibrium type of stability*[6.6]. The preys and predators in the system have continued to exist in such numbers as each would continue to survive and be there to fill its *niché*. The vegetational types have evolved in such a way that it would continue to support the herbivores in the system, as otherwise the herbivores would migrate out of the area or suffer extinction, forcing the carnivores also to find their way elsewhere.

Such an ***autochthonous*** ecosystem is *edaphic-based* and *climate-inspired*. For example, the influences of the soil type and those of the seasonal weather (climatic and meteorological) conditions are essential factors that determine the evolution of the tropical rain forest, which is a good example of an Autochthonous Ecosystem. (See Figures 4.12, 4.14, 4.21). ***Any disturbance of the balance in the biotic community*** (*q.v.* below) would also change the type of ecosystem naturally. And when the disturbance of such a native ecosystem is caused by human activities, the result would be an ***anthropurgic ecosystem.***

4.3 (g) ***Synanthropic ecosystems***

A *Synanthropic Ecosystem* is the third in this classification. The factors responsible for the evolution of such a system include both the edaphic and the human elements. The characteristics of the soil type are one thing. The result of deliberate human activities is another. Sewage farms, polluted streams; rivers, ponds, lakes and irrigated agricultural lands and even rubbish heaps as in abattoir premises are examples of *synanthropic* systems. (See Figures 4.64 and 4.65).

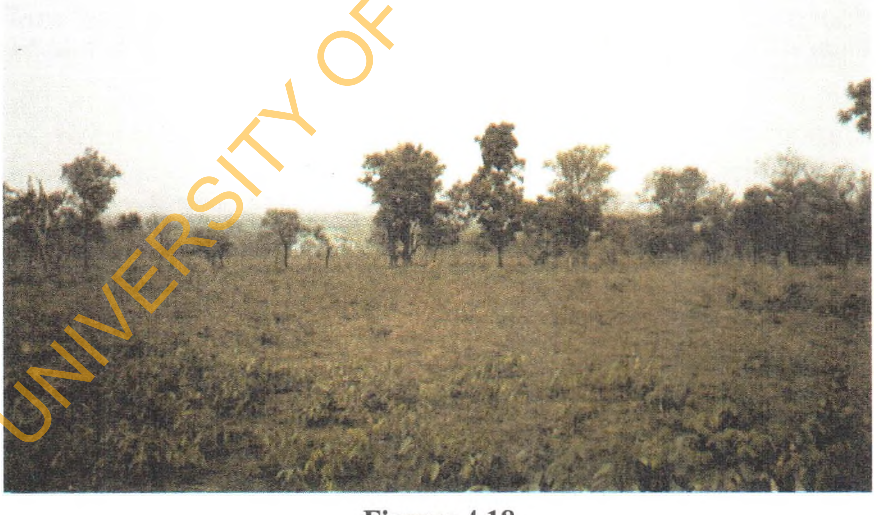
Figures 4.15 and 4.16: Example of *Anthropurgic ecosystems*



Part of University of Ibadan Piggery Section of the Teaching and Research Farm often used for detailed ecological content study and teaching as part of Ecological Epizootiology to students of Veterinary Medicine, U.I. from 1976-1991, and for postgraduate (M.Sc. Epizootiology, M.P.V.M. & M.V.P.H.) students from 1978-1998.The lush giant star grass (Cyanodon species) were planted and nurtured specially for the stock. The pawpaw trees are encouraged as they provide nourishment for both man and pig.
[Photographs taken in 2004 by Olugasa, B.O.]

Figures 4.17 and 4.18: More examples of derived guinea savannah ecosystem along a major south/north road route in Nigeria

Figures 4.17
Observe the early dry season vegetation, especially the drying elephant grass.



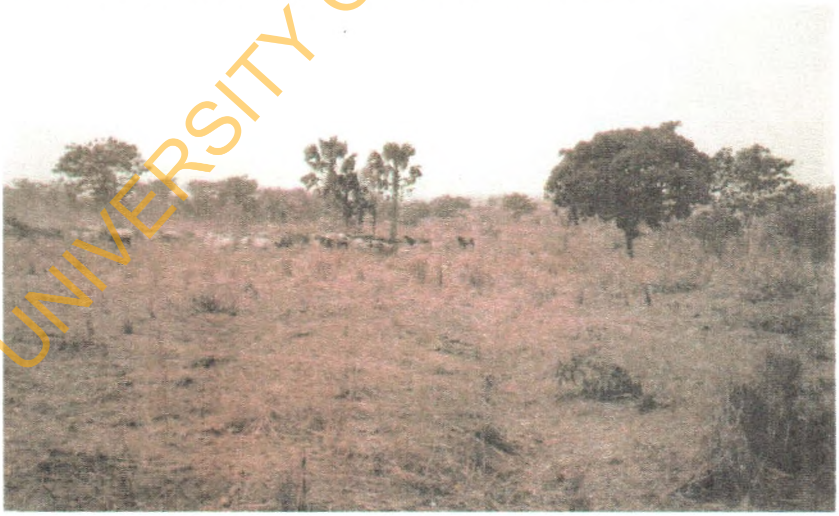
Figures 4.18
Observe the early wet season vegetation, especially the sprouting weeds.
[*Observations and photographs by Esuruoso, G.O., 1998*]

Figures 4.19 & 4.20: More views off the trunk road running from Southwest to Northern Nigeria

Figure 4.19: Dry season vegetation in the Guinea Savannah belt in Nigeria

Observe the unmade road/foot path that serves as part of the trade cattle route earlier shown in Figure 4.11 (ibid).
[*Observations and photograph by Esuruoso, G.O., 1998*]

Figure 4.20: Dry season vegetation in the Guinea Savannah belt in Nigeria:



Observe a cattle herd grazing in the background; this is a common sight during the dry season in the country.
[*Observation and photograph by Esuruoso, G.O., 1998*]

Figure 4.21: Picture of a Rainforest area of South West Nigeria

Taken off a road between Sagamu and Abeokuta. Observe luxurious Oil palm and Banana trees, which are characteristic features of the ecosystem of the rain forest
[*Observation and photograph by Esuruoso, G.O, 1998.*]

NOTES ON NIGERIA FLORA AND FAUNA
(in the various Geographic and Ecosystem Types)

Flora and fauna mean plants and animals of a region, epoch or environment. The flora and fauna are the most prominent groups of organisms in an ecosystem; knowledge of their biology, i. e. forms, functions, habitat, life cycles and the dynamics of the bio-economics of their survival and prosperity are always essential considerations in an epizootiological study. Some of the prominent members of Nigeria's flora and fauna will be mentioned here; their systematics will be reserved for our study in Advanced / Systematic Epizootiology.

The flora can be divided into trees, shrubs, herbs, grasses, other green and flowering plants as well as the non-flowering and chlorophyll-free mostly fungi *species*. A study of the nature of the forests of the world will show that the various forest types have peculiar distributions of the *species* in the various ecosystems. Here we shall only mention some of the prominent *species* in Nigeria, providing materials for heuristic learning by diligent students according to their topical needs and interests, and for detailed treatments in Systematic Epizootiology.

Now, there will always be a number of reasons why an epizootiologist should be familiar with the *species* and families of plants in a study area. These reasons will among others include the fact that, it is among the plants that one would find: -

1. Preferred resting places for disease vectors and reservoirs, e.g. the trunks of the Tamarind and Acacia trees and others in the Sudan savannah region of West Africa, are known to provide preferred resting places for high infection rate tsetse flies such as *Glossina morsitans sub-morsitans*[6.94]:
2. High moisture areas, about river beds being the most suitable habitation for riverine tsetse flies and other haematophagous flies, such as tabanids, stomoxys and culicoides:
3. Dry season browsing materials for cattle such as toxic flowering plants like *Erythrophleum africanum* , Harms (Hausa: Semberu / Samberu) found in Kaiama cattle ranch [6.65] and T*ururubi* (Hausa), which is common along trade cattle routes beyond River Niger bridge on the north-south treck:
4. Some survival browse plants such as *Daniella oliveria (Hausa, Maje)*[6.95] for feeding cattle during dry season.
5. Some medicinal herbs and common vegetables for the various *species* of herbivores and omnivores, including man:
6. Medicinal trees, including *Garcinia kola* (Bitter kola, *Orogbo;* Yoruba) and *Azadirachta indica* (Neem tree) and others.
7. In addition, almost in every epizootiological study, the investigator would seek to know the relevant plants of the ecosystem in the area. For example, in the ecological epizootiology of bovine haemoprotozooan and helminth infections in parts of Nigeria, it was found useful to include tables of flora and fauna e.g. wildlife in parts of Bauchi, Kaduna and Kano, and Plateau states, common weeds in Plateau and Kaduna states and common trees in Plateau and Kaduna states of Nigeria[6.96] (see Appendix IX)

In view of these reasons why an epizootiologist should be familiar with the *species* and families of plants in a study area, some of the prominent and preponderant trees of the savannah lands of Nigeria are listed below:

Baobab[6.97] is an African tree (*Adansonia digitata*) with enormously thick trunk and large fruit with edible pulp

Tamarind: is a tropical tree, the Indian tamarind (*Tamarindus indica*)[6.97] (Hausa, *Tsamiya*) with fruit, whose acid pulp is used in making cooling or medicinal drinks and other uses. Its seeds have a particularly hot, sour taste that evokes a peppery and burning sensation when ingested.

Locust tree: This is the locust bean (*Carob*) tree (False Acacia tree)[6.97] Kowhai. Carob is a horn-shaped edible pod of the Mediterranean evergreen tree *Ceratonia siliqua*.

Acacia is a tree or shrub, of genus *Acacia* some members of which yield gum Arabic False acacia is the locust tree *Robinia pseudo acacia* (often grown for ornament) Doum palm tree (Egyptian palm-tree) is (*Hyphaene thebaica*) with edible fruit.

Toxic plant found in Kaiama cattle ranch[6.65, 6.72] was *Erythrophleum africanum*, Harms (Hausa: Semberu / Samberu)

Wildlife species in Borgu Game Reserve[6.65]**:**
Fauna example of an ecosystem content mentioned for cognition

Elephant	Bushbuck	Oribi	Rodents variety*
Buffalo	Waterbuck	Hippopotamus	Birds variety**
Hartebeest	Red-flanked Duicker	warthog	Hyenas

Details will be presented in the next volume titled *Systematic Epizootiology*
**Booth, A. H., 1977*[6.98] ***Elgood, J. H., 1976*[6.99]

Among the Primates found in Nigeria are Gorillas, Chimpanzees and Monkeys[6.98]

Small mammals such as the Pouched Rat (Giant Rat) *Cricetomys gambianus* (Okete/Ewu) found to be reservoir of *Haemonchus contortus* and *H. place* for cattle, sheep and goats (Esuruoso, G.O., personal observation).

Prominent among the reptiles found in Nigeria are the following

Gabon viper	Puff Adder	Alligator
Python	Green snakes	Crocodile
Cobra	Agama lizard	

Terrestrial domestic vertebrate species found in Nigeria include Horses, Donkeys, Camels, Cattle, Sheep, Goats, Rabbits, and Domestic Fowls consisting of the various nondescript indigenous breeds under range management and imported ones from chosen parent stocks being managed under intensive production systems. Birds like owls, other captive, wild and semi-domesticated birds including Guinea Fowls, Quail and others are all parts of the ecology of the various regions of our country and the other parts of West Africa... These contents of the environment are mentioned for epizootiological cognition here only, while their details will be presented in the next volume titled *Systematic Epizootiology*.

4.3 (h) Biotic Community

It should be obvious that the evolution and constitution of an ecosystem are important determinants of the *biotic community* (*Biocenosis*) in the system. A major biotic community is called a *biome*[6.68, 6.92]. Examples of biomes recognizable in the Nigerian scene are **tropical rainforest** and **Forest swamps**, Guinea and Sudan **Savannah grasslands**, the **arid/semi-desert area** to the north-east of the country, as well as the **Mountain vegetation** in the north east and south east parts of the country next to Nigeria's borders with the Cameroons. Some of the most prominent

Nigeria's Fauna of Epizootiological importance

Table 4.2: SOME WILDLIFE SPECIES IN BORGU GAME RESERVE, NIGER STATE[6.65]

English	Yoruba	Hausa	Zoological name	Remarks
Elephant*	Erin	Giwa	*Loxodonta*	
Buffalo*	Efon	Bauna	*Africana*	
Hartebeest*	Ira Kunugba	Kanki	*Syncerus caffer*	
Bushbuck*	Igala	Mazo/Ganja	*Alcelaphus*	
Reedbuck *	Etu obeje	Kwanta-rafi	*buselaphus*	
Waterbuck *	Otolo	Gwambaza	*Tragelaphus*	
Red-flanked		Makurna	*scriptus*	
*Duicker	Esuro	Batsiya	*Redunca spp.*	
Oribi*	Asiaro/Ogoro		*Kobus spp.*	
		Dorina	*Cephalophus*	
Hippopotamus*	Elede egan		*rufilatus*	
		Mugun Dawa	*Ourebia ourebia*	
			Hippopotamus	
Warthog*	Imado		*amphibious*	Wild pig
		Gamsheka	*Phacochoerus*	Africa's only
			spp.	large python
Python**	Ojola			Spitting cobra
Cobra**	Agbadu			
Gabon viper**	Paramole		*Python sebae*	Described as
			Naja nigricollis	not easily
Puff Adder**	Oka		*Bitis gabonica*	provoked
			Bitis arietans	Some are
Green snakes**			*Dendroaspis viridis*	described as egg-eater

*Ref. Brown, L., 1965 [6.102]
**Ref. Cansdale, G. S. 1981[6.101]

Nigeria's Fauna of epizootiological importance

TABLE 4.3: SOME WILDLIFE SPECIES IN YANKARI GAME RESERVE, BAUCHI STATE NIGERIA

English	Yoruba	Hausa	Zoological name	Remarks
African Elephant	Erin	Gina	*Loxodonta Africana*	
Baboon	Obo	Bika	*Papio anubis*	
Gorilla			*Gorilla gorilla*	
Chimpanzee	Inaki		*Pan troglodytes*	
Giraffe	Agunfon			
Lion	Kiniun		*Pantera leo*	
Hippopotamus	Elede egan		*Hippopotamus amphibius*	
Duiker	Etu		*Cephalophus rufilatus*	
Monkeys*	Obo		*Cercopithecus aethiops*	

*Ref. Booth, A. H., 1977[6,98]

Table 4.4: Nigeria's Flora of Epizootiological relevance: A List of Some Poisonous Plants in Nigeria

English	Yoruba	Hausa	Botanical/Family	Remarks
		Tururibi /Dandana***	*Lasiosiphon kraussianus**	
		Samberu*	*Erythrophleum Africana**	
	Erun*	Gwaska*	*Erythrophleum guineense**	
			*Dichapetalum barteri**	
Crotalaria	Ayanamoigbo†	Chika saura*	*Crotalatia retusa intermedia** *Gloriosa species eg superba**	
Cassava*	Ege†, Paki†, Gbaguda		*Manihot Esculenta**	
	Adapopo†, Omoso†, Otuke†		*Clematis hirsuta**	
	Eti†, Odundun†		*Kalanchoe lanceolate**	
			*Morea zambesica**	
			*Nerium oleander**	

English	Yoruba	Hausa	Botanical/Family	Remarks
	Isu Omode† (Orin Ekiti), Kakansela† (Oyo)		*Paullinia pinnate**	
	Esinsin uroro† (Ise Ekiti)		*Urginea Nigritania**	
Cassia			*Cassia siamea*	
Sapele Mahogany			*Entandrophragma cylindricum***	

*Nwude, 1981[6.72] **Gledhill, 1981[6.97] ***Nwude, N. and Ibrahim, M. A., 1980[6.103]
†Gbile, Z. O., 19846.104
N.B. This brief list is given for cognition, as the systematics will be presented in another volume, to the extent to which they are of relevance to the title '*Systematic Epizootiology*'.

Epizootiological relevance and importance of savannah grasslands (and the various species of grasses (Family *Gramineae*[6.105])

The grasslands provide natural home for the most important species of both domestic and wild herbivores, their diseases and other problems. They are part of the ecosystem and therefore adequate knowledge of their forms, functions, life cycles and distribution over space and time is important in all considerations of ecological epizootiology.

Nigeria's tropical grassland (the savannah)

Nigeria's tropical grassland (the savannah) can be divided into three zones, namely (i) Derived Guinea Savannah, (ii) Guinea Savannah and (iii) Sudan Savannah. These three zones are further divided for animal husbandry potential purposes into four belts[(6.106] as shown in the following table.

Table 4.5: Some prominent grasses* of the various grass belts and grazing areas in Nigeria (Grasses and Legumes for Pastures and Fodder)

Pennisetum Belt	*Hyparrhenia* type	*Andropogon Type*	*Cenchrus* belt
Pennisetum purpureum, P. subangustusm Panicum maximum, Andropogon tectorum, Hyparrhenia rufa, H. subplumosa, Rottbellia Exalta, Imperata cylindrica and others	*Hyparrhenia Rufa, H. Subplumosa, H. Chrysargyrea, H. Cayanescens, H. dissoluta,*	*Andropogon gayanus, A. schinensis, A. pseudopricus, A. tectorum,*	*Cenchrus belt which covers parts of the upper Sudan savannah and is characterized by the annual species of Cenchrus such as C. biflorus, C. prieurii along with C. Ciliaris, Chloris gayana, Eragrostis tremula, Ctenium elegans, Aristida longiflora, A. stipoides, Cymbopogon proximus, Sporobolus spicatus and Andropogon gayanus.*

Ref. Philips, T. A., 1977[6.106]

Also of relevance and importance are varieties of grasses (Family *Gramineae*) which include Banana trees, which are examples of tropical and subtropical fruit-trees (*Musa sapientium*), the finger-shaped pulpy fruits of which are eaten when ripe (usually yellow). Related to these are 'Plantain trees' which are Banana tree-looking piants, bearing fruits similar to banana and it is equally a tropical herbaceous species, but are usually much bigger than bananas, and are eaten either fresh but preferably fried (as *Dodo*, Yoruba) or cooked for geriatric reasons.

Grass means plant or herbage (of family *Gramineae* which include cereal plants, reeds and bamboos) the blade/leaves and stalks of most of which are eaten by grazing animals such as cattle, sheep, camels, horses and giraffe etc. Grassland can be grazing land or pasture land if being so used. Bamboos are like tropical giant grasses (of genus *Bambusa*[6.92], family *Gramineae*) with peculiar hollow stems used as sticks and building materials of sorts, while the leaves (especially the shoots) are used as food. Bamboos are prominent components of the tropical rainforests as well as of the Guinea savannah land of Nigeria. They are prominent components of the flora of the various ecosystems in those regions.

Biotope

There are always much smaller areas of characteristic ecosystem. A *biotope* is the smallest area with relatively uniform conditions for supporting life.

Each of the biotic components of an ecosystem usually has a role to play and a fate to share in the affairs of the system; each component has a '*niche*'. And a niche is defined as the functional position of a living unit (a discrete system) in an ecological community. Every member of the community always has something to contribute apart from its mass. 'Every member matters, in addition to having mass and occupying space'[6.55]. The usual natural role is often concerned with their involvement in the recirculation of matter, nutrients in the food and energy chain characteristic of the community in each ecosystem type.

"Matter and energy are neither destroyed nor created; they are in fact being transformed, recirculated, recycled, even if often dissipated in parts. The health of the environment is naturally maintained through healthy recirculation, as opposed to unhealthy dumping leading to pollution; and that should be seen as a fundamental knowledge and lesson for all who are wisely interested in **environmental health studies and promotion**.

*4.3 (i) **History of ecological epizootiology***[6.107]

(i) Introduction

Adherents of various scientific disciplines and professions built up the body of knowledge on this approach. The development and its' eventual acceptance as a worthy cause can be traced back to the detailed work of individuals and their foresight in the careful documentation of their methods and experiences. Such people are far too many to be properly acknowledged in this type of presentation, without the risk of unnecessary distraction through an unduly long digression, which in turn may be counter-productive. Nevertheless, it will be useful to mention at least a few of them across the disciplines and the continents.

(ii) ***Pioneers***

Among the many pioneers and adherents were Frederick Kilborne[6.69] who reported on the complex role of the arthropod vectors that transmitted malaria, Texas fever and Yellow fever. The complex nature of each successful transmission was only made meaningful when studied from the ecological viewpoint. Others[6.69] have mentioned Karl F. Meyer, a Veterinarian in the USA, Robert Daubney in East Africa, Eugene Pavlovsky (a Zoologist) in the USSR, Howard Ricketts, a Physician in the USA, Charles Elton, an Ecologist in England, David Bruce in Malta and Africa, Theobald Smith[6.108] in the USA, Whittaker,[6.68] an Ecologist also in the USA, and many others from a variety of scientific disciplines and professions across the world. Ecological Epizootiology is thus the most patently multidisciplinary approach to the natural study of problems in groups, populations and communities of living organisms as *diffuse systems*[6.1]. The potentials for quantitative approaches, and therefore for the biostatistical aspects are extensive.

To some of the pioneers, *Ecological Epizootiology* is synonymous with *Geographical Epizootiology* and *Landscape Epizootiology*[6.1, 6.107]. As a result of this reality, we shall here make a graphic presentation of the geography of a country (Nigeria) with which the authors are most familiar. The idea is to highlight those aspects of the country's geography that illustrate the various scenes that show the variety of flora and fauna complexes in which the various group problems of animals are likely to be encountered.

Readers should recall that we have always categorized animal group problems as being related to their breed, breeding and genetics, feed, feeding and nutrition, as well as housing, mode of management practices and environmental situations. In other words, we consider the groups, the place or environment and time factors. In this context, we shall now consider and illustrate housing, management and environment issues in epizootiology.

Figure 4.22: Tropical Cattle shed at U.I. Teaching and Research Farm

This is model tropical cattle shed with good and effective air current and adequate space in the teaching and research farm of the University of Ibadan (U.I.). The farm is jointly used by the Faculties of Agriculture and Veterinary Medicine. It also serves as a demonstration farm for farmers around Ibadan. The house is within the fenced premises of the farm. [*Observation and photograph by Esuruoso, G.O., 1984*].

Figure 4.23: Entrance to the fenced premises of a Dairy Herd farm in Oria/Irua, Mid-Western State of Nigeria, 1978

The fencing is effective in separating these imported dairy animals from contact with local flock. That also is an epizootiological issue. [*Observation and photograph by Esuruoso, G.O., 1974* on Study of Brucellosis in the Dairy Herd]

Figure 4.24: Mokwa Cattle Ranch in Northern Nigeria, during a study visit, 1974

In spite of its expanse, even the Mokwa cattle ranch was effectively fenced in. The picture shows a newly acquired herd being moved for observation, inspection and epizootiological sampling for Bovine Brucellosis and Trypanosomosis.
[*Observation and photograph by Esuruoso, G.O., 1974*]

Figure 4.25: N'Dama cattle at Western Livestock Company Farm, Fashola

In a tsetse fly environment, the N'Dama breed of cattle is usually considered the safest choice for beef production in southern Nigeria. And this is an epizootiological issue.
[*Observation and photograph by Esuruoso, G.O., 1981*]

Figures 4.26 and 4.27: N'Dama cattle, grazing in an oil palm plantation of the Nigeria Institute for Oil Palm Research (NIFOR), near Benin City (at long and close range)

(i) Here the cattle are at constant risk of challenge by tsetse flies (Glossina species), especially the bush flies that are cyclical vectors of pathogenic trypanosomes, such as *Trypanosoma vivax*, *T. congolense* and *T. brucei*:
(ii) They are also exposed to Tabanids, Stomoxys, and other haematophagous flies, which are mechanical transmitters of the trypanosomes:
(iii) The N'Dama breed of cattle survives in areas like this because of their natural resistance to the effects of trypanosomal infection. This does not however mean that they do not ever succumb to the infection. Many outbreaks of the disease were recorded in several N'Dama herds, and the mechanism of their superior resistance to the effects were described in both natural and experimental exposures of the N'Dama cattle to tsetse fly challenges in different parts of Nigeria (Esuruoso, G. O. 1984[6.100].
(iii) Therefore, the keeping of this species of Bos indicus in the oil palm plantation has epizootiological implications. It is a matter of their immunobiology[6.100]
[*Observations and photographs are by Esuruoso, G. O.*]

Figure 4.28 and 4.29: A healthy Zebu herd at a Livestock Breeding Centre in Northern Nigeria and a clinically ill Zebu herd in Western Nigeria during a dry season

Well-nourished and given prophylactic treatments routinely

Outbreak of trypanosomosis in Zebu cattle, in Western Nigeria Igbeti Area: Derived savannah zone at the peak of dry season after bush fire [Observation and photograph by Esuruoso, G.O., 1984]

Figures 4.30 and 4.31: Tropical pig house at the Nigeria Institute for Oil Palm Research (NIFOR), Near Benin City.

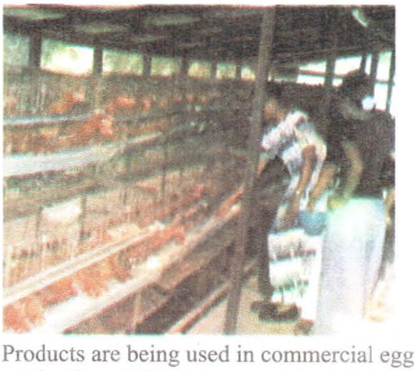
Pig house in the bush — Pig house in a cleared area of the farm
in the Black fly infested oil palm plantation area of NIFOR, Benin, Mid-Western Nigeria.
[*Observation and photograph by Esuruoso, G.O., 1984*]

Figures 4.32 and 4.33: Pig breeding at the University of Ibadan Teaching and Research Farm facility

A breeding boar and a sow, and a nursing sow at the U. I. farm. Each group has its peculiar epizootiological problems

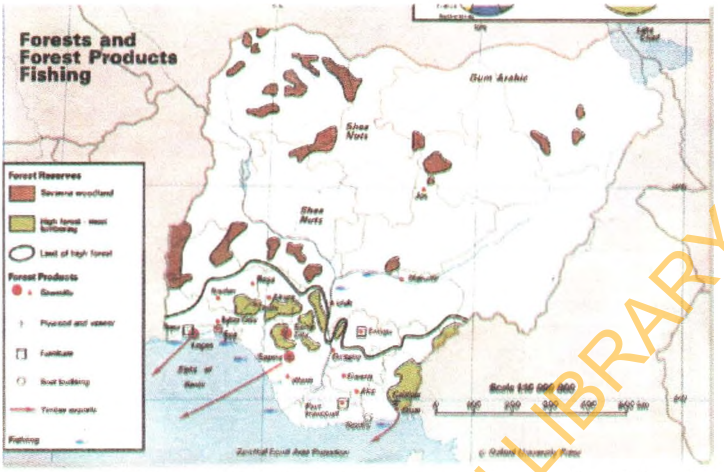
Figures 4.34 and 4.35: Poultry Breeding at Western Nigerian Government Investigation and Poultry improvement Farm at Fashola, near Oyo town and Egg production house at the Teaching and Research Farm, University of Ibadan

White Leghorn Hens with Rhode Island Red Cocks were used for improvement in brown egg production



Products are being used in commercial egg production at U.I.

Figure 4.36: Forest products and major fishing areas in Nigeria

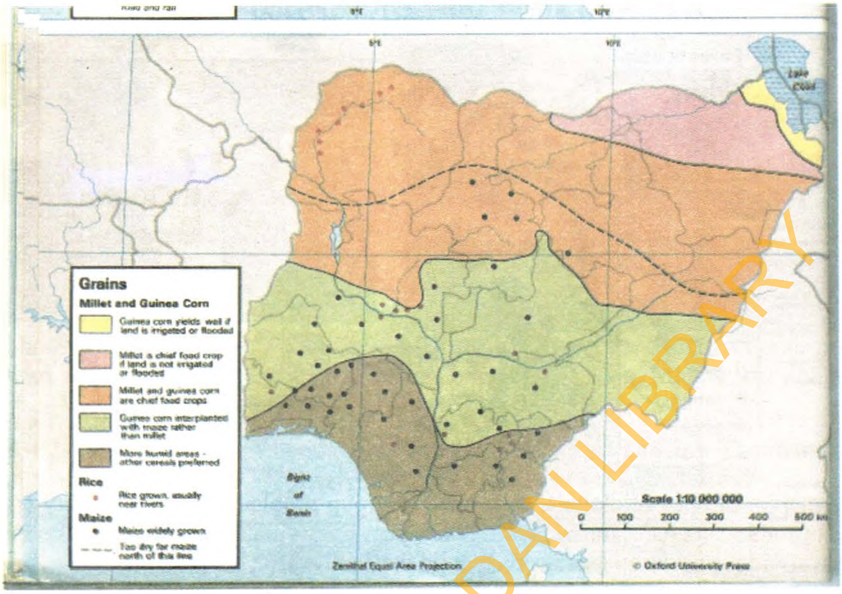


This map is of epizootiological relevance to group problems of each locality (i) The forest products include, lumba and wildlife peculiar to the ecosystem. (ii) The fishing areas provide opportunities for tropical wild fish hunting

Figure 4.37 and 4.38: Two fish ponds in the rain forest area of western Nigeria

These are two of four fish ponds established along the path of a stream behind the consultancy services unit of the University of Ibadan. They are used in aquatic ecological studies and aquaculture for both undergraduate and postgraduate students in the University. They are presented here to remind us that the epizootiology of fish problems of *husbandry*, *health* and *economics of production* are patently linked to the health of the aquatic environment.

Figure 4.39: Areas of grain production in Nigeria



Grains are some of the *energy chain food items* for which both man and animals compete in energy flow system in the region. Hence their distribution has ecological epizootiology implications. They are therefore amongst important issues in considering the dynamics of problems, sharing and competition between man and livestock. Both issues are of both ecological and epizootiological relevance and importance.

With housing, management and environment issues illustrated we shall now consider and illustrate essential stages in epizootiological study of herd problems. In this context, while a clinician may be content with treating a sick animal on the basis of his clinical diagnosis, an epizootiologist must do the clinical diagnosis and then follow up with detailed examination of the entire herd from which the sick individual has come. It is by this that he highlights the spatial and temporal extent of the problem, the proportion of the exposed hosts that have fallen ill, and from these the relevant economic and social importance of the problem/s. This is usually a deliberate effort of an epizootiologist.

Thus the attitude to carrying out this deliberate effort demands special skills and experience, especially when dealing with a variety of local possibilities such as nomadic Fulani herds[6.126] and their extensive management system, and with settled institutional or government owned cattle herds[6.65] and their intensive and semi-intensive management systems. In this context we now illustrate essential stages in epizootiological study of herd problems, appropriate vehicles for an epizootiological field trip and some usual scenes on a field trip for investigation of herd problems.

Figure 4.40: Essential stages in Epizootiological Studies of Herd Problems:

(a) Structured observation, followed by Field data and specimen collection and recording,

(b) Laboratory investigation, (c) Computer processing (d) Seminar presentation and Publication

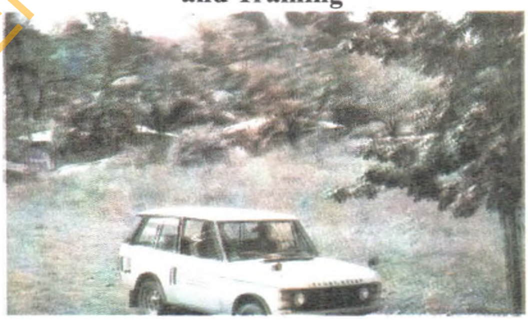
Reader should note the progress: -

(i) From field/abattoir **data and specimen collection and recording**, to **laboratory investigation**, to **computer processing** (including analysis) and **documentation**, to **seminar presentation** & **publication**:

(ii) Those are some of the important and essential stages in every epizootiological inquiry

[*Observation, Computer data processing, illustrations and photograph by Esuruoso, G.O., 1992*]

Figures 4. 41 and 4.42: Appropriate Vehicles for Epizootiological Field Study and Training



A land rover on Epizootiological field study. Observation and photograph by Esuruoso, G.O., 1978
Provision of appropriate vehicles is one of the basic conditions for Epizootiological field studies, research and training of veterinary students; for example, land rovers, range rovers, other four wheel drive jeeps and station wagons have been found useful for our department of Veterinary Public Health and Preventive Medicine, at the University of Ibadan *ab initio*.
[*Observation, policy initiative, strategy for implementation and photographs by Esuruoso, G.O., 1978]*

Figures 4.43, 4.44 and 4.45: Dry season vegetational geography en-route Sokoto - Dabagi Farm.

Camel as means of transportation en-route Sokoto to Dabagi Farm.
[*Observation and photograph by Esuruoso, G.O., 1992*]

Figures 4.46 and 4.47: Some Veterinary Students of Usumanu Danfodiyo University Sokoto (UDUS) on an Epizootiological study trip en-route Sokoto to Dabagi Farm with Professor G.O. Esuruoso 1992

(i) Depicting the dry season vegetation and geography of the area as part of ecosystem studies in *Ecological Epizootiology*.

(Ii) Dabagi is the location of the Teaching and Research Farm of UDUS faculties of Agriculture and Veterinary Science, some 40 Km NE of Sokoto town
(iii) Making observation en-route a study area is part of the usual plan in epizootiological studies.
[*Observation and photograph by Esuruoso, G.O., 1992)*]

Figure 4.48: A grazing cattle herd crossing the road

This is a common scene in most parts of Nigeria. They are part of the subsistence extensive system of cattle management and they contribute to road safety problems.
[*Observation and photograph by Esuruoso, G.O., 1977*]

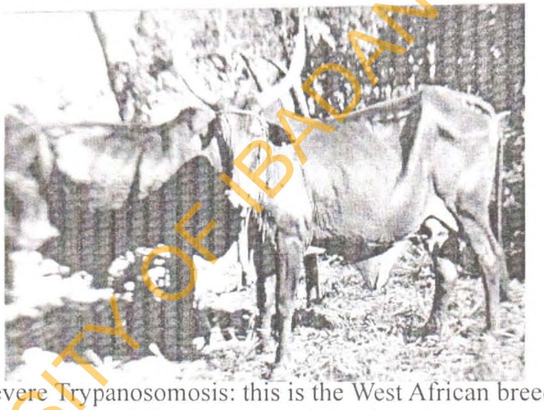
Figure 4.49: Typical Red Bororo (Rahaji) cattle herd of Northern Nigeria

This is the West African breed of cattle that is the most susceptible to demodicosis, strepthothricosis, listeriosis and trypanosomiasis; its meat is often watery at slaughter.
[*Observation and photograph by Esuruoso, G.O.*, 1969 ff.]

Figure 4.50: Part of the defunct Western Nigeria Government's Dairy Herd at Iwo Road, Ibadan

These were never kept on zero grazing as some are in other parts of the country, partly to control streptothricosis.
[*Observation and photograph by Esuruoso, G.O., 1970*].

Figure 4.51: Emaciated Bunaji (Red Bororo) Cattle



Red Bororo cattle in severe Trypanosomosis: this is the West African breed of cattle that is the most susceptible to demodicosis, streptothricosis and trypanosomosis[6,100].
[*Observation and photograph by Esuruoso, G.O., 1974*]

Figure 4.52: Bovine Papillomatosis (Skin Warts)in a Zebu Herd near Kano, Nigeria

19 out of the 26 cattle in this herd had prominent lesions of the disease during our visit. They nevertheless looked robust in spite of the outbreak
[*Observation and photograph by Esuruoso, G.O., 1968*]

Figure 4.53: Another case of *Bovine Papillomatosis* (Skin warts) in Nigeria

Observe the peculiar location of the lesions and
the fact that the affected animal maintained its body weight
/Diagnosed and photographed by Esuruoso, G.O. 1968]

Figure 4.54: A Sporadic case of Norcadiosis in a cow on a Government Farm at Fashola, Near Oyo in Nigeria

Observe the lesions along the neck and in the dewlap
[*Observation and photograph by Esuruoso, G.O., 1984*]

Figure 4.55: A scene at Government Farm, Fashola, Near Oyo during an epizootiological visit for the study of brucellosis

There is usually a crush for handling the animals on these farms. [*Observation and photograph by Esuruoso, G.O., 1966.*]

Figure 4.56: A scene during an epizootiological trip to a Fulani herd in Igbeti cattle area

Blood sampling for Brucellosis test of Fulani Herd. Fulani herdsmen may not have cattle crush but they know how to restrain their animals effectively for blood sampling. [*Observation and photograph by Esuruoso, G.O., 1968*]

Readers should also recall that we have always categorized animal group problems as being related to their breed, breeding and genetics, feed, feeding and nutrition, as well as housing, mode of management practices and environmental problems. In other words, we consider the groups, the place or environment and time factors. In this context, we shall now consider and illustrate trade cattle route, control posts, cattle markets and abattoir environments as epizootiological issues in Nigeria.

Figure 4.57: Various scenes of trade cattle movement on Jebba Bridge Railway line and Road

(i) The Jebba Bridge, once the only link by rail between northern and southern western Nigeria:
(ii) Users include trains, motor vehicles, local people/pedestrians, trade cattle, their drovers and the tsetse flies that follow them:
(iii) The pictures show the type of hold-up on the multi-purpose bridge that used to be a daily bottleneck for travellers by road from Southern to Northern Nigeria and *vice versa* en-route Jebba. This constant event has *epizootiological* (including socio-economic and vph) implications, which an epizootiologist *sensu stricto* can readily visualize as combined problems of animal groups and human populations at risk.
[*Observation and photograph by Esuruoso, G.O., 1972.*]

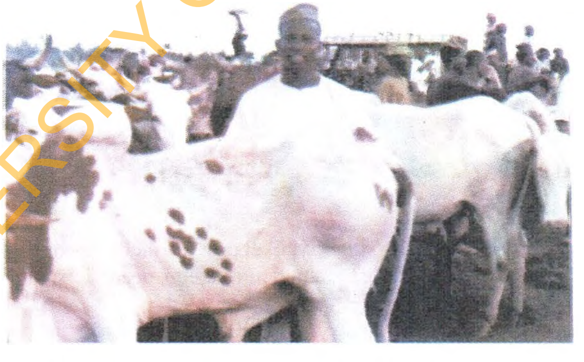
Figure 4.58: Entrance to Bodija Control Post and Cattle Market of the State Ministry of Agriculture and Natural Resources, Ibadan

(i) The Bodija Control Post and Cattle / Stock Market provide facilities for the official inspection of trade cattle (and other stock, especially the small ruminants) meant for slaughter on arrival from the north:
(ii) Suspected / clinically diseased animals are usually isolated and kept under observation in special enclosures provided for the purpose; those due for destruction are then picked up from there, while others are released into the market:
(iii) In the stock market animals are sold for slaughter, either in the nearby abattoir or for further journeys to other parts of the same and adjacent states; such animals must again be inspected, found safe and fit to travel before being issued with an official travel permit:
(iv) The control post is therefore **an important *epizootiological intelligence centre***, where problems of cattle herds in the north may be visualized in Ibadan, which is in the south-west.
[*Observation and photograph by Esuruoso, G. O., 1994]*

Figure 4.59: Scenes at the Trade Cattle Control Post, Ibadan

Trade cattle at the Municipal Abattoir Ibadan on arrival from the North, 1969.
[*Observation and photograph by Esuruoso, G.O1969.*]

Figure 4.60: Trade cattle at the control post and cattle market, Bodija Ibadan



Observe the swelling due to reaction to infected injection ('*Kumbura*', Hausa) of Trypanocidal drugs en-route the journey down South to their slaughter
[*Observation and photograph by Esuruoso, G.O., 1984*]

Figures 4.61, 4.62 and 4.63: Some related scenes at the Sokoto State Abattoir: Slaughtering of Camels

(i) & (ii) depicting some stages in the Slaughter of camels and (iii) Tuberculous lesions in a Camel's lungs; some of the students were encouraged to carryout an *epizootiological survey* (including the laboratory and vph aspects) of the disease is slaughtered camels over a convenient period of time.
[Observation and photograph by Esuruoso, G.O., 1992]

Figures 4.64 and 4.65: Sokoto Abattoir premises: Examples of synanthropic *ecosystem*

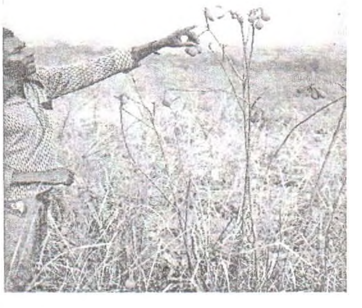
(i) The free open area consisting of fenced-in bare land and part of the drainage system:
(ii) The heaps of organic waste products, consisting of horns, hoofs, trimmings and bone - being incinerated for commercial purposes but still attractive to rodents while still there:
Both situations depicted have epizootiological (including *socio-economic* and *vph*) implications.
[*Observation and photographs by Esuruoso, G.O .1992*]

Epizootiological data from stock movement, the events in which they are involved en-route, their sale, further movement, eventual slaughter, and disposal of their products and wastes should provide surveillance information on their diseases and other problems over time and across the country.

Again as we have always said, animal group problems are usually related to their breed, breeding and genetics, feed, feeding and nutrition, as well as housing, mode of management practices and their environment. In other words, we consider the groups, the place or environment and time factors. In this context, we shall now consider and illustrate the choosing of a suitable location for a field station for studying livestock health and productivity as part of infrastructure for teaching and research for a faculty of veterinary medicine in Nigeria.

Figures 4.66 and 4.67: Dry season vegetation and geography of the site chosen for a Teaching and Research Outstation at Eruwa for the Faculty of Veterinary Medicine, University of Ibadan

Field outstation, chosen for U.I. by Esuruoso, G. O. and Ayanwale, F. O. on an initial surveillance tour in 1978. This was after others such as Professor Sellers and his public relations team had convinced the Eleruwa to give some land to our Faculty of Veterinary Medicine, and he (The Eleruwa) had permitted the Faculty to choose an area suitable for use as our teaching and research out-station. Observation and photograph by Esuruoso, G.O., 1978



Identifying a flowering plant's family at Eruwa Field station, considering epizootiological implications: [Observation and photograph by Esuruoso, G. O. 1978]

We have always recommended that students of epizootiology should carefully study all aspects of the subject and thereby have a comprehensive database on the flora, fauna (vectors, hosts and agents) edaphic and climatological systems of the place. This will enable clear indirections of potential problems including diseases, productivity levels intoxication by plants and exposure to poisonous snakes, and thus control and prevent them before much damage is done.

(iii) Present situation

Having presented something of the past situation and the pioneers (section 4.3 (i) and (ii) above), we shall now briefly indicate the present situation. An Internet search in 2001 produced over 2000 articles from a single station on Epizootiology alone; another search in November, 2004 produced 17, 300 scientific articles from one web search. And yet another search in 2005 produced 21,500 articles on Epizootiology (see Appendix II to this book). Going through some of those articles it was clear that ecological epizootiology has continued to advance in many fields of scientific endeavour. No wonder, it is the most productive of all the stages discussed in this book. It gives the opportunity for visualizing problems in natural settings. And when the settings change, the effects are usually obvious to common epizootiological sense. Moreover, the multi-disciplinary nature continues to be taken advantage of, whereby surveillance in various disciplines have continued to make use of the key areas of the subject, namely the biomedical, statistical, socio-economic and geographical aspects. Global Positioning System (GPS) [6.49, 6.109] and *Geographic Information System (GIS)* [6.110] are two issues that fit into the concept of Geographical / Ecological Epizootiology.

Thus, *Geographic Information System* (GIS) [6.49, 6.110] is now being actively employed in visualizing and aiding the tracking and early diagnosis of herd, group, population and community problems (see section 5.6 of this book). Also global positioning system (GPS) is being used to monitor groups of animals and their migratory patterns, yielding useful knowledge of the system. It is, by the way, the same GPS that is being applied in modern cars for real-time effective navigation by automobile drivers who can afford such vehicles. Also, the GPS is being seriously applied to monitor seasonally migrating wolves. Special collars are tied round their necks and these send out signals, which are detectable and accessible by electronic receivers of the signals even on the GPS. It should be obvious that in this case, information and expertise from geography, computer technology, biological sciences and social studies are being used. This brief account should be enough to emphasize the importance of ecological Epizootiology and its composite disciplines in the study of animal group, human population and a variety of community problems. To us Geographical Epizootiology is synonymous with *Eco-systematic Epizootiology* [6.1]. Hence a good understanding of the relevant terms and issues in ecosystem studies should be addressed.

(iv) Nidality of diseases

An account of the ecosystem approach is naturally never complete without mentioning the nature of associated locations and the usual environmental factors. From such lines of thought the theory of nidality and *focality* of disease and other problems was propounded and developed by scientists like Eugene Pavlovsky[6.91] (1938, 1939 & 1959). The word nidality is derived from "nidus" meaning nest. The idea was that every disease has a favoured nest in the ecosystem, where all the factors and conditions necessary for its establishment and maintenance are fully met. The soil type, the plant and animal contents, the vector, host and agent, the climatic factors, and the appropriate numbers and relationships necessary to maintain the disease are always present. This is in effect the import of the *nidality*[6.107] and *focality*[6.107] of diseases and other problems of animal populations in ecological communities[6.68].

(v) Breaking the weakest link

That being the case, the removal of a *critical factor* or condition, and in fact the breaking of the *weakest link* in the natural history of a disease will usually afford the cheapest way of controlling the disease or at least its extent, maintenance or spread. In this way, several authors had in the past regarded African trypanosomosis as an *entomological problem*, indicating that if the insect vectors, especially the tsetse flies responsible for the cyclical transmission were removed, the problems would be solved. But it was later found that trypanosomosis still occurred where there were no *Glossina species*. Other flies like Stomoxys and Tabanids have provided alternative vector links through mechanical transmission. Others had described trypanosomosis as a protozoological problem. They thought that if effective trypanocides were developed to eliminate the parasites in the blood of affected hosts, the problem would be solved. However, as far back as 1973, some researchers had questioned both of these ideas[6,61]. The full story of the natural history of this major problem will be related in the appropriate section of this book and during the lectures on the specific disease or groups of diseases caused by trypanosomes. The occurrence and distribution of animal population problems are best visualized in natural / ecological community settings, where the findings become most meaningful.

(vi) Natural history approach

Nevertheless, the theory of nidality and focality of diseases have been found most useful in many other cases where the natural history approaches have been adopted. For example, when animals are prevented from grazing in lead areas of the country, lead poisoning is reduced. When there is a natural barrier to the free movement of rabid animals, rabies have ceased to occur on the other side of the natural barrier. Whereas an alkaline environment as in silages has provided a suitable nidus for *Listeria species* of bacteria to proliferate, the result had been the occurrence or "outbreak" of listeriosis in the cattle herd feeding on the silage. *Jungle yellow fever* is a risk taken by hunters and foresters who frequent the jungle areas where there are sub-human primates in which the viral agent is maintained, while the appropriate mosquito vectors are also in abundance. In each of these and other similar cases the theory of nidality has fitted into the ecological approach to the study of the problems and their control in specified areas.

(vii) Baseline in ecological approaches

Even at the risk of saying the obvious, it must be of cardinal importance for students of Ecological Epizootiology to realize and keep in mind always, that:

(a) A particular disease or problem

A particular disease or problem will not occur where the host, or the agent, or the vector (where appropriate) or a suitable environment, or any other critical condition does not exist. Bovine brucellosis cannot occur where there are no cattle. Rabies will not occur in man where there has been no natural or artificial means of inoculating the virus into man; etc.

(b) A particular disease will disappear

A particular disease will disappear from a geographical area:

(i) If and when the conditions for maintaining the parasite/agent have ceased to exist;

(ii) If the usual or other means of contact between the host and the agent have been effectively broken;

(iii) If the life-cycle of the agents or vectors has been effectively interfered with;

(iv) If all the potential hosts have disappeared;

(v) If a solid herd immunity has been established, etc.

These examples are far from being exhaustive; there are many others, which are matters of common sense, sometimes of biological, ecological or biomedical commonsense and understanding. The application of the knowledge gained in the study of Biology, Anatomy, Physiology, Biochemistry, Parasitology, Microbiology, Immunology / Immunobiology and even Botany and Toxicology must always be handy and applied in Ecological Epizootiology. Plant poisoning cannot occur unless the animals have access to toxic plants. And the detection of members of a family of toxic plants on the ranch is an *indication of the risk* to animals grazing on the field. The usual approach is to ensure that field practical exercises on this subject are based in potential areas for each type of problem around the country where the college is located (see recommended practical exercises below), usually starting from the teaching and research farm including field stations of the college or university.

4.4 Mathematical Approach

Mathematical approach to Epizootiology or Mathematical Epizootiology is synonymous with Statistical Epizootiology. It is one of the three essential components (the tripod) of epizootiology as earlier explained.

4.4 (a) Justification:

Epizootiology is, among other things, the comprehensive study of problems and the basis for their control and prevention in populations of animals. Obviously then it could never be enough just to study the qualitative nature or attributes of those populations and their problems. One must also instinctively seek to know, not only the sizes of the populations, but also the value, the volume or quantity, the extent and intensity of the various problems, as well as the amount of damage done, the degree of losses caused, the relative and total contributions of each determinant factor to the undesirable outcomes of the problem, and the value of real and potential benefits that may be derived from the control and prevention of the usual damages and losses appertaining should also be of interest to the epizootiologist.

All these are quantitative measures, in their various units, that have to be taken, compared, computed, interpreted and translated into useful knowledge about each population of concern and about its specific and general problems. They then have to be recorded, summarized, reported, presented and disseminated as information basis for reasonable decisions and salutary actions in the relevant systems. Mathematical tools provide one of the essential means of doing all these.

4.4 (b) Objectives

The objectives of mathematical epizootiology can be readily derived from its justification in the preceding paragraphs above. The justification can be seen as bordering on the profiles, and acting as the indicator of the need. But in order to give a complete picture of what the studies are expected to involve, what questions to answer, what outcome to produce, and what problems are to be solved, the following objectives will be listed - i.e. we carry out mathematical epizootiology in order:

(i) To be able to determine the size and value (but not necessarily the importance) of the populations or groups in problem;

(ii) To understand how to measure in each case, the size of the problem and the (financial, economic and other social) values of the potential damage occasioned by the problem without intervention, with limited or on full-scale intervention and with early or late intervention;

(iii) To be capable of calculating the physical, environmental and biological implications that are being, or can be associated with the problem as matters of facts and figures;

(iv) To be trained to quantify the relative and real contributions of the various variable determinant factors of the problems (including diseases);

(v) To learn how to measure the rates and ratios of the occurrence of the disease/problem over time (frequency) and over specific locations (spatial distribution) leading to figures of incidence* and prevalence* (of the problem);

(vi) To know the methods for placing values on, and for measuring the worth of the problems/diseases in populations in terms of losses suffered, benefits foregone using various simple mathematical methods and specific statistical techniques;

(vii) To learn how to calculate the correlation coefficient of the associations/relationships that lead to the problem;

(viii) To be able to work out the probability of the outcome of the problem in hand and of the chances of future occurrences in view of established and potential relationships involving the hosts, the agents, and vectors of the diseases and their environment;

(ix) To be able to determine mathematically/statistically the significance of results obtained by the various tests and techniques;

(x) To be able to calculate and make sensible deductions on the specificity, sensitivity, validity and significance of the various quantitative techniques used in the definition of the problems/diseases;

(xi) To be able to understand and interpret the values of the tests of significance generally; to know not only what they mean or prove but also what they do not prove or mean to prove (i.e.) their limitations;

(xii) To be able to engage in the formulation and mathematical testing of hypothesis, design, sampling methods appropriate for each problem and present the statistical summary of the results in a form useful for valid decision making processes; and to be able to appreciate the value and uses of, and where possible carry out regression analysis and predictive mathematical modelling all in attempts to shed light on the nature of problems in animal populations and to come as close as possible to the truths of their causation and the magnitude of the damages done by them at every stage of the problem's evolution.

This listing is not meant to be exhaustive, nor is it meant to be always invariably applicable in all cases and for all circumstances. Experience will prove when and where one or the other objective must be achieved as a means to the end of controlling the problem in hand or of preventing anticipated ones. What these guidelines are meant to achieve include the provision of tools of thought and the appropriate logic paths for the students to work on in real-time operations.

It should always be remembered however, that knowledge of and experiences in epizootiology are the materials that could provide the soundest basis for preventive veterinary medicine, which is synonymous with preventive medicine in its widest sense[6.3]. This is only possible if the tools of thought are properly utilized.

4.4(c) Methods of mathematical epizootiology

In a nutshell the methods are those of descriptive and analytic statistics applicable to the science of epizootiology. Starting with the simple process of counting the numbers of animals that are sick, dying or dead, out of how many exposed or at risk, and then applying the basic arithmetic operations i.e. addition, subtraction, multiplication, division, exponential and factorial measures.

Next one should obtain the skills for representative sampling, in order to obtain figures for the sample statistics which could be extrapolated to the population to obtain the parameters* on the basis of probability and of sound sampling technique.

4.4(d) Sampling methods

Sampling is a process of picking a number of objects, from a particular group, population* or the universe* of such objects. The idea is to be able to make statistical inferences from the results obtained from the sample/s and extrapolate same to the population from which the sample was taken, and not to a different or larger population. It is to be noted that measures of sample statistics i.e. mean, median, mode, variance, standard deviation, standard error, error of means, etc are exactly the same as measures of population parameters. And if the sample is large enough and is adequately representative of the population, then the value of sample mean is very close or the same as that of the population mean (u). Whatever relationships may be claimed to exist between samples and populations can only be justified, explained and acceptable on the basis of probability. This is a key statement.

Methods of sampling, on the other hand, may be random (i.e. representative and probabilistic i.e. stochastic), or non-random (i.e. Non-representative and non-probabilistic/non-stochastic). Maybe in a textbook of this nature a graphic presentation of the sampling methods will be more readily appreciated, thus: -

Sampling may be

(i) Non-random (i.e. non-representative, non-stochastic)
OR
(ii) Random (i.e. representative, probabilistic / stochastic)

Random Sampling may be

(iii) Simple
OR
(iv) Stratified

An example of simple random sampling is Epsem sampling which is "an equal probability of selection method" by which all the relevant population units have the same probability of being selected from:

*See glossary section of this book for details.

There could also be other types of sampling, such as

(v) "Grab" type or "sampling of convenience" (a non-probabilistic method i.e. the "man-in-the street" method e.g. every herd whose owner stops to water his beast at the brook and allows blood sampling from some of the beasts).

(vi) Cluster* in which each unit selected is a group e.g.

(a) N'Dama bulls on the Teaching and Research Farm (TRF)

and

(b) Bunaji heifers on the TRF.

(vii) Systematic sampling, which involves selection on a simple rule. E.g. selecting odd-numbered calves/cows in a herd. OR Selecting calves born during every third month of the year.

Although such sampling obviously has its merits, it also has the danger of incorporating errors, which will invalidate generalizations from the results. Generalization from the outcome of Grab sampling is of course mostly unsound. But is still used when it is the only possibility of assessing the parameters needed. Other methods of sampling include:

(viii) Purposive sampling the quality and value of the outcome will of course depend on the purpose or selected bias prepense. And in any case, the application of the result can only relate to the specified purpose generalization interdict (oder verboten). (German, meaning that 'it is forbidden to generalize'. And

(ix) Multi-stage sampling involves selection processes in two or more stages, especially where definite/suitable frame could not be found ab initio. The first selection stage then provides materials for the frame of the second and/or subsequent selections. For example, in a survey of some diseases of cattle in Nigeria, the first stage may involve selection of some cattle states in which the survey may be realistically conducted. The knowledge gained about the structure and apparent distribution of herds in those states can then be used to construct a frame for subsequent stage sampling of choice all based on methods appropriate in each case. Care should be taken to ensure the validity of the methods chosen at each stage; the more clearly the bases are stated the better the chances of achieving sound interpretations of the results.

4.4 (e) Sampling Theory

Notwithstanding all the above, a working knowledge of sampling theory will enhance the chances of adopting the most suitable method for each particular enquiry or survey. Now, sampling theory is the speculative view or supposition that should be considered, studied and, if suitable, used in the expression of relationships between samples and the populations from which the samples are taken. Earlier in these notes, mention was made of the nature of and relationships between sample quantities (i.e. statistics) and population quantities (i.e. parameters). It can now be explained that parameters are quantities, which are constant in the case, considered but vary in different cases; and examples include population mean and standard deviation. Whereas sample statistics are the quantities, which include sample mean, sample variance and standard deviation as examples. It is the usual expected, foreseeable and observed relationships between these quantities that are the concern of sampling theory.

4.4 (f) Uses of sampling theory

Sampling theory is useful

(i) In estimating unknown population quantities (i.e. parameters such as mean, variance, etc) from the knowledge of corresponding sample quantities (i.e. statistics such as mean, variance, etc). Such estimations of course have the chances of being closest to the truth if the samples are representative, large enough and fairly free from the various sources of error in arriving at the sample quantities;

(ii) In determining whether observed differences between two samples are due to chance variation or are real and significant differences. And it is usually a matter of probability;

(iii) In making statistical inferences about a population based on the statistics of samples taken from the population, with some indications of the accuracy of such inferences based also on probability theory.

In addition to all these the relevance of tests of hypothesis and tests of significance to the theory of decisions, all based on the theory of probability, may be briefly mentioned at this stage.

Statistical decision theory deals with the philosophy of making decisions about populations based on information obtained from samples from the populations. To make such decisions one starts with some statistical hypotheses, which are assumptions or guesses about the population, which may eventually be proved right or wrong. Such an assumption is called the *null hypothesis* (H_0) e.g. to decide whether the contents of A is different from those of B we start by saying, there is no difference and any observed difference is due to method or time or nature of sampling. Alternative hypotheses to null hypothesis ideas are called assumptions and they form the basis for the formulation of relevant hypothesis.

> Hypothesis is supposition made as basis for reasoning without assumption of its truth; it is the usual starting point for scientific investigation. Groundless assumptions however, have no place is such efforts. Good assumptions are based on some existing facts.

The next step will be to prosecute the experiment, collect data, which are then processed, finally analyzed and interpreted. The information thus obtained will be made available to decision makers and those who are charged with the duty of tackling and controlling the problems at hand. The most important message here is that before data are collected, their processing must have been envisaged, so that the data may be suitable, adequate and accurate enough for the purpose. An Epizootiologist is better off working with sound Biostatisticians and other disciplines from the very beginning of an investigation, before the data collection or sampling is commenced. These facts will be demonstrated during the practical exercises that will be associated with this section of the course.

4.4 (g) Statistical procedures

The usual first stage in any statistical inquiry is to collect data that will be suitable for ***descriptive statistics*** of the sample, which may properly represent the group or population from which the sample has been collected. It should be noted here that the usual sources of **descriptive statistics** for a group of animals are the same as those that supply the data for ***descriptive epizootiology***. In either case, the usual outcome is a **summary description** of the group or population within a stated range. For example, when we study the weight of a group of cattle and find the mean to be 300Kg, we may then find and say that the statistics of the weights for that group / population is '300Kg plus or minus 15 Kg'. Our result is thus a summary of the weight range into which all the members of the group would fit. What we have just said here is the interpretation of our findings. Very often, it is the proper interpretation of the result that determines the value of the statistics.

The usual next stage is *analytical statistics*. This should be seen as starting from measures of association (relationship) between uniformly varying factors or events along the X and Y axes of a functional system. The next step is the determination of dependent and independent associations between a pair or groups of variable factors or events. And the next is the determination of causal relationships, otherwise known as asymmetrical associations. Following these are experimental studies in modelling and simulation that enable forecasting within reasonable assumption levels. For what is reasonable should be a matter of fact; it is a matter of common sense in which the relationships between dependent and independent variables are defined. And it is that which identifies / indicates where preventive measures are judiciously defined. This is a point where statistical procedures directly complement analytical epizootiology.

The actual beginning is measure of correlation, or to be exact and in quantitative terms, it is a matter of correlation coefficient (r). Positive Correlation is of course a measure (which like probability) has a range from 0 to +1. Negative correlation extends to 1. Thus correlation coefficient has a range from 1 to + 1It then goes on to include other procedures mentioned in the immediately preceding paragraph, and ending in interpretation for decision and useful action. Hence statistical procedures contribute to resource management toolkit in the epizootiological approaches.

4.5 Socio-economic and Socio-cultural Approaches

Animals and their problems, the uses to which they are put, the ways in which they are regarded and treated, the values placed on them and their (humane) management for the production of food and work all are usually part of the culture of human societies. The creatures also have their own natural culture, which means lifestyle.

Under *socio-economic approaches*, one should rightly and properly consider such topics as '*resource management approach* [6.5], as well as *socio-economic jurisprudential approaches* [6.48, 6.53]. These two topics will however be properly presented under *Advanced / Systematic Epizootiology* [6.1].

4.6 Recommended Practical Exercises

A planned and well-organized trip to and tour of the teaching and research farm of the college (or university) is highly recommended for a start. Other extensive livestock production farms and ranches should also be visited and investigated.

4.6 (a) Before and during planned visits
(i) The geography of the region should be studied along the way, from the starting point to the farm. The nature, contents and volume of the vegetation along the route should be observed, discussed, noted and recorded on paper and by a camera or cine-camera with the implications and in relation to the weather, climate and prevailing meteorological circumstances. What the nutritional status of the animals, and what other problems at that time of year should be envisaged and discussed en-route;
(ii) On arrival on the farm, the grid reference of the location should be identified on the map and the geographical north, south, east and west orientation should be established. The presence and any effects and direction of local and prevailing winds should be recorded and discussed. The weathercock should be located and observed, the rain gauge and its records should be located and recorded;

4.6 (b) Examples of recommended formats
For recording field and laboratory data: See tables below.

The type of format/tables below may be used for the purpose of gathering data both during a field study visit and in the laboratory.

Field Visit datasheet Form 1

Date of visit: Time of visit:
Name of Farm: Owner of Farm:
Location of farm:
Farm Manager: Address and Phone, etc
Animal species: Breed/s
Size of each group (population) of animals on the farm
(i) Bovine (ii) Ovine (iii) Caprine (iv) Porcine (v) Equine (vi) Leprine
(vii) Canine (viii) Feline (ix) Others

Table 4.6: Herd statistics

S/N	*Species*	Breed*	Number		Total Number	Remarks***
			Male**	Female**		
	Bovine					
	Ovine					
	Caprine					
	Porcine					
	Equine					
	Canine					
	Feline					
	Avian					
	Turkey					
	Domestic fowl					
	Guinea fowl					
	Duck					
	Quail					
	Ostrich					
	Others					

* Specify e.g. Dairy/Beef: Broiler/Layer
** Specify Neutered/Entire
***Specify husbandry, health and production history from Manager

Table 4.7: Record sheet for morbidity and mortality over 5 years

Species of Animal	Total Number on farm now		Five years ago		Four years ago		Three years ago		Two years ago		One year ago		Remarks
	No	% Reduction	No	% Reduction	No	% Reduction	No	% Reduction	No	% Reduction	No	% Reduction	
Bovine													
Ovine													
Caprine													
Porcine													
Equine													
Canine													
Feline													
Avian													
Turkey													
Domestic fowl													
Guinea fowl													
Duck													
Quail													
Ostrich													
Others													

The full details of each table should accord with the purpose of the visit and investigation according to the lecturer leading the students.

4.6 (c) Species and numbers of animals on the farm

(i) Species and numbers of livestock herds and flocks on the farm should be recorded, as on the table above. Questions should be asked (from the attendants and the farm manager) about the history of the farm, the common problems of the herds, records and patterns of morbidity and mortality over the past 5 years or so, the productivity of the stock and the population parameters of the various species of livestock;

(ii) Physical observation and close inspection of the animals should be carried out in order to form opinions about the health status of the herds and the conformation of the individual animals;

(iii) Records of routine preventive treatments and vaccinations should be sought, obtained and recorded; the types and sources of drugs and vaccines used on the farm should be recorded;

(iv) Facilities for handling, sheltering, watering and feeding the livestock species should be examined and discussed with the farm staff and between the tutor and his group of students;

(v) An ecological tour of the farmland should be undertaken during which the flora and fauna contents and their species and volume should be studied directly and indirectly; and samples should be taken for full identification of unfamiliar specimens especially of the predominant species. This can be achieved in the following ways: -

- By identifying and tracing tracks and other pieces of evidence of the wildlife species in the area. These should be studied and investigated in detail starting with discussions with the local human population. Pieces of evidence such as snake casts (through *ecdysis*), faecal pellets, decaying carcasses and skeletons, types of bush meat caught by local hunters, presence of carrion birds will aid such ecological enquiries.

- By the group of students going grazing with the animals following the shepherds and asking questions all the way about feeding, watering and related problems noted over the past five years and during different seasons.

- By carefully identifying specimens of plants, remains of animals and samples of ticks and blood from the animals. These should be taken for further identification and laboratory analysis back on campus.

Haematophagous flies caught during the visit, if engorged, could be processed for blood meal identification tests in the laboratory.

4.6 (d) On arrival back home

(i) On arrival back home, students should be requested and encouraged to submit written reports on the field exercise to their tutors within 48 hours of arrival from the field trip. Since we recommended that such reports should routinely be prepared in duplicates using A4 or foolscap duplicate books, each student should always keep a carbon copy of what he/she submits to his/her tutor following every field training. In actual fact, the evaluation of the student's report should provide materials for the *continuous assessment* marks of the student at the end of the course.

(ii) Figures obtained from this exercise should be kept for future exercises in mathematical epizootiology which may involve exercises in *descriptive statistics* (i.e. measures of central tendency, measures of dispersion and correlation) and in *analytical statistics* (including regression analysis, mathematical modelling and other predictive techniques). **It will usually be of much value to the students if figures obtained from real-life practical surveys are used for the exercises in statistical epizootiology.** The topic will be resumed in the appropriate sections of chapter 5 of this book.

(iii) Recording the details of specimens brought from the field and their preservation and processing in the laboratory should be carried our as earlier explained in the first chapter of this book. Remember that facts and figures from laboratory findings are to be computed, and then used in seminar presentation later.

4.7 Details of some practical training exercises Recently conducted for DVM students in Ibadan: Investigation of a disaster affecting pigs

4.7 (a) Introduction

When a swine epizootic occurred in groups of pigs in South Western Nigeria in 2001[6.111], a class of epizootiology students at the University of Ibadan (U.I.) was involved in the investigation. This was an example of participative teaching and learning process. Comprehensive information about the nature and causation of the disease was provided. Basis for the control and eradication of the disease was also established. The students had thus learned by taking part in a real case in real time. They were able to collate their data and produce respectable scientific publications[6.75, 6.89], which was also a form of training for them in scientific communication. Some details of their actual activities will now follow.

4.7 (b) The objectives of the investigation are stated below.

i. To visit affected farms and make observations on the clinical signs of the disease;

ii. To visit affected farms and carry out a structured interview on date of outbreak, what events, factors or forces the farmer considered to be the most responsible source of the outbreak on his farm. What was the initial population of pigs on the farm? How many became clinically ill over time? How many died over time? How many were culled? How many survived? The remaining stocks on the farm now, are they the survivors or new ones (if any)?

iii. To visit affected farms and collect blood samples and other tissues samples from some; pigs showing clinical signs of the disease and some that were not showing the clinical signs of the disease for laboratory confirmatory diagnosis of the cause of the disease;

iv. To visit a town planning office in Ibadan and obtain the paper map of one affected local government area within Ibadan city, so that the pattern of entry and spread of the disease within that area could be prepared and presented based on the data gathered in i iii above;

v. To make use of conventional symbols to identify and locate pig herds on the obtained map of a local government area. To include on the map, date of occurrence of the disease in each herd, source of entry of the causal agent into the herd and ports of entry into the entire local government area selected;

vi. To use GPS Toolkit e.g. Margellan 360® to collect the precise geographic coordinates of each farm visited in a selected local government area and to upload the saved farm coordinates into a prepared digital map of the same local government area on a GIS, especially using Arc view GIS software to design a map[6.75] on the pattern of spread of the agent that can be manipulated on a computer system; a comprehensive study and wider community-based presentation of which may lead to effective formulation of control strategies.

vii To find out if convalescent survivors were immune protected against the disease and if their offspring received the antibodies from their dam.

viii. To find out which chemical disinfectant was effective in killing the causal agent of the disease in a premise. This was to be determined through farm visits to see outcomes of efforts made by farmers with regards to use of different disinfectants;

ix. To collect data on social, economic and financial effects of the disease outbreak upon pig farmers and their families within the same chosen local government area;

x. To proffer clear interpretation of how the outbreak occurred and pattern of spread based on all available information derived from the investigation.

4.7 (c) Location of investigation and groups of investigators

Ibadan South West Local Government Areas was selected for mapping of the disease spread[6,75]. The class was divided into 4 groups each to work on some aspects of the ten objectives listed above.

4.7 (d) Achievements of the groups

The four groups of students achieved the following respectively: -

(i) Produced a confirmatory diagnosis of the cause of the disease in selected farms visited and affected by the epizootic;

(ii) Prepared a digital map of the spread of the disease within Ibadan southwest local government area;

(iii) Determined immune response to and carrier status of convalescent survivors, and the efficacy of two disinfectants in the control of the causal agent of the disease. The two disinfectants monitored were (i) Sodium Hypochloride (JIK® bleach) and Lysol;

(iv) Determined social, economic and financial effects of the epizootic on pig farms in Oyo State of Nigeria. In effect, the findings were: Financially 29,044 out of 31,916 pigs were reported dead; and these were worth

N113,939,000 at current market price in 2001. Economically, some of the piggeries closed down which meant some of the workers lost their jobs and means of livelihood. Socially, families were destabilized and at least one person was reported to have died apparently as a result of the distress. In addition, some others carried out panic selling of their pigs which further complicated the spread of the disease and increased the financial loss.

Each aspect of the outbreak investigation represents one or more approaches of epizootiology earlier described in this chapter, namely: medical detection approach, ecological (geographic) approach, mathematical approach and socio-economic approach.

1. Confirmatory diagnosis of cause of the disease

The students and teachers in this group (Group A) made the following records of case history, clinical signs and laboratory findings on farms visited:

Case history:

Each farm affected had experienced a sudden onset of loss of appetite in pigs, weakness, and sudden death within one to two days after manifestation of loss of appetite in one or two pigs. The larger pigs in the herd were affected first, especially newly farrowed sows, in-sows, dry sows, boars and gilts[6,111]. Thereafter an entire herd was affected with the disease and most of the pigs died. Rapid spread of the disease from one farm to another was noted.

Clinical signs:

Anorexia, weakness, *cutaneous hyperaemia,* petechial *haemorrhages* noticeable on ventral side of thigh and abdomen, e*chymotic haemorrhage* found at the back of the ears, especially at the base of the *pinnae.* Fever was observed especially on first and second days during clinical signs. The body (rectal) temperature on first and second days ranged between 40°C and 42°C. Pregnant sows aborted their foetuses. Aborted foetuses died few hours later. Blood discharged from natural body orifices including the nose, mouth, ears, anus, prepuce and vulva. All pigs in a herd were usually affected. Very few pigs recovered and survived. Table 4.8, provides population of pigs on 306 farms affected in Oyo State in 2001.

There were 271 small-scale farms (comprising of 1 200 pigs), 28 medium scale farms (comprising of 201   500 pigs) and 7 large-scale farms (comprising of 501 and more pigs) in the affected population.

Table 4.8: Population of pigs on farms affected by African swine fever (ASF) in Oyo State in 2001 (Based on reviewed reports submitted by farmers)

Farm size	Piglets	Weaners	Growers	Finishers	Gilts	Sows	Bowers	Total Number of Pigs
Small	6504	4878	2981	1897	1084	1626	542	19512
Medium	1904	1596	1232	1148	784	728	252	7644
Large	1008	812	784	714	476	672	294	4760
Total	**9,416**	**7,286**	**4,997**	**3,759**	**2,344**	**3,026**	**1,088**	**31,916**

Differential diagnoses:

The case history and clinical signs presented above suggest that any of the following five diseases[6.111] could be considered as possible cause of the outbreak. These are given in order of priority: -

i. African swine fever
ii. Classical swine fever
iii. Encephalomyocarditis of pigs
iv. Haemorrhagic septicaemia
v. Anthrax

Group A investigators ranked the possibility of causation in the order listed above with African swine fever rated highest and Anthrax least. The use of laboratory diagnostic support for a confirmatory diagnosis was done first for African swine fever. The immunoblotting assay, being a reliable confirmatory test for ASF was used.

What should be done in laboratory diagnosis of ASF in countries free from the disease but suspecting its presence as was the case in Nigeria is to direct efforts towards isolation of virus by inoculation of pig leukocyte or bone marrow culture, and where possible, carry out the detection of genome DNA by the polymerase chain reaction (PCR), (OIE, 2000);[6.112] preferably in that sequence. However, due to limited resources, what was actually done by group A was detection of antibodies against ASF virus by immunoblotting assay. And in order to still carry out virus isolation and detection of genome DNA by PCR, tissue samples were sent to three other laboratories including:

(i) Instituto Nacional de Investigacion y Technologia Agraria y Alimentaria (INIA), in Madrid, Spain for virus isolation.
(ii) National Veterinary Research Institute (NVRI) in Vom, Plateau State, Nigeria for PCR and Indirect Enzyme Linked Immnunosorbent Assay (I ELISA) and;
(iii) Onderstepoort Veterinary Institute (OVI) in South Africa for PCR.

The results obtained from these laboratories, using the other three diagnostic techniques were compared with that of the immunoblotting assay. Immunoblotting assay confirmed all samples that tested positive on virus isolation and PCR. It should be noted that where the resources are available, immunoblotting assay was relatively easier to use, highly sensitive and specific for ASF confirmatory diagnosis. It was however costlier in application for large sample size testing compared to I-ELISA.

Group A investigators visited ten farms[6.113] from which clinically affected and not yet clinically affected pigs were bled. Sixty-seven pigs were bled for serological diagnosis, out of which 35 sera samples were tested using immunoblotting assay technique. Samples of spleen, hepatic lymph nodes, mesenteric lymph nodes, and the liver, collected from 7 pigs among 67 bled were sent to and tested for ASF genome DNA by PCR at the NVRI Vom, Plateau State, Nigeria and at OVI, South Africa (Permit No13/1/130/4-017)[6.111, 6.113]. ASF virus was isolated from the samples sent to INIA, Madrid, Spain (Permit CISA-INIA of 19 October 2001)[6.113]. In all these, 24 samples tested positive by immunoblotting assay, 5 samples tested positive by PCR and two samples by ASF virus isolation.

Table 4.9 provides names of farms visited, the local government areas where the farms were located, and numbers of pigs bled. Usually approximately 15ml of whole blood was collected from each pig. Blood was allowed to clot for serum to form and be collected. Figure 4.68 shows the process of bleeding a pig through the anterior vena-cavae. This was a specific training for the students. The ten farms from which samples were collected had pigs that were positive for African swine fever[6.113]. This was confirmed on immunoblotting assay by the presence of ASFV specific antibodies in the test sera which was indicated by presence of specific bands at IP 23, 25, 25.5, 30, 31, 34, and 35 positions on immunoblotting strips, see Figure 4.71.

Table 4.9: Farms from which blood samples were collected for laboratory tests

S/No.	Name of Farm	Location of Farm	Local Government Area	Number of Pigs bled	Number Tested	Number Positive
1.	Teaching and Research Farm	University of Ibadan	Ibadan North	15	10	7
2.	Murewa Farms	Ejioku Village	Lagelu	4	2	2
3.	Timade Farms	Ajibode Village	Akinyele	2	2	2
4.	Government Farm	Iwo Road, Ibadan	Lagelu	4	2	2
5.	Obiwale Farm	Ologuneru Village	Ido	4	2	1
6.	Alabata Farm	Alabata Village	Iseyin	10	5	3
7.	Oshigbesan Farms	Barika, Ibadan	Ibadan North	4	2	1
8.	Shaba Farm	Abadina, University Ibadan	Ibadan North	1	1	1
9.	Anon OBJ Farms	Ota, Ogun State	Ado-Odo/Ota	8	4	2
10.	Lords Farm	Moore Plantation, Ibadan	Ibadan south west	15	5	3
Total				**67**	**35**	**24**

The bands were dark blue in colour. The positive control sample had six clear bands with two faint bands. The negative control sample had no bands at all. The group obtained negative results on bacteriological tests carried out for the possibility of *Bacillus anthracis,* causative agent of anthrax and negative result for *Pasteurella multocida* causative agent of haemorrhagic septicaemia. Encephalomyocardits virus was negative on isolation test at the University College Hospital (UCH) Ibadan, Virology department.

The method of immunoblotting assay

African swine fever immunoblotting assay is a serological diagnostic procedure that detects antibodies against African swine fever virus that are present in test serum samples. The toolkit is made up of nitrocellulose filters containing positive labelled African swine fever proteins, standard positive and negative sera samples, and the indicator system. Prelabelled nitrocellulose were produced from the complete and quantitative transfer of ASF proteins from sodium-dodecyl-sulphate (SDS)-gels while preserving the antigenic properties of the proteins under denatured conditions (Pastor et al, 1989)[6.114].

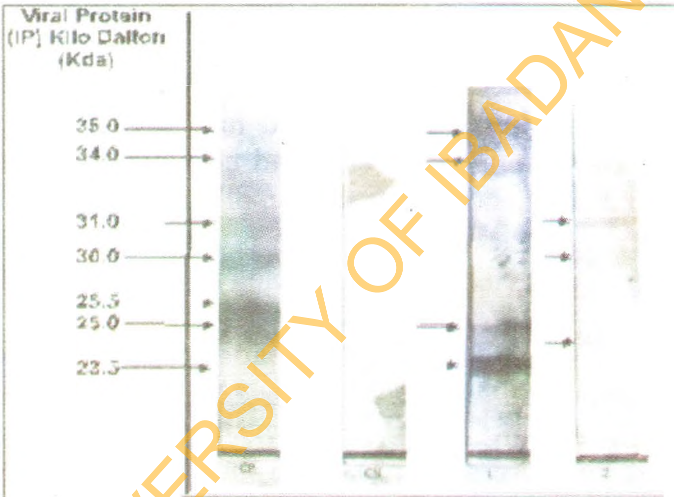
Fifty nitrocellulose strips (or immunoblotting strips) already labelled with African swine fever virus (ASFV) proteins; standard positive and negative reference sera samples were obtained from Instituto Nacional de Investigacion y Technologia Agraria y Alimentaria (INIA) in Madrid, Spain. The method described by Pastor et al (1989)[6.114] was used in carrying out this test. Phosphate buffered saline (PBS) solution was prepared with PBS tablets (sigma), dissolved in 200 ml of distilled water. This provided a buffer solution pH 7.2. Two grams of non-fat dry milk was added to 100 ml of PBS pH 7.2. This PBS-milk 2% buffer was used to dilute sera samples and for blocking on immunoblotting antigen strips (this will be described below).

A chromogen, 4-chloro-1-naphtol (Sigma-Aldrich) was used to detect presence of ASFV immunoglobulins in the reaction. 12 mg of 4-chloro-1-naphtol was dissolved in 4 ml of Methanol. The 4-chloro-1-naphtol Methanol solution was slowly added to 20ml of PBS buffer pH 7.2. A characteristic white precipitate was formed. The precipitate was removed with a filter paper. Figure 4.69 shows the filtration of 4-chloro-1-naphtol precipitate. The substrate of 4-chloro-1-naphtol Methanol solution, with 8 H_20_2 was used as chromogen. This was prepared just before use.

Each test serum sample (1:50 dilution in PBSmilk 2% solution) was incubated at 37°C for 45 minutes on an immunoblotting strip. The strip was washed 4 times with 0.5ml of PBS milk 2% solution for 5 minutes at the last wash. Protein A-peroxidase conjugate was then added (0.5 ml at a 1:1000 dilution in PBS-milk 2% solution) and incubated at 37°C, in continuous agitation. The strip was washed 4 times. The substrate H_20_2 with 4-chloro-1-naphtol (0.5ml) was added to the strip. The reaction was stopped after 10 minutes with running water. See Figure 4.71 for result of immunoblotting assay.

Figure 4.68, 4.69 and 4.70: Bleeding a pig through anterior vena-cava, filtering of 4-chloro-1-naphtol precipitate in methanol solution (the chromogen) and washing of immunoblotting strips with PBS-milk 2% buffer to obtain test results on sera samples collected from pigs

Fig 4.71 Result of immunoblotting test carried out on serum samples collected from clinically ill pigs and convalescent survivors at U.I Teaching and Research farm



Specific bands (IP 23.5, 1P 25.0, 1P 30.0, IP 31.0, 1P 34 and IP 35) of antigen-antibody complex on immunoblotting strips of 2 pigs (samples 1 and 2) infected with ASF virus at the TRF University of Ibadan, compared with control positive (CP) and control negative (CN) sera samples from (INIA) Madrid, Spain

Confirmatory diagnosis

Based on the test results of immunoblotting assay, virus isolation, PCR I-ELISA, the cause of 2001 swine epizootic in southern Nigeria was confirmed to be due to ASF. Five tissue samples were sent to INIA for virus isolation. Isolation was made from two of them. We however tested all the 10 pigs with the immunoblotting technique; 7 of them were positive. Three out of five samples sent from Alabata farm tested positive on PCR. The three samples out of five also tested positive by immunoblotting assay. Use of the I-ELISA with its 96 WHO wells was more economic compared to individual nitrocellulose strips used in immunoblotting assay. Thus responsible for the larger coverage by NVRI[6.113] using the I-ELISA compared with the small test coverage size at the University of Ibadan by immunoblotting assay. Immunoblotting assay was sensitive and specific for ASF confirmatory diagnosis, but its use in large size screening was not economically advantageous.

Since ASF has no effective vaccine for its control at the moment, the group of students thus prescribed strict hygiene measures including restriction of movement of personnel, affected and in-contact pigs, pig products, farm equipment and effective disinfection of farm environment to be maintained by farmers[6.75; 6.89]. This real-time practical training for students is an example of what teaching in epizootiology should inculcate.

2. Preparation of a map of ASF 2001 spread in Ibadan southwest local government area of Oyo State

The initial pattern of spread of ASF in 2001 in southern Nigeria was investigated using Ibadan southwest local government area as a case study. To ensure accuracy of map design, global positioning system (GPS) was used to collect geographic data and geographic information system (GIS) was used to display, edit, and analyse the data presented on a map. Location and distribution of pig farms, and their physical and functional relation in space with lake, streams and roads in the area were described on the map. The map showed direction of spread of ASF in the area. A strong positive coefficient of area correspondence ($Ca = 1$) was obtained for ASF outbreak, road networks and transportation to pig farms[6.75]. A weak Ca was obtained for streams and lake. The outbreak pattern was random but showed positive correlation to trade route for pigs and pig farm inputs. The initial pattern of spread was stock-trade route related. Increased contamination of the environment resulted in spread along stream.

Group B investigators identified seventeen pig farms in Ibadan southwest local government area during the 2001 ASF outbreak mapping exercise. Two of the farms had suspended operations at the time of visit, on accounts aside from ASF outbreak. The group made a list of the farms, dates of ASF outbreak on the farms as provided in Table 4.10. We then used modern geographic data collection tools to map out the outbreaks.

Table 4.10: Locations and dates of 2001 ASF outbreaks on pig farms in Ibadan southwest local government area of Oyo state, Nigeria

S/No.	Name of Farm	Longitude (Degrees)	Latitude (Degrees)	Date of outbreak	Position of date of outbreak	Initial population of pigs on herd
1.	Ade Bode	3.85802	7.39297	07/04/2001	1st	134
2.	Popoola	3.86182	7.36098	09/05/2001	2nd	176
3.	Lord's	3.84005	7.38950	12/05/2001	3rd	607
4.	Bascol	3.84508	7.39200	21/05/2001	4th	971
5.	Adepoju	3.87475	7.35225	01/06/2001	5th	90
6.	Dibiam	3.83572	7.38672	06/06/2001	6th	160
7.	Ojih	3.82350	7.38953	08/07/2001	7th	44
8.	Akanmu	3.82328	7.38553	08/07/2001	7th	214
9.	Tony Jay	3.83109	7.38569	10/07/2001	9th	126
10.	Okusanmi	3.84225	7.36703	20/07/2001	10th	178
11.	Kehinde	3.86624	7.38403	23/07/2001	11th	134
12.	Adeyemi	3.82150	7.38940	10/08/2001	12th	127
13.	Kunlex	3.82678	7.38977	12/08/2001	13th	46
14.	Oyeneye	3.84105	7.37739	21/08/2001	14th	14
15.	Itelorun free-range	3.88561	7.36806	11/09/2001	15th	157
16	Caroline	3.88543	7.36774	-	-	0
17.	Mama Elelede	3.88566	7.36569	-	-	0

In presenting the figures of longitudes and latitudes of the pig farms, five places of decimal was used to ensure what we considered as adequate precision in locating the farms in view of their proximity to one another.

Figures 4.72 and 4.73: Use of the GPS and GIS tools for geographic data collection and management in ASF outbreak investigation

As technology advances, so do our capabilities for disease diagnosis and tracking. GIS technology is one of such advancements that is becoming a more common part of everyday life[6.49]. Schools or departments teaching epizootiology should therefore aspire to have the GPS and GIS equipments for carrying out this type of exercise. Students can then be trained to use them

Group B investigators used GPS to obtain Pig Farm location coordinates and those of free-range pigs. They recorded their readings in decimal degrees. A paper map of Ibadan southwest local government area was obtained from Ibadan southwest Town Planning Office, Ring Road, Ibadan which they converted to a digital map, using a digitizing tablet (Summer Sketch 3[(R)], see Figure 4.74). Digital maps of streams, lake and roads in Ibadan southwest local government area were obtained from Department of Geography, University of Ibadan. They used a desktop and a laptop computer with Arc View GIS Demonstration Edition software license installed on them. They keyed values of pig farm location coordinates into the GIS with other data gathered during field investigation to produce a map of the initial pattern of ASF outbreak in the local government area.

Figure 4.74: A veterinary student using Summer Sketch III (a digitizing tablet) at the University of Ibadan, Nigeria, indicating the usefulness of such equipment in epizootiological studies

A digitizing tablet is used to convert a paper (analogue) map into a digital map to be used in geographic information systems. Training students in this use is considered an essential aspect of a course in Epizootiology.

Method used for designing spatial spread pattern of ASF 2001 outbreak

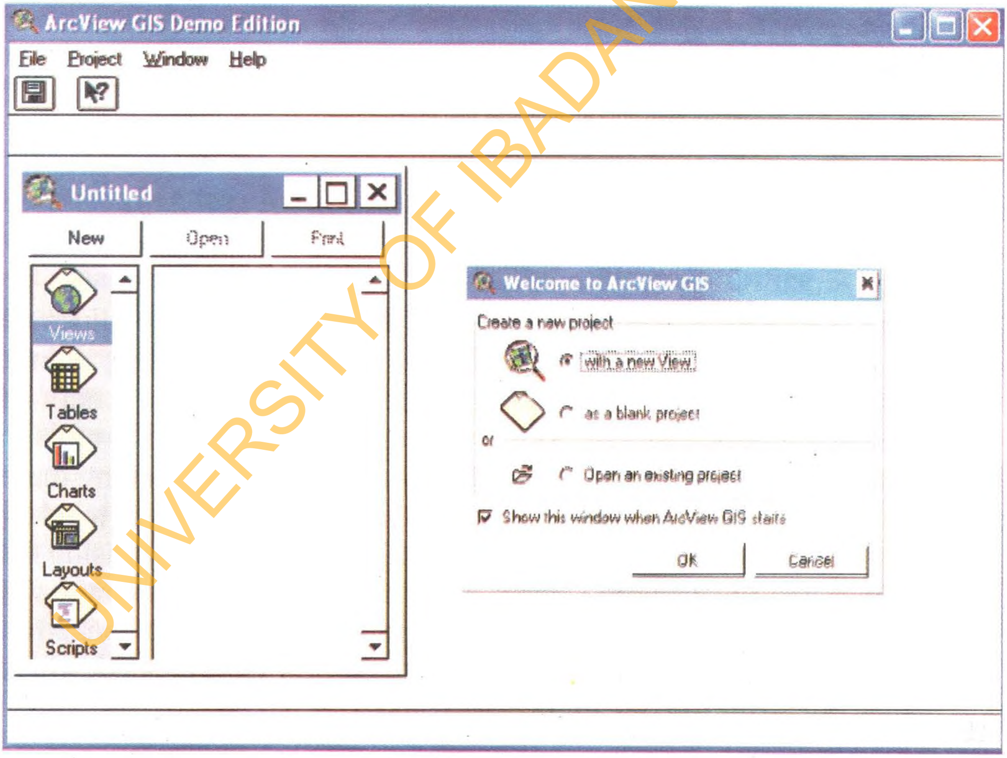
This subsection provides details of the steps taken to illustrate especially the integration of GPS readings into GIS for plotting points, using Arc View GIS Demonstration (Demo) Edition for the benefit of those that may not be familiar with the use of the GPS and GIS tools in biological risk management[6.49]. The step-by-step order of achieving these tasks is provided for easy assimilation. Starting from the welcome window into Arc view GIS application software (see Figure 4.75) to accessing the File menu in Arc View Demo Edition are illustrated to open a new table. New project was selected to access the new project window. We clicked on Tables, opened a new table and added fields to the new table created, which was named *pig farms.dbf*, see Figures 4.76 and 4.77.

In a sequential order, we created ten fields with seventeen records each as shown in Figure 4.77. Fields created were; (i) Identification (ID) No. (ii) Name of Pig Farm (iii) X-CoordLong (iv) Y-CoordLat (v) Date of ASF outbreak (vi) Initial population of Pigs (vii) Number clinically ill pigs

(viii) Number dead (xi) Number culled (x) Number of Survivors. Into each record field, the group typed in data obtained from field investigations at the individual farms.

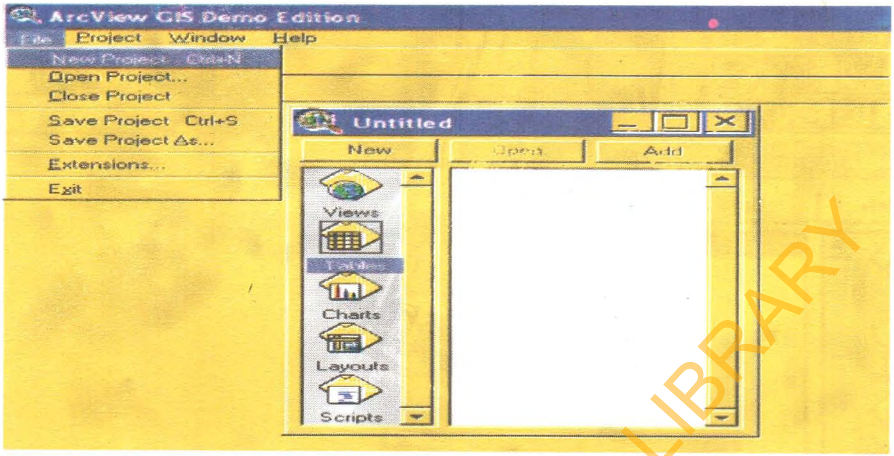
Figure 4.77 shows the table, ***pig farm.dbf*** created in Arc View project. The group used the longitude (X-CoordLong) and latitude (Y-CoordLat) fields to create points representing pig farms and points of ASF outbreaks in Ibadan southwest local government area of Oyo state in 2001. In sequence, we carried out this task. In the menu bar, we clicked on Window, then on View1 to make the view window active. See Figure 4.78.

Figure 4.75: Showing Arc View GIS window that welcomes users to the software



A new GIS project may be created with a new view or from a blank project with a table using this window. Notice Demo Edition on the top left corner of the window, above the menu bar.

Figure 4.76: Showing steps in Arc View GIS window for opening a new project and creating a new table for capturing pig farms coordinates and population data



The blue background on File, New Project and on Tables indicates activity of this menu and the options. Clicking on Tables opens a new table into which data from GPS and other sources including data collected through interviews and observations may be typed. This is a way of integrating GPS into GIS for plotting locations of pig farms and designing a map of ASF outbreak.

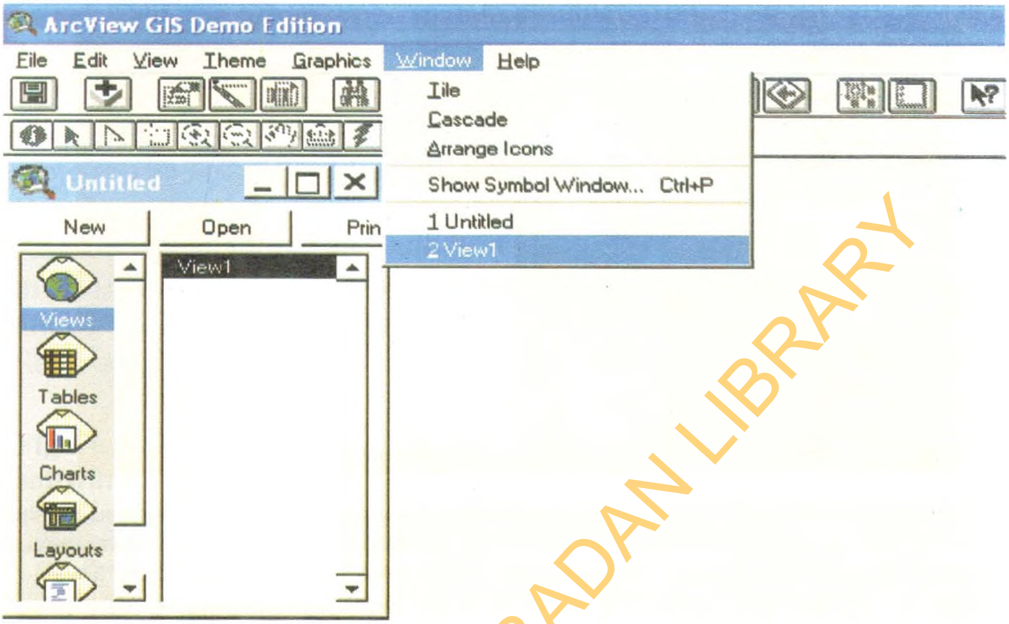
Figure 4.77: Showing pig farm table created in Arc View GIS Demo Edition

pig farms.dbf

ID No	Name ofPig Farm	X-Coord Long	Y-Coord Lat	Date of as	Initial po	Number of	Number dea	Number cul	Number of
1	Ade Bode	3.85802	[illegible]	04072001	134	134	101	[illegible]	10
2	Popoola	3.86182	[illegible]	05092001	176	176	169	0	7
3	Lord's	3.84005	[illegible]	05122001	607	575	494	32	81
4	Bascol	3.84506	7.39200	05212001	971	919	790	[illegible]	129
5	Adepoju	3.87475	7.35225	06012001	88	88	79	5	12
6	Dibiam	3.83572	7.38672	06062001	160	148	148	[illegible]	4
7	Ojih	3.82350	7.38953	07082001	44	44	36	0	8
8	Akanmu	3.82328	7.38553	07082001	214	214	214	0	0
9	Tony Jay	3.83109	7.38569	07102001	126	116	110	10	6
10	Okusanmi	3.84225	7.36703	07202001	91	91	68	15	8
11	Kehinde	3.86624	7.38403	07232001	178	178	134	36	8
12	Adeyemi	3.82150	7.38940	08102001	127	127	115	0	12
13	Kunlex	3.82678	7.38977	08122001	46	30	30	15	1
14	Oyeneye	3.84105	7.37739	08212001	14	14	14	0	0
15	Itelorun freeran	3.88561	7.36806	09112001	157	157	150	7	0
16	Caroline	3.88543	7.36774		0	0	0	0	0
17	Mama Elelede	3.88566	7.36569		0	0	0	0	0

The records in this table provided in 10 columns and 17 rows were created in ArcView project by using the steps in edit mode to add field and records to a new table.

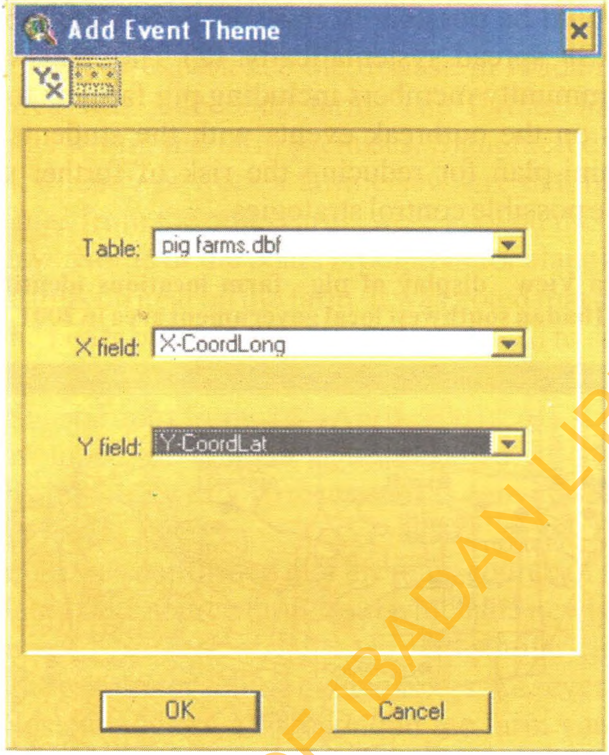
Figure 4.78: Showing steps in Arc View for opening a new view to display a map of pig farms



Blue background on Window, View1 and on Views indicates activity of this menu and the options. Clicking on Views opens a new view into which geographic data from existing folders and files on the desktop (or laptop) could be added. Locations of pig farms were then viewed on the screen in this way.

A click on View in the menu bar and then on Add Event Theme was done. A dialogue box appeared. In the dialogue box that appeared, the group specified **pig farms.dbf** for table to use in creating an event theme that would be added to the new view. We specified X-CoordiLong for the required X field and Y-CoordiLat for the required Y field (see Figure 4.79). We then clicked OK. Pig farms appeared as points on the view. The group added roads, streams and lake to the view. Roads, streams and lake were available in a folder named Ibadan southwest local government area as shape files. We made pig farm theme active in the view, they then accessed the theme menu and clicked on auto-label to display names of farms at their respective locations on the view. The result is shown in Figure 4.80.

Figure 4.79: Arc View GIS Add Event Theme Dialogue box

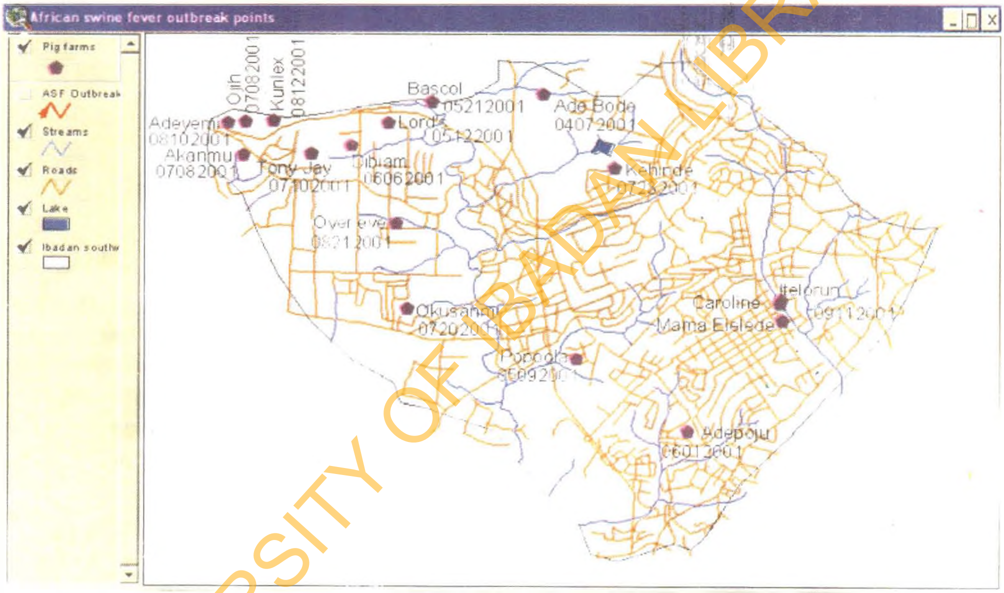


This dialogue box enabled the students to use Arc View GIS to produce an event theme of pig farms on a new view using the x and y coordinates of points taken by GPS and typed into a new table, named pig farms.dbf

Up till this point work done by the students in Arc View GIS had been in **data view** mode. Figure 4.80 shows how maps in Arc View data view appear. To complete their design of 2001 ASF outbreak in Ibadan southwest local government area the group transferred pig farms displayed in data view to **layout view** where it was possible to insert title of map, north arrow, scale bar, and a legend. Thus presenting the map in cartographic convention. The result is shown in Figure 4.81.

A map of ASF outbreak created on Ibadan southwest local government area gave two advantages to the study group, namely (1) it provided spatial insight for helpful questions to ask and hypotheses to consider in the pattern of spread of the disease. With appropriate hypotheses, it would be possible to investigate and describe events that contributed to ASF spread systematically. (2) The map was a suitable visual aid for community members including pig farmers to comprehend and share views on the outbreak events with the students group while drawing up a mini-plan for reducing the risk of further spread of the disease, and some possible control strategies.

Figure 4.80: Data View display of pig farm locations identified and ASF outbreak points in Ibadan southwest local government area in 2001



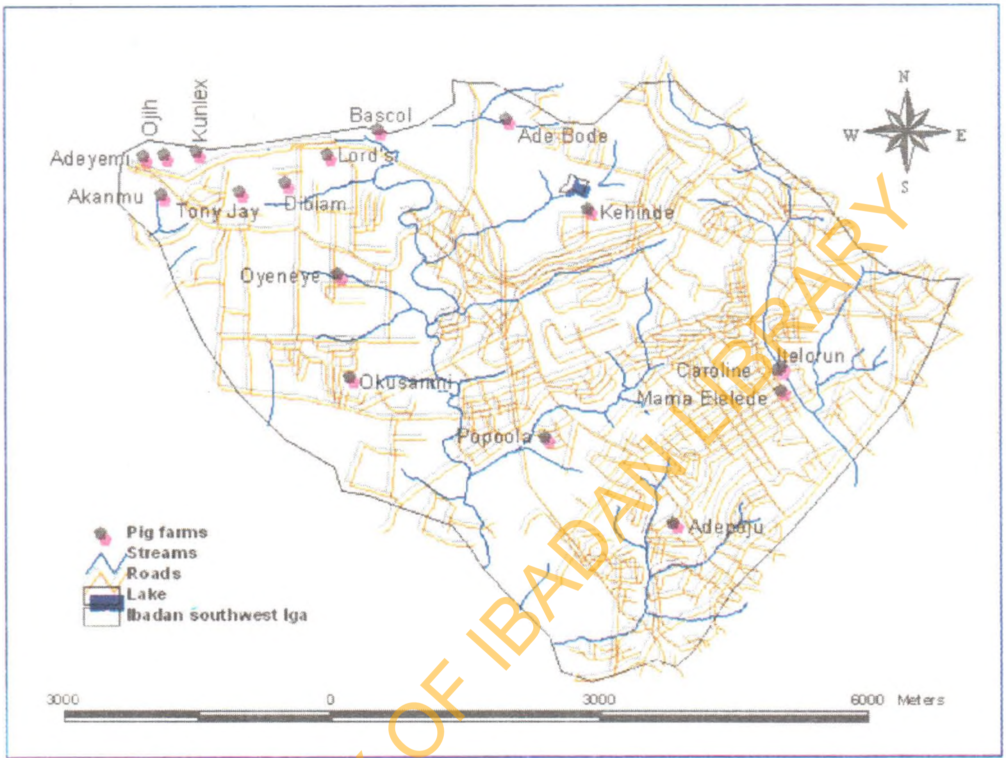
The locations of seventeen (17) pig farms visited for collection of geographic data by Group B DVM students under supervision of a lecturer at the Department of Veterinary Public Health and Preventive Medicine of the University of Ibadan, during the ASF outbreaks of 2001 [6,75]

Spatial spread pattern of ASF 2001 outbreak

The first farm to experience the disease in Ibadan southwest local government area was Ade-Bode farm. The farmer had embarked on slaughter of pigs within the farm premises. Slaughtered pigs were either from her stock directly or from a farm elsewhere that had finished pigs. Pre-slaughter pigs from the other farms were kept on this farm for usually three to four days. Some of the boars brought in for slaughter were used to serve sows and gilts on heat on the farm. It was noted that on the 7th of April, 2001, one of the boars brought for slaughter and used to serve gilts on heat developed clinical signs of ASF and died on 9th April. The in-contact pigs developed ASF starting from 14th April 2001. All in-contact pigs in succession developed the clinical signs and died. 134 pigs on the farm were eventually infected. Only 10 recovered as convalescent survivors.

On this farm it was confirmed that the main source of the outbreak was stock trade related. The source farm from which the newly introduced pigs came had witnessed outbreak of a disease with similar clinical signs. This was probably the reason for selling out their pigs. As several pigs died, they were buried close to edge of a fish pond in the farm yard. A stream runs through the edges of the fishpond yard. There is high possibility of environmental contamination with ASF virus by this event of burying ASF viraemic pigs without sterilization. And by extension the downward flow of the stream may equally spread the contamination to other pig farms especially free range pigs that may feed along stream sides. This hypothesis was considered in the last outbreak point in the study area. Such contamination may contribute to spread of disease[6,75]

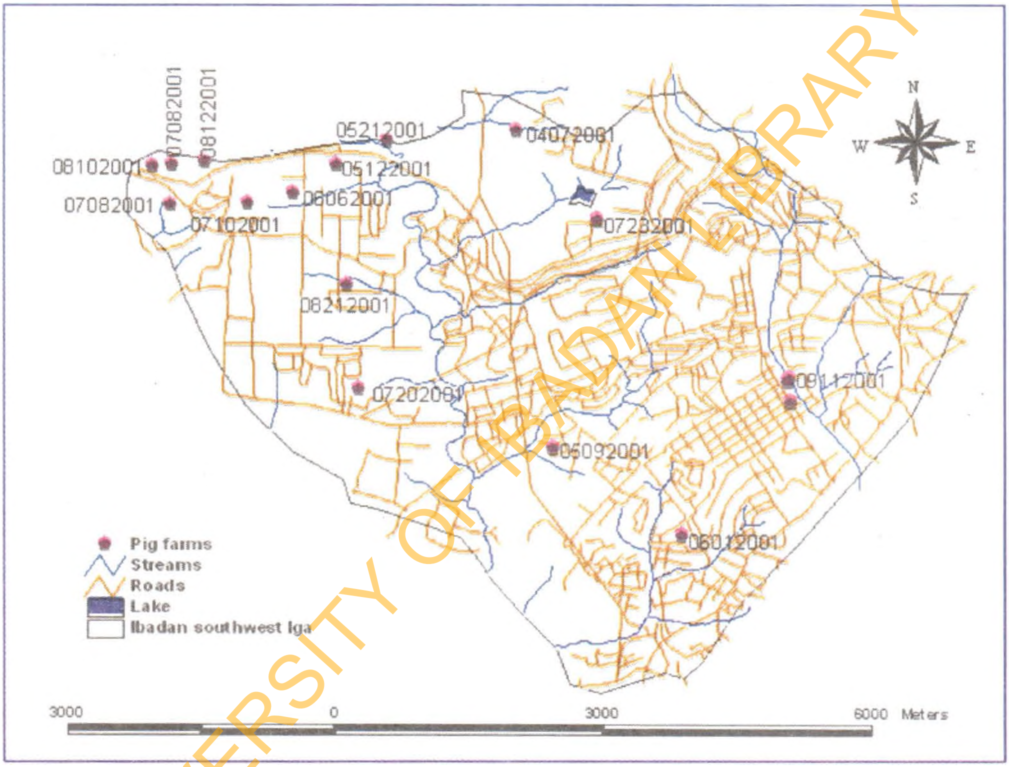
Figure 4.81: Spatial distribution of Pig farms in 2001 in Ibadan southwest local Government area presented in Arc View GIS layout view



What separates GIS from other types of information databases is that everything is based on location (georeference) such as latitude and longitude coordinates. Georeferenced data on pig farms in Ibadan south west local government area of Oyo State, Nigeria were used to produce this map.

In addition to names of farms, date of outbreak was used to label the map. Thus, the spatial distribution map presented with dates of outbreaks resulted in clues to pattern of ASF outbreak on pig farms in Ibadan southwest local government area in relation to streams, lake and roads. Epizootiological questions that may not have been readily perceived if ASF outbreak related data had remained on tables and graphs only now became obvious. Thus, questions such as 'is there positive correlation between proximity of pig farms to streams and lake in the sequence of outbreaks?' Or, is such observed correlation, if any weak or strong? Is road proximity to farm of any importance in the sequence of outbreaks? These are relevant questions that arose by looking at the maps produced. The next set of questions was 'how do we find order in the apparent disorderly pattern of outbreak? Is there a geographic phenomenon that cuts across all these features (lake, streams, roads and farms proximities) that may be considered as a unifying force responsible for sequence of outbreaks?

Figure 4.82: Dates and sequence of African swine fever outbreaks in 2001 on pig farms in Ibadan southwest local government area

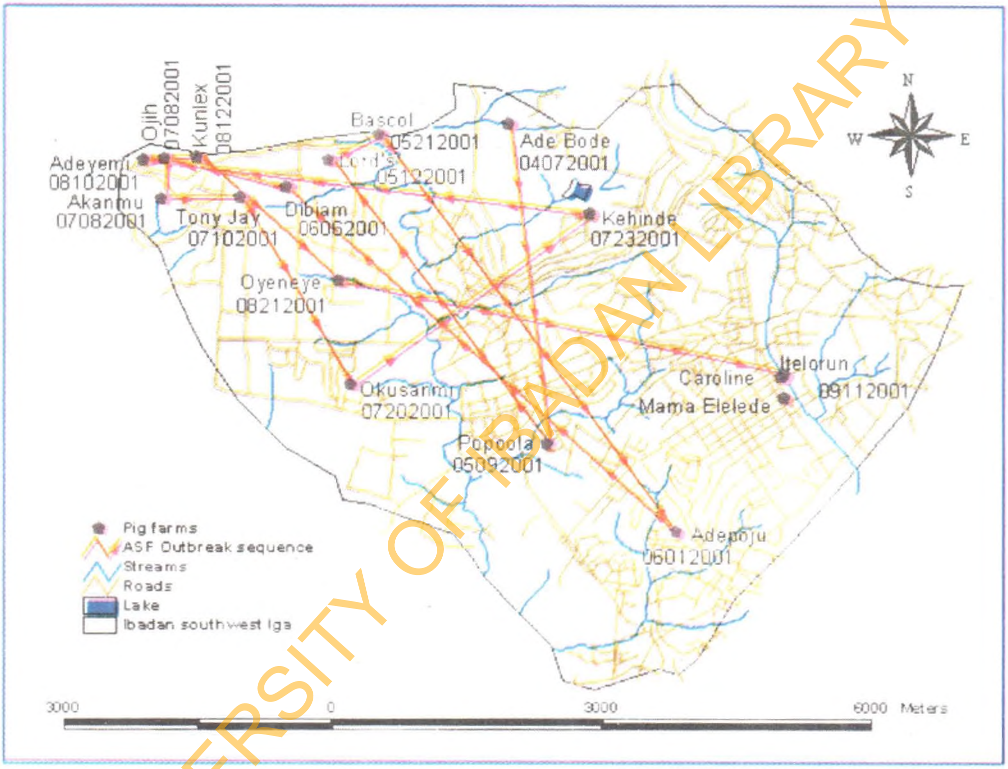


Labelling of georeferenced pig farms with dates of ASF outbreaks in place of names of farms is a step to preparing pattern of initial spread of the disease in a study area.

ASF outbreak had a strong positive coefficient of area correspondence[6.114] (Ca=1) to road networks and transportation to pig farms. This is a measure of spatial overlap showing perfect correspondence. The coefficient of area correspondence of ASF outbreak to lake and streams flow to pig farms was weak Ca= 0.1. This is a measure of spatial overlap showing negligible areal correspondence.

$$Ca = \frac{\text{area covered jointly by both phenomena}}{\text{total area covered by the two phenomena}}$$

Figure 4.83: Pattern of initial spread of ASF in Ibadan southwest local government area in 2001



The pattern of outbreak is shown in red arrow line. Roads, streams and lake have relative roles associated with the spread of the disease across farms.

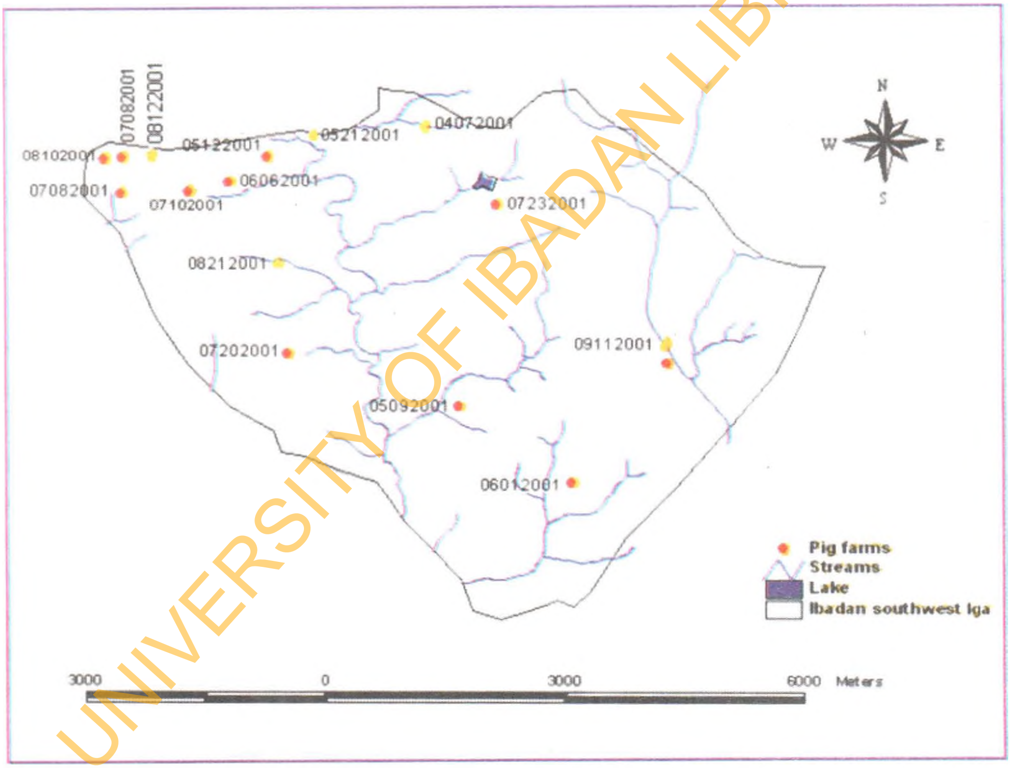
The pattern of spread shown here is multi-directional and linear. It was irregular in direction. The first outbreak point was in the north central area, while the second outbreak point was in the south central area. The direction from 2nd to 3rd outbreak points was northwest ward, affecting two farms in succession to become the fourth and fifth outbreak points. Sixth outbreak point was a location in south east area in the vicinity of the second outbreak point. Tow farms fitted into the seventh outbreak point having occurred on the same day and both were in northwest area ASF continued to spread to another farm in northwest area to become the 9th outbreak points. The 10th outbreak point was in the mid western area. The eleventh outbreak point was in the north east. The 12th, 13th and 14th outbreak points were in the northwest area. The last outbreak point was in the mid eastern area. In all of these points, six farms out of seventeen were within 100 meters distance of streams and used the water from the streams for the purposes of farm sanitation without pre-treatment of the water. These farms included Ade Bode, Bascol, Kunlex, Oyeneye, Itelorun and Caroline.

Roads network reached all the farms. The selling and buying of stocks and pig products which were carried out along defined routes may be a link between roads, farms and the spread of ASF. Thus, transportation of these commodities from one farm to another was shown to be responsible for pattern of the initial spread of ASF in the local government area.

Specific commodities purchased and transported to pig farms included brewery wastes (spent grain) fed to pigs and obtained from a few common depots in Ibadan. The movement of farm workers from one herd to another, especially to farms initially unaffected, may be contributory to the spread of the virus. Popoola and Lord's Farms were the second and third outbreak points respectively. The investigators did not find specific clue to source of outbreak on Popoola farm. But on Lord's Farm, outbreak was traced to eight after sales return pigs, brought to the farm based on an initial opinion that they were poisoned at their own usual premises out of which three were clinically ill. The supposed poisoning was in fact clinical ASF cases. Returned pigs died and in succession other pigs on the herd of approximately 607 pigs were affected. Five hundred and eleven became clinically ill. Five hundred and one died representing 98% case fatality rate. Twenty-three pigs were culled, 10 recovered as convalescent survivors. Forty one piglets and 22 weaners that did not show clinical signs at first later developed the typical clinical signs and died. The survivors were not retained on the farm[6,69]; they were slaughtered for home consumption on the farm.

The outbreak of ASF among free-range pigs by streamside in September 2001 at Itelorun farm area in Oke Ado district of Ibadan was considered due to contaminated environment of the stream by farms with earlier outbreaks, located upstream in the local government area. This, though may explain the spread of ASF to free range pigs by streamside at this location, it was only an hypothesis.

This geographic map of ASF is a special purpose statistical map designed to demonstrate particular features such as location of pig farms, roads, streams and lake and concepts such as transportation and trading, that may present a graphic theme about ASF outbreak 2001 in Ibadan south west local government area. Mapping of the physical features associated with ASF outbreak and abstracting ideas about the disease spread gives a clearer visualization of the problem and for making of plans for its control.



There were six farms within 100 meters of streams and that used water from this source for farm sanitation without prior treatments.

It may be useful to have a **query builder** to select features. Therefore, we used it for selecting pig farms located within 100m distance of streams and thus to indirectly arrived at the coefficient of area correspondence in the spread of ASF by streams in the study area. See Figure 4.85.

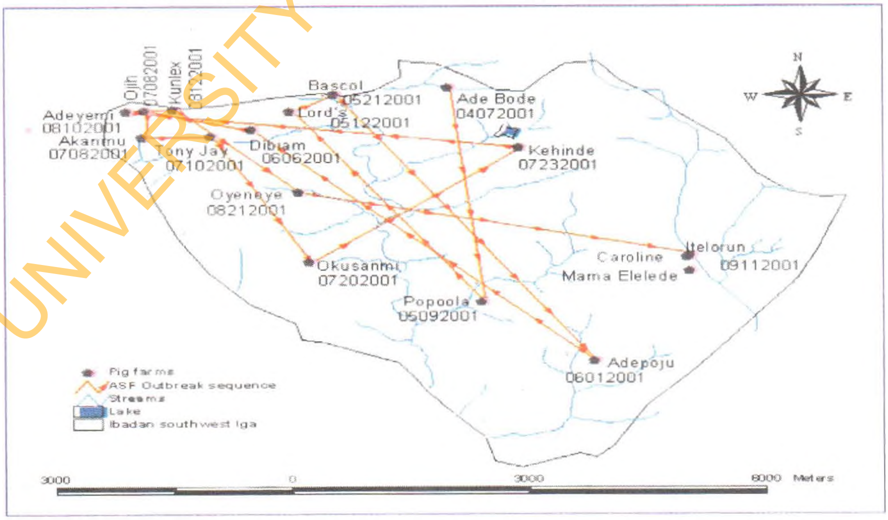
Figure 4.85: Selected pig farms within 100 meters distance of a stream

Attributes of Pig farms.dbf

Shape	ID. No	Name of Pig Farm	X-Coord.Long	Y-Coord.Lat	Date of ASF outbreak	Initial population of Pigs	Number_cl	Number_dea	Number_cu	Number_of
Point	1	Ade Bode	3.85802	7.39297	04072001	134	134	101	23	10
Point	4	Bascol	3.84508	7.39200	05212001	971	919	790	52	129
Point	13	Kunlex	3.82678	7.38977	08122001	46	30	30	15	1
Point	14	Oyeneye	3.84105	7.37739	08212001	14	14	14	0	0
Point	15	Ilelorun Ireeran	3.88561	7.36806	09112001	157	157	150	7	0
Point	16	Caroline	3.88543	7.36774		0	0	0	0	0
Point	2	Popoola	3.86182	7.36098	05092001	176	176	169	0	7
Point	3	Lord's	3.84005	7.38950	05122001	607	575	494	32	81
Point	5	Adepoju	3.87475	7.35225	06012001	88	88	79	5	12
Point	6	Dibiam	3.83572	7.38672	06062001	160	148	148	8	4
Point	7	Ojih	3.82350	7.38953	07082001	44	44	36	0	8
Point	8	Akanmu	3.82328	7.38553	07082001	214	214	214	0	0
Point	9	Tony Jay	3.83109	7.38569	07102001	126	116	110	10	6
Point	10	Okusanmi	3.84225	7.36703	07202001	91	91	68	15	8
Point	11	Kehinde	3.86624	7.38403	07232001	178	178	134	36	8
Point	12	Adeyemi	3.82150	7.38940	08102001	127	127	115	0	12
Point	17	Mama Elelede	3.88566	7.36569		0	0	0	0	0

Six farms were selected here (1, 4, 13, 14, 15 and 16) and promoted to the top of the table. An attribute table displays selection result and gives yellow background colour to items selected.

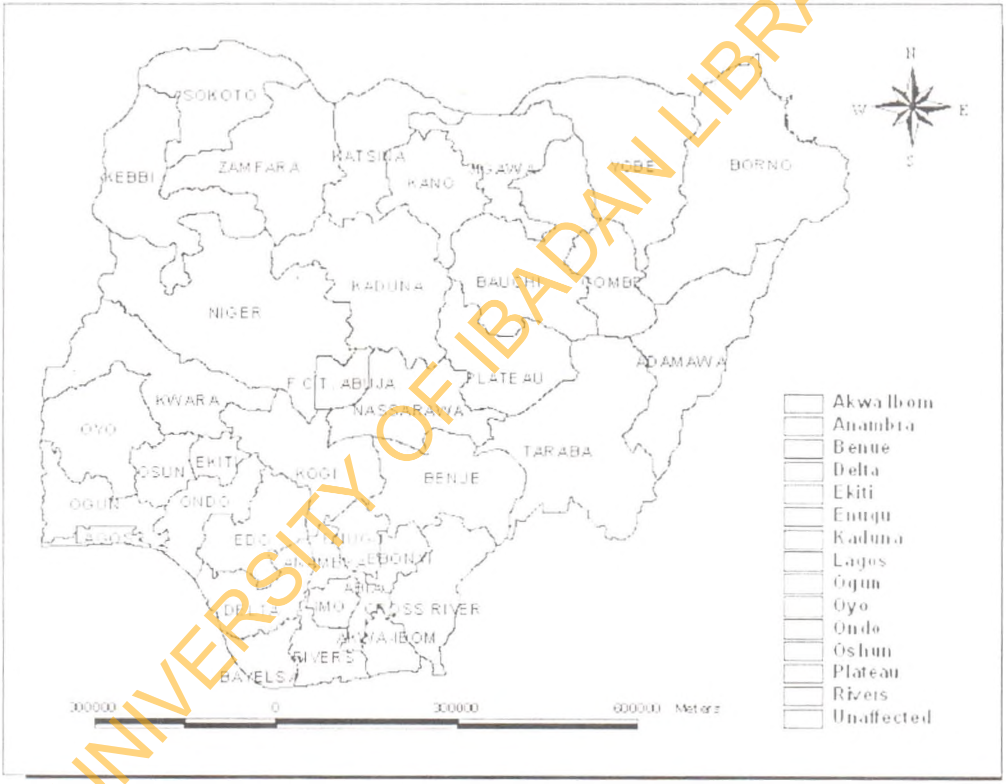
Figure 4.86: African swine fever outbreak sequence in 2001 in relation to streams in Ibadan southwest local government area



Points of first outbreak and last outbreak in Ibadan southwest local government area (with green arrow pointers) were both within 100 meters distance of a stream

In the meantime, fourteen states were confirmed to have had outbreaks of ASF in Nigeria between 1997 and 2004 through diagnostic tests results obtained at the National Veterinary Research Institute[6.113]. Figure 4.87 below presents states affected. The study area covered by students at Ibadan thus represents small sample coverage of what was happening across the country. Thus, the students had an opportunity for disease investigation in a part of Nigeria.

Figure 4.87: Locations of confirmed African swine fever outbreaks in states of Nigeria (1997-2004)



Map designed by Dr. B.O. Olugasa based on data published by Majiyagbe *et al*, 2004[6.113].

Using I-ELISA diagnostic technique and a larger quantity for national coverage, the NVRI was able to carry out confirmatory diagnosis for all states of the federation that witnessed the outbreak and submitted samples for laboratory tests.

3. Determination of virus carrier status of convalescent pigs on farms

Group C investigators found out that convalescent pigs (survivors) were significantly resistant to the virus. This was due to the fact that all the convalescent pigs basically experienced typical clinical signs of ASF but recovered. While other pigs within the same pens and herd developed the clinical signs and died, these ones remained fully recovered. It was also observed that when an unexposed boar to ASF was used to serve convalescent gilt, the boar developed full clinical signs within three days of serving the gilt and died within two days of clinical signs. This situation suggested that convalescent survivors were carriers of the ASFV. The resistance shown was considered to be antibody mediated.

Table 4.11: Illness pattern and deaths in 2001 ASF outbreak on A pig farm in Ibadan, Oyo State, Nigeria

Day of Clinical Signs	Number of Pigs on Farm	Number Clinically ill	Number Dead	Age group Dead
1	55	1	0	Nil
2	55	3	0	Nil
3	55	3	1	Dry sow
4	54	3	2	In-sow and a Grower
5	52	8	0	Nil
6	52	8	0	Nil
7	52	10	4	In-Sows and Boars
8	48	9	1	Nursing Sow
9	47	10	5	Dry and In-sows
10	42	10	6	Piglets, Boar and Gilt
11	36	16	1	Finisher
12	36	16	1	Finisher
13	36	17	2	Gilts
14	33	14	5	Piglets
15	27	12	6	Piglets and Finishers
16	21	8	3	Piglets
17	18	6	1	Gilt
18	17	6	1	Gilt
19	16	8	2	Growers

20	14	6	2	Growers
21	12	5	2	Weaners
22	10	4	2	Weaners
23	8	4	2	Weaners
24	6	3	2	Weaners
25	4	2	1	Grower
26	3	1	0	Nil

The days in the table covered 13th September through 8th October 2001.Location of Farm: Iwo Road, Lagelu local government area of Oyo State. Date of visit: 15th September 2001. Breed of Pigs: Large white. Name of Farm owner: Ministry of Agriculture and Natural Resources, Oyo State. Initial population of pigs was 55. Name of Farm: Government Farm, Ibadan.

Number clinically ill on each day implied the obviously ill ones and is independent of the number that died on that day. In other words, the number that died in a day is also included in the number clinically ill. Thus for example on day 3, there were 3 clinically ill cases out of which one later died the same day.

Figures 4.88, 4.89 and 4.90: Picture of a pig that died suddenly with blood discharge from the mouth, at U.I. Teaching and Research Farm (See a post mortem section of the liver, *ibid.*)

ASF outbreaks in 2001 and 2002 devastated the piggery section of UI Teaching and Research farm at Ibadan with its high morbidity and mortality rates.

[1] Convalescent survivor

The piglets of convalescent survivors also showed resistance against the virus. A serological test of the presence of specific antibodies against ASFV in the piglets of convalescent survivors was done. These piglets had antibody passed to them from the dam, probably via colostrum.

Figure 4.91: An ASF convalescent survivor sow with nine piglets

Piglets of convalescent survivors had maternal antibodies to ASF in their serum samples. They were resistant to the disease.

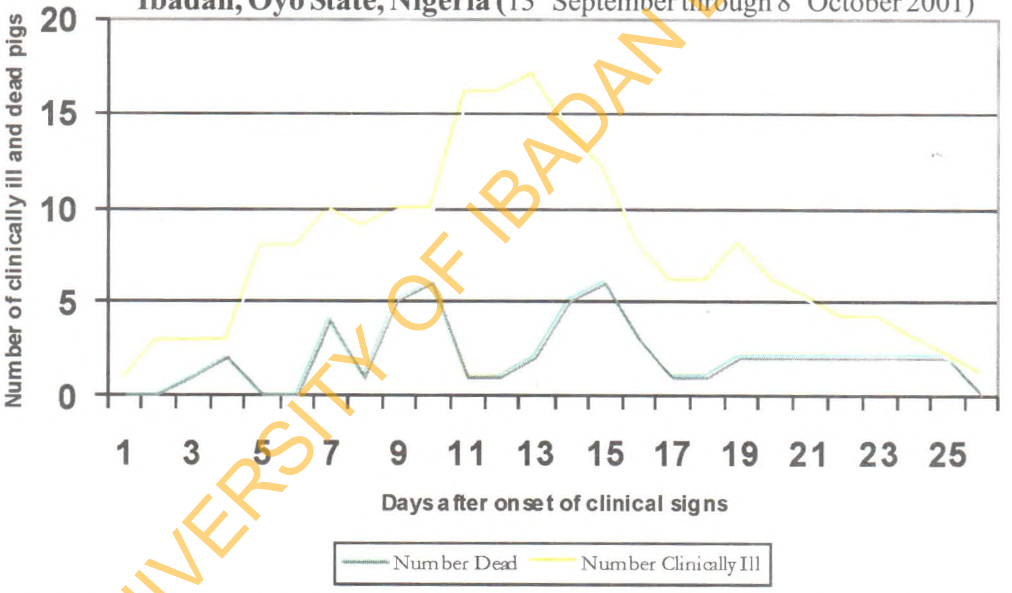
Non-implementation of slaughter policy resulted into diverse styles of restocking carried out by farmers. Some farmers depopulated all survivors and disinfected their premises with hypochloric acid and Lysol in alternate pattern. This group of farmers restocked with pigs that were confirmed ASFV-free. Restocking this way was successful. Another group of farmers restocked with the convalescent survivors, which were carriers, without disinfecting their premises. This was also successful in that outbreaks were forestalled. This situation whereby ASF virus carriers exist along with ASF virus free pigs makes future outbreaks risk high.

4. Social and economic effects of African swine fever 2001 outbreaks on pig farms in Oyo State of Nigeria

Group D investigators compiled social and economic effects of 2001 ASF epizootic on pig farms and farm families. It was found that a variety of social damages ranging from a farm family that lost the life of a wife as an indirect consequence of the disease, up to a family that had to recall the children from schools of training occurred[6,89]. Most farmers were destabilized and vigorously pursued a dire resort to herbal trials for possible remedy to ASF.

Financially, 29,044 out of 31 916 pigs were reported dead; and these were worth one hundred and thirteen million, nine hundred and nine thousand Naira (N113,939.000) at current market price in 2001. See Table 4.12. Economically, some of the piggeries closed down which meant some of the workers lost their jobs and means of livelihood. Socially, families were destabilized and some others carried out panic selling of their pigs which further complicated the spread of the disease and increased the financial loss.

Figure 4.92: 2001 ASF death and illness time curves on Government Farm, Ibadan, Oyo State, Nigeria (13th September through 8th October 2001)



This investigation may be further enhanced if the researchers could produce a time related line graph for each farm that witnessed the outbreak.

In economic terms, massive culling of pigs at significantly low prices and high death rates up to 100% on some farms were recorded. Farm environment witnessed massive burial of carcasses and exposed dead pigs were found in some pig pens. There was no form of compensation to the farmers affected. This outbreak was a typical epizootic. Where the facilities were available, farm families adopted risk-sharing strategies in the form of diverting into fish farming, poultry production and wage/salary earning jobs. Sharing risk with fish farming in particular gave effective financial returns to some affected farmers and the courage to undergo gradual physical, mental and social re-stabilization.

Table 4.12: Financial loss due to ASF 2001 outbreaks in Oyo State, Nigeria

Age Group	No. Dead	Unit price	Lost value (Naira)	Lost value (USD)
Piglets	9.314	1,000.00	9,314.000	79,616.67
Weaners	6.053	2,000.00`	12,106,000	100,883.33
Growers	3,791	3,000.00	11,373,000	9,477.00
Finishers	3,428	5,000.00	17,140,000	142,833.33
Gilts	2,344	8,000.00	18,752,000	156,266.67
Sows	3,026	11,000.00	33,286,000	277,383.33
Boars	1,088	11,000.00	11,968.000	99,733.33
Total	**29,044**	-	**113,939,000**	**941,491.69**

Two years later many of the farmers had adjusted and stabilized physically, mentally and socially. But pig production in this part of the country may be in continual risk of outbreaks of ASF due to carrier convalescent survivors. Group D investigators integrated their findings on social and economic effects of ASF outbreaks on pig farms into geographic maps of the outbreak created by group C. They compiled a summary of financial losses from the outbreak on the various farms. This was in the range of N113,939,000 at current market price in 2001. They compiled this in anticipation that government may wish to compensate farmers through the animal health authorities in Oyo state, Nigeria.

Figures 4.93 and 4.94: A pig farmer and a veterinary student assessing workability of a miniplan on ASF control. A group of public health veterinarians assessing a miniplan

It is important that all interest groups should understand and accept the miniplan to ensure effective implementation.

In assessing workability of a mini-plan for control of ASF, Groups A, B, C and D reckoned that a successful plan management depended on the quality of the mini-plan, leadership, and the degree of public participation in each local government area. The condition set was to put together a miniplan in an open and organised fashion with well-researched and carefully analysed information, so that the management of the plan should become somewhat obvious. This partnership strengthened the arms of farmers for collective bargaining for state assistance on the effect of ASF on pig farms. It also cleared doubts about authenticity of claims since many farmers in attendance were aware of the situations when they happened. They were able to contribute to planning information for ASF control.

The investigators in these practical exercises found that Epizootiology provided opportunities for environmental systems description and community studies on problems affecting animals and by extension man. They recommended that group leaders in epizootiology (which may be a professor or teacher) must show a long-term commitment to planning, guaranteeing continuity and an open planning process. Eleven Doctor of Veterinary Medicine students that actively participated in this exercise eventually developed topics for their DVM project reports based on the exercise (see Appendix VI).

Summary and Conclusion

While these exercises provided the classes of DVM students with opportunities for real-time case studies in 2001 and between 2002 and 2004 on a topic of epizootiological importance, the following issues were considered after these exercises for training undergraduate students.

(i) The exercise by the students was limited to a small area of the outbreak. Therefore, it is obvious that a comprehensive study of such a problem should involve much of the area or a representative sample of the area affected. By this, the coverage will provide more realistic information on the pattern of the disease, the magnitude of the losses, and the implications of the outbreak in social, economic and financial terms.

Chapter 5

APPLICATIONS OF EPIZOOTIOLOGICAL PRINCIPLES AND METHODS

5.1 Introduction

Epizootiology, as defined and explained earlier, is never an end in itself; it is usually meant to be a means to many possible ends. One of the major ends is that of prevention of group problems, i.e. problems of groups of animals (herd, flock, pack, hoard, flight, shoal, and human population), family systems and relationships. Another useful end is the cost-effective control of such problems, based on appropriate knowledge (of factors, events, forces, circumstances, relationships, interrelationships and interactions) provided during relevant epizootiological studies. Therefore, some of the applications of epizootiological principles and methods are as listed above and discussed below.

In ultimate terms, epizootiology is meant to provide the soundest basis for preventive veterinary medicine (pvm) or preventive measures (pm) in the broadest, strictly holistic and deepest sense. Hence pvm is preventive measure (*pm*) in the most comprehensive and holistic sense. This has to be so, since what veterinarians seek to prevent are never limited to the problems of lower vertebrate animals; they include human problems (which is a major aspect of **veterinary public health (vph) practice**, which is most apparent in (but is not limited to) **food hygiene** and **control of zoonoses**). The prevention of degradation of the external environment, which is shared by most types of living things in each ecological zone and is affected by all *meteorological* and *edaphic* factors in each type of ecosystem are important aspects of veterinary public health and preventive medicine being contributions to **community development** and **environmental health**. More so, all these would be in vain without due attention to the *internal environment* of each vertebrate animal species, which is a major aspect of *immunobiology*. These are key statements that would be taken up in greater details during advanced studies in systematic epizootiology.

5.2 Classification of animal group / population problems

The principles, methods, components, phases and approaches of epizootiology have been presented in the preceding four chapters of this book. The ultimate goal is to explain how these principles and methods can be applied to investigate, elucidate and then solve the problems of animal groups or human populations in a defined geographical location, over a stated period of time, through the cheapest and natural means at our disposal. We should be aiming at breaking the chain of events leading to the problems at its weakest link. The first steps therefore are to identify, define, describe, explain and then classify the varieties of the usual problems affecting such populations, be they of livestock, or of pets or companion species, or of beasts of burden, of wildlife or even of *Homo sapiens**.

One natural way of identifying and classifying the various problems of members of the biological animal kingdom is to consider the various essential activities of their living as a baseline for all the species as well as the nuances, whereby some prefer the words epidemiology for animals to epizootiology *sensu stricto*. In brief this should involve a study of their breeding, feeding, nutrition and their living conditions in relation to their habitat or external environment (all of which should properly come under *husbandry practices* in the case of livestock). It should also include the study of the natural ways of coping with, controlling and surviving their pests and other enemies in the common environment, maintaining their normal hygienic practices, their *bionomics*, as well as how they maintain their health so as not to succumb to their usual problems should also be studied.

What we have mentioned above in brief is a major section in *Systematic* (i.e. Advanced) *Epizootiology*, especially covering *community studies*, which is the treatment of the same subject at an advanced level. The most important thing to note at this introductory / elementary (Epizootiology/Epizoology) level is that animal breeding, feeding, nutrition, living styles in relation to habitat, patterns of reactions to their enemies and how they maintain their health with or without human interventions, are each associated with some peculiar problems. The understanding of such problems in their proper perspectives is the first

*See Glossary section of this book for details essential step towards solving or controlling them and the associated undesirable effects. This topic will be resumed under *epizootiological diagnosis* in sub-sections 5.4 below). But in the meantime it may be useful to consider the natural histories of some diseases and other problems in groups / populations of animals.

5.3 Natural histories of diseases and other problems in animal herds (or populations)

5.3 (a) From an epizootiological point of view, diseases constitute only one of the many groups of problems to which the principles and methods are applicable. There is almost no limit to the varieties of problems in animal populations, as in human herds to which the methods are applicable, howbeit with appropriate modifications according to the nature of the problem and that of the variable determinant factors … and their relationships with one another. Nevertheless, in order to show that epizootiology is a natural continuation of the scientific stories already started in anatomical, physiological, immunological, other biological, pathological, microbiological and parasitological studies, the examples of the natural histories of diseases to be cited here will be those also applicable to the teachings of those other disciplines.

5.3 (b) (i) The *natural history of bovine brucellosis*

Classical bovine brucellosis is the one caused by interaction between cattle and the bacterium called *Brucella abortus*. The student should recall his knowledge of bacteria as obtained during the earlier course in Bacteriology (or Microbiology). That knowledge will be assumed. Hence, we need not repeat here the classification, morphological, biochemical and other characteristics of *B. abortus*. But we would say that the knowledge is relevant. And building on that essential foundation, we shall continue here with the natural history (not of *Brucella per se,* nor of the cattle sufferer but) of bovine brucellosis as a disease, being the outcome of a *system of relationships* between a *species* of *Brucella* organisms and some *species* of domestic cattle i.e. *Bos indicus* and *Bos Taurus*). Remember also that by definition Epizootiology is a study of relationships.* In the present case, it is of an asymmetric (i.e. causal) relationship between a parasite *B. abortus* and its host cattle (Recall

*See Glossary section of this book for details

Theobald Smith's infectious diseases as parasitism[6.108], type of relationship. Cattle is the host, brucella is the agent/parasite. The disease (brucellosis) is caused by the parasite (*Brucella abortus*) in the bovine (cattle) *species*. Hence it is called Bovine brucellosis. But it occurs in various scenarios, depending on how and where the *event* begins and *where* and how it ends.

5.3 (b) (ii) *The usual beginning*

The usual beginning of the relationship is either by *contamination* or by *ingestion* or by direct *inoculation*. Obviously the mode of first contact ("the first impression or encounter of each other sort of") is an important variable determinant of the *nature* and outcome of the subsequent relationship and the problematic aspect of it, or so would be our first epizootiological assumption. The assumption should provide a ready basis for some hypothesis, based on established knowledge and amenable to hypothesis as well as experimental testing. But first we should try to trace the course of a relationship that starts with contamination.

5.3 (b) (iii) Scenario *1*: *Relationships commencing with contamination*

Abortion is one of the cardinal signs[6.58] of bovine brucellosis. When this occurs the organisms are shed in their millions with the uterine and vaginal discharges from the aborting cow. In one way or the other, the natural orifices of potential hosts are contaminated. The outcome of this then depends on the number of organisms, the resistance of the hosts and the ability of the *brucellae* to survive and establish themselves on the mucous membranes of their new hosts.

If the organisms survive, they will then invade the tissues of the host. They may find their way into the labyrinth of *lymphatic capillaries* under the hosts' *mucous membrane*. There they are readily picked up by the phagocytes (microphages and macrophages), and then transported into the various local lymph nodes in the area. There they multiply and burst out of the cells, finding their ways into the blood circulatory system, thus producing the stage of *bacteraemia*. In the blood, the organisms are exposed to the defense mechanism of the host. The serum antibodies are attracted to combine with them, and with serum complement they become susceptible to phagocytosis and elimination from circulation. Eventually, the organisms that evade phagocytosis settle into the cells of the lymphoreticular system where they remain quiescent, until something triggers off their multiplication and release into circulation again.

One of the factors that trigger their multiplication and circulation is a polysaccharide substance called *erithritol*, which seems to have its origin in the gravid uterus of cattle. So that the *brucellae* eventually invade the uterus, the placenta and the blood of the foetus, where they again multiply astronomically. And when abortion or even "normal" calving occurs, the bacteria are discharged in large quantities into the external environment, in the byre or on the field where the cattle are grazing. From there other susceptible hosts (man or lower vertebrate animals) become infected through contamination, leading to infection or through ingestion of contaminated materials by the host, also resulting in clinical infection of the new hosts.

5.3 b (iv) Scenario *II: Relationship commencing with ingestion*

When brucella organisms are ingested by cattle, either with infected or contaminated milk or with grass or other feed items, the organisms find their way into the blood circulatory system. This is the first stage of bacteraemia and fever. The rest of the cycle of events proceeds as for the scenario I, starting with contamination and up to bacteraemia. Fever is usually an indication that the organism is getting round the body via the blood circulatory system. As this stage is repeated from time to time, the patient is said to have undulant fever. It is of more significance in man than in cattle.

5.3 (b) (v) *Scenario III: Relationship commencing with inoculation*

Whenever virulent brucella organisms are accidentally injected into cattle, acute inflammation occurs at the site of injection. The first phase of bacteraemia occurs being marked by severe fever. The rest of the cycle of events proceeds as for other scenarios, except that the clinical signs and the effects on the host are more severe and most dramatic.

5.3 (b) (vi) *All scenarios*

To a greater or lesser extent, the undulant nature of the fever associated with the disease, especially in man (brucellosis is a zoonotic disease) is manifested also in the lower vertebrate species. Periods of high fever are followed by spells of remission until abortion or "normal" calving occurs in cattle (or severe debilitation, mental derangement and agonizing death occurs in man; it is never a pleasant situation in man if the disease is not effectively controlled).

It should be noted that peaks and troughs of clinical signs are usually associated with appropriate immunological (and other biological) responses of the host. These responses are indicated by rises in the titre of the various types of (early and later) anti-bodies and cell mediated immune (cmi) responses, all of which may be detected and quantified by appropriate immuno-diagnostic tests.

The actual course of the disease and the likely outcome at every stage and of every scenario can be predicted by epizootiological methods on the usual scale of probability if all the variable determinant factors and events have been carefully, accurately and adequately defined, monitored and measured in the appropriate units and at the appropriate levels of specificity, sensitivity and validity.

What all these points indicate is that by following the appropriate methods of Epizootiology the natural histories of the various diseases and other problems in groups / populations of animals (and people) can be comprehensively uncovered and thereby facilitate their natural control and determination at every conceivable stage. It should also be noted how the knowledge and skills obtained from studies in the other disciplines (and more appropriately the actual participation of those other disciplines) become relevant to the efforts of the epizootiologists. Again, it is here emphasized that Epizootiology is a multi-disciplinary, even inter-disciplinary subject, right from the stage of definition and diagnosis of the problems, their nature and their volume. Hence Epizootiological diagnosis will next be considered in the following section.

5.4 Epizootiological diagnosis

5.4 (a) What is diagnosis?

Diagnosis means **making statements** about the *occurrence*, *nature, causation and likely course* of a disease (or other *problems*). Diagnosis is usually preceded by case history, relevant observations, further investigations, acquisition of specific knowledge, application of experience of previous cases of similar nature and the results of specific tests have been achieved[6,59]. **Diagnosis therefore usually consists of expressions of observations made and interpretation of results obtained at the end of study tasks by various disciplines, at various stages, in the course of disease, other problems and their undesirable effects.** For human problems, such statements of feelings and observations would usually start from the patient himself/herself e.g. when he/she says "I have fever." For veterinarians the very first statement is often made by the client/owner of the patient (e.g. when he/she says "My dog is coughing" or that "My dog is behaving abnormally", "My horse is lame.", "My pigs have worms.". And in this case of bovine brucellosis, "My pregnant heifers are aborting." It is to be noted that **such statements made by the owner is a form of diagnosis at the level of the owner.**

But then, the physician or veterinary **clinician** is next given the opportunity to examine the patient before **making his own statement of diagnosis.** And that would be the **stage** and **expression of clinical diagnosis**. The clinician may, for example conclude that the patient has metritis, or in other circumstances pneumonia. But he could also take specimens from the patient and send same with specific requests to a bacteriologist, virologist, parasitologist, haematologist, immunologist, or histopathologist for further investigation in their various laboratories. **Each of these will also then make their own statements of diagnosis** after conducting their own investigation (tasks) on the same problem. Hence we could have stage-wise clinical, microbiological (bacteriological or virological), haematological, immunological, cytological, histopathological and/or parasitological statements of diagnosis whichever one or group is relevant to the suspected disease or other problem, as determined by the clinician or clinical epizootiologists, whichever one encountered the problem first.

Moreover, epizootiological diagnosis fundamentally takes into account factors, forces, events and circumstances of

- **Groups** or populations of hosts, agents, vectors and reservoirs of disease;
- **Places** in geographical and ecological terms;
- **Time** in terms of dates, season/s, when, since when, duration, how often, trends, peaks and troughs;

- symmetrical and asymmetrical **associations**, interactions, dependence and interdependence in terms of food, nutrient, energy requirements and chains, also in terms of mutualism, commensalism, parasitism, chance and ephemeral associations with or without climax or stability in the relevant ecosystem: **and**
- in terms of **environmental health**, degradation, sustenance of natural variety of species, their survival, threatened state, increasing and decreasing prosperity. These are all in the context of **community health**.

The usual conception is such that an epizootiological diagnosis may not be considered or adjudged to be complete or holistic unless those classified issues are given due consideration, depending of course on the nature of the system's problem being considered, the context and level at which it is being considered, the objectives of the system and that of the exercise, project or programme. Thus, **epizootiological diagnosis will always cover the scope of being as comprehensive as** the protagonists may think necessary and optimally cost-effective, and depending on the availability of resources or as much as the system's capacity for resource management approach may permit.

Following the systematics, logic paths and tools of thought just presented, epizootiology will readily prove to be the soundest tools, not only for determining the most reliable prognosis, but in choosing from the most appropriate or optimum of solution options for control, extermination and prevention of the group problem in hand and its envisaged extension or worsening. It will also lead the way to wisdom in minimizing the adverse or undesirable effects of group problems (i.e. problems of herds, flocks, populations *et hoc genus omne*) cost-effectively in financial, economic and social terms, these being issues in *socio-economic jurisprudence* (sej), which is always of cardinal concern in epizootiology.

5.4 (b) Phases of Diagnosis

Eventually the **Epizootiologist** comes round to look at all those early statements. Or, he *ab initio* seeks the help, collaboration or cooperation of any or rarely all of those other disciplines. Or he approaches the problems partly along the line from the points of view of the relevant disciplines. But in addition he looks, not only at the sick and the dead, but also at the apparently normal members of the group / herd / flock / population in which some members have fallen ill or have become overtaken by the problem and are dead; he **looks at the entire group** or population (*cohort*) **at risk or exposed**, or at *representative samples* from the group or population of his concern, and also at similar but unexposed groups / populations as controls. As a result of his investigations, **the Epizootiologist then makes his own statement of diagnosis, which is usually most embracing, and likely to provide materials that may guide sound and conclusive decisions or actions for control and prevention of the group problem and that of their environment.**

Triangulation[6.47]

In summary and conclusion, we could say that **diagnosis is a network of activities and pronouncements** on which epizootiologists and adherents of cognate disciplines, base their decisions on the nature of and take appropriately cost-effective management actions on group problems.

Diagnosis is therefore a stage-wise affair; and **epizootiological diagnosis is the fulcrum on which the understanding, definition, simplification, control, eradication and prevention of diseases and other problems in specific groups of animals** (and/or human populations) **revolve.** Proper diagnosis is a network or system of accurate and adequate observations, investigations, tests, data processing (including computations, summary presentations and analysis) and interpretation of the results that may guide us to make valid decisions and take effective actions in the control and prevention of problems in populations of men, women, children, adults or mixtures of all the above (that being a matter of *Epi'demiological* diagnosis), as in groups (herds, flocks, etc) of *animals* (that being a matter of *Epi'zootiological* (which includes *epidemiological* diagnosis) and in groups of plants in lots and plots, crops, forests, and fields (that being a matter of *Epi'phytological* diagnosis), or and of mineral elements and substances (that being the concern of *Epi'inanimatological* diagnosis). For example, it was concluded that a sero-epizootiological diagnosis could be based on antigen and antibody ELISA technique. And these were found to be valuable adjuncts to clinical and parasitological methods of diagnosing animal trypanosomosis, studying the epizootiology of the disease, and monitoring the effectiveness of control methods[6.115].

The usual starting point is to consider which group/s of objects is/are having the problem/s to be diagnosed. And when considering matters affecting objects, which may be animate or inanimate, one could learn a lot from the "OPST approaches and logic paths" enunciated by Esuruoso[6.1, 6.44],. And that is the basis for comprehensively covering the wide scope of problems, to which epizootiological (more than any other logical) principles and methods may be applied. The epizootiologist always has interest in groups of animals, people and things in their surroundings, wishing to know as much as possible about their *nature*, reactions and interactions with and exposures to one another, all of which may contribute directly or indirectly to the occurrence, distribution and magnitude of manifested problem/s at hand and over time. **Such comprehensive concern is the basis for the practice of veterinary public health** (vph) **and preventive veterinary medicine** (pvm)[6.3] which are the first ends to which epizootiology (as presented in this book) is the soundest means of reaching. That is a key statement. Read it over and over again, until you fully understand the import and achieve cognitive knowledge of the implications. And if still in doubt or at sea, go into heuristic learning or discuss with an intelligent colleague around or ask your teacher to expatiate.

5.4(b) (i) Traditional Phases/Stages of Diagnosis

Also in the traditional way, diagnosis may be considered in phases/stages, as may be appropriate for each type of problem being considered. The phases are: -

(i) Initial or *tentative* diagnosis:

(ii) *Differential* diagnosis: and

(iii) Final/*definitive* diagnosis.

And while in other disciplines all these stages are applicable to the individual patients or casualties, not necessarily related in usual location, real time implications or shared circumstances of living and culture, epizootiological diagnosis is by definition concerned with the problems of entire groups or populations at risk or exposed due to sharing of the fortunes and misfortunes of an immediate environment, in a given geographical location, over a stated period of time, in qualitative and quantitative terms, of problems-current, evolving or planned (for prospective studies), past (for retrospective studies), and even in predicting the future events and probable outcome of real-time exposure or potential exposure to harmful agents (infective, toxic or otherwise causing unpleasant health status). We shall therefore now consider at some length, the characteristics.

5.4 (c) Epizootiological Diagnosis and other group problems

Epizootiological diagnosis is usually based on types of diseases and other problems of groups of animals and population of people in defined geographical areas over time. By examining or studying the mode, volume, distribution and speed of occurrence, incidence, prevalence and usual course of a disease or other problem in a group (herd, flock) of animals or populations of humans, the following types of disease and other group problems (as defined below) may be diagnosed *epizootiologically as*: -

(i) A *sporadic* disease / problem:

(ii) An *enzootic / endemic* disease or problem:
(iii) An *epizootic / epidemic* occurrence:

(iv) A *point epizootic / point epidemic* occurrence:
(v) Propagative enzootic / epizootic (*endemic / epidemic*) disease.

Nor is the above list meant to be comprehensive, exhaustive or exclusive of other possibilities. In fact, one can immediately think of panzootics and pandemics, which are indications that the diseases or other group problems so described tend to manifest global dimension in their distribution. They tend to be capable of worldwide distribution if not rapidly contained at the point of first detection. Perhaps one should note here that such group problems may include diseases, syndromes, and other group problems, such as terrorism, suicide bombing, corporate fraud, depletion of ozone layer, *et hoc genus omne* based on the wicked nature of man and man's inability to live within the laws of nature. The consequences are ultimately everyone's problem. But now, as befits an introductory presentation of the subject, we shall concentrate on the usual outcome or summary description and presentation of the nature of such groups of problems listed as (i) to (v) above. We describe in words and tables, and illustrate in graphs, charts and histograms as the case may be.

Representations of frequency distribution

Frequency distribution may be represented in various forms, namely in tables, graph, and histogram form. Examples of these are shown in Tables 5.1 Figure 5.1 (graph) and Figure 5.2 (Histogram) below. In further representations, only table and graph forms will be used in this book. Each graph is drawn from the table that precedes it.

Table 5.1: Presentation of Frequency distribution of sporadic outbreaks of diseases (or other group problems)

Months	Frequency
January	0
February	0
March	0
April	15
May	0
June	0
July	0
August	10
September	0
October	0
November	12
December	0
Annual Total	37

[E.g. Anthrax outbreaks (or flooding of animal house/s)]
(Also expressed below in graph and histogram)

Figure 5.1 Frequency distribution of sporadic outbreaks of diseases

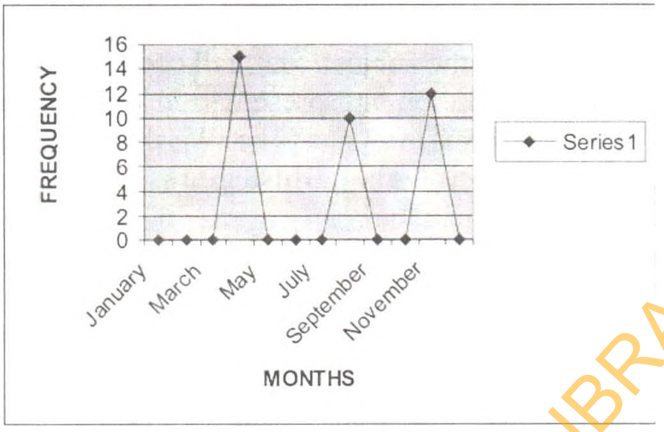


Figure 5.2 Frequency distribution of sporadic outbreaks of disease

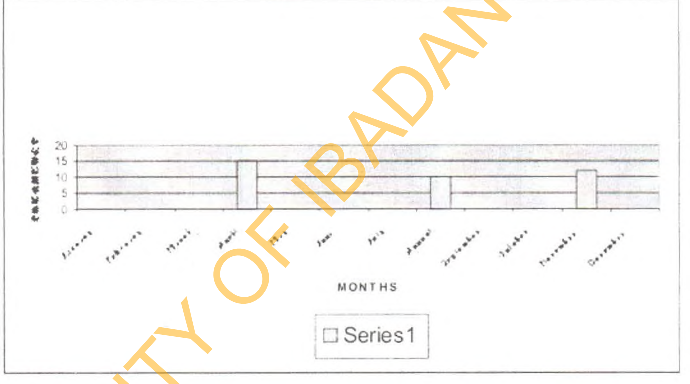


Table 5.2: Presentation of Frequency distribution of enzootic / endemic presence of diseases (or other group problems)

Months	Frequency
January	25
February	18
March	20
April	23
May	30
June	25
July	20
August	19
September	10
October	15
November	18
December	20
Total:	**245**

(*Also expressed in Figure 5.3 below as a graph*) [e.g. Bovine brucellosis in nomadic herds in Nigeria]

Figure 5.3: Graphic presentations of *enzootic / endemic* diseases and other group problems

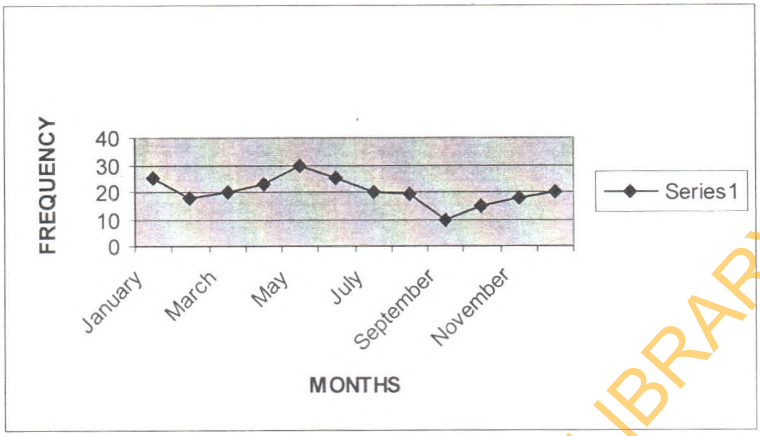
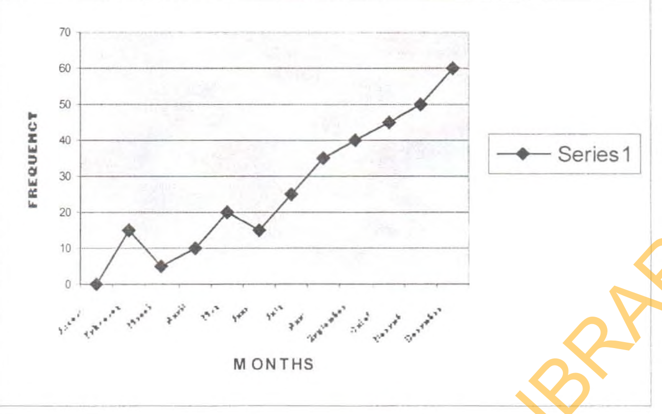


Table 5.3: Presentation of Frequency distribution of epizootic / *epidemic* (occurrence of) diseases and other group problems of animals and people

Months	Frequency
January	0
February	15
March	5
April	10
May	20
June	15
July	25
August	35
September	40
October	45
November	50
December	60
Total:	**320**

(This is also expressed in Figure 5.4 below as a graph) [e.g. Rinderpest and Pest des petit Ruminants in Nigeria]

Figure 5.4: Graphic presentations of *epizootic / epidemic* occurrence of diseases and other group problems of animals and people



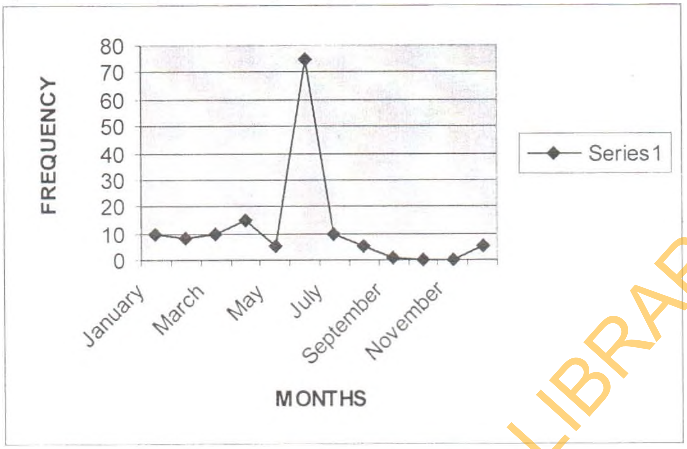
An epizootic/ epidemic is a disease that occurs in sudden outbreaks; quickly affecting high proportions of the group/s of animals (or people) at risk or exposed e.g. Newcastle Disease of poultry (or '*flu*' in the case of people). For deeper understanding, it should be noted that the term *epizootic* (or *epidemic*) is a function of the pattern of occurrence as well as of group, spatial and temporal (i.e. speed of spread in the) distribution of the disease/s in question[6.1].

Table 5.4: Presentation of Frequency distribution of (the occurrence of cases in) **a point enzootic / epidemic** (outbreak of a disease/s or other group problems of animals or people**)**

Months	Frequency
January	10
February	8
March	10
April	15
May	5
June	75
July	10
August	5
September	1
October	0
November	0
December	5
Total:	**144**

(This is a*lso expressed in graph form (Figure 5.5 below)* e. g. Haemonchosis in yearling dairy heifers at Ikorodu farm settlement[6.116]

Figure 5.5: Line Graph presentation of *point epizootic* / epidemic (ocurrence of) **diseases** (or other group problems)



(i) A *point epizootic / point epidemic* is a sudden rise and fall in the number of animals/people affected by the outbreak of the disease as a proportion of those at risk and exposed in the geographical area.

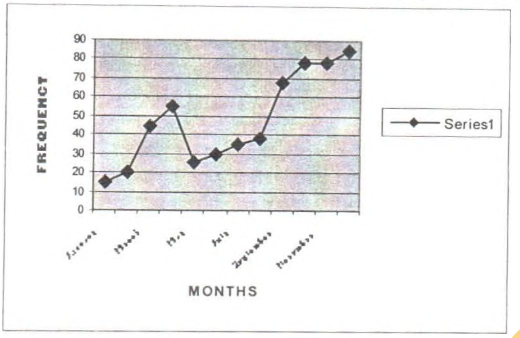
(ii) Other possibilities include propagative enzootic disease outbreaks as is the case of Bovine brucellosis in cattle ranches in Nigeria[6.78, 6..81]. Once one or two cases are established on the ranch, the potential for affecting more and more proportions of susceptible animal species at risk on the ranch is readily realized. For example, in one year, we diagnosed a brucellosis prevalence of 2% in the breeding female cattle in a ranch, and advised the authorities to cull or remove the positive reactors from the ranch; but this was not done. Four years later, when the prevalence of the disease was again investigated, it was found that 78% of the animals had been affected. The frequency distribution of propagative presence of such a disease is provided below.

Table 5.5: Presentation of Frequency distribution of the outbreak of a *propagative enzootic* disease

Months	Frequency
January	15
February	20
March	45
April	55
May	25
June	30
July	35
August	38
September	68
October	78
November	78
December	85
Total:	**562**

(This is also expressed in graph below as Figures 5.6, e.g. Bovine brucellosis on ranches in Nigeria[6.81]

Figure 5.6: Line graph presentation of a *propagative enzootic / endemic* (or even a *propagative epizootic / epidemic* (outbreak of)) **disease** (or other problem



Line graph of Bovine brucellosis occurrence on a ranch in Nigeria [6.78, 8.81]

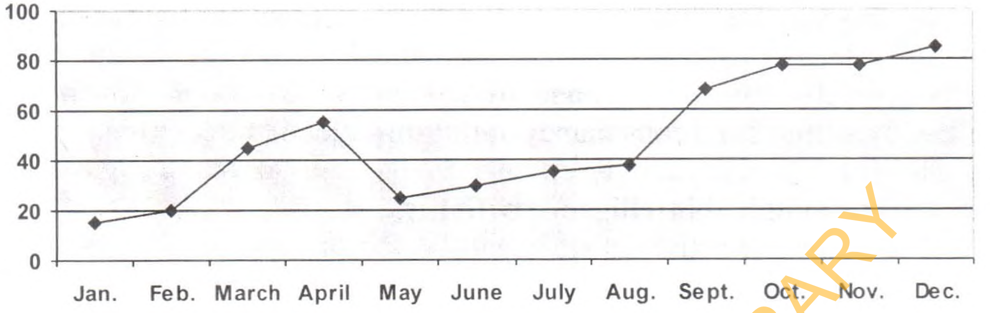
Foot-and-Mouth Disease (FMD) is another good example of propagative epizootic occurrence. Hence we provide a table and graphical representation of the epizootiologically diagnostic indicators.

Table 5.6: Presentation of frequency distribution of Foot and Mouth Disease (FMD) outbreaks in Nigeria

Months	Frequency
January	15
February	20
March	45
April	55
May	25
June	30
July	35
August	38
September	68
October	78
November	78
December	85
Total:	**562**

(This is also expressed in graph below as Figures 5.7)

Figure 5.7: Line graph presentation of Foot-and-Mouth Disease (FMD) outbreaks in Nigeria



An epizootic / epidemic disease is a sudden occurrence or outbreak of a disease to a much higher level than would normally be expected. FMD is a good example of a propagating epizootic and enzootic year after year. It is of major economic importance.

As a practical exercise, students should produce a histogram or bar chart of the frequency distribution from each of the data sets provided in tables 5.2, 5.3, 5.4, 5.5 and 5.6, and submit same to their lecturer, who may decide to use the submission as part of materials for continuous assessment that would count at the end of the course.

Every year outbreaks of FMD are recorded throughout the country. Once it is established, many other cases are diagnosed in the surrounding herd. The strains and serotypes of one particular outbreak have been found to be the same for the initial spread. But very soon, a new serotype has evolved, accounting for the problems of getting a vaccine for the control of the disease. The vaccine has to be specific for the strain and serotype that is prevalent at the time the vaccine is being administered. And since changes take place very rapidly, even a multivalent vaccine may not prevent the spread and toll any outbreak may cause in a particular instance. This is also one of the reasons why the slaughter policy is the main control method for FMD in the United Kingdom[6.76, 6.117]. It is very expensive; but it is considered cheaper than allowing the disease to become enzootic/endemic in the country. The economic losses in calf mortality and loss of milk yield are so great, that they would be intolerable.

Above is also part of the reasons why the United Kingdom would not import meat, milk or live animals from countries like Nigeria, where FMD is probably enzootic/endemic. Every epizootiologist should know a lot about the pattern and problems of most of these diseases of economic and international importance, and thereby reflect the reality, both in their management and in giving advice to Government and entrepreneurs on livestock industry development and production in the country. Much greater details may be obtained from the experts in our universities, research institutes and consultancy outfits throughout the country.

5.5 Epizootiological intelligence activities

The following activities are usually discussed under the general title *Epizootiological intelligence*; they are:

5.5 (a) Survey of diseases and other problems

Disease surveys are basic investigations that lead to information on the occurrence and distribution of the specific disease in populations of animals in defined geographical areas. Time distribution studies enable the investigator to report on the *incidence or prevalence* of the disease investigated. Usually, representative samples of the group or population units and individuals within the units are examined. Very often also it is the prevalence surveys that are carried out. But this may be followed by periodic say annual incidence surveys (see monitoring). A disease survey may take the form of clinical, pathological, serological, microbiological, parasitological, haematological, or a combination of any two or more of these. A comprehensive survey is the epizootiological form in which most of the above, as may be relevant to the type of disease, are carried out. Remember, epizootiological intelligence has holistic and peripheral components. It also has biomedical, statistical and socio-economic aspects, costs and benefits that must be carefully investigated and reported on in both qualitative and quantitative terms. This is another point in the study of epizootiology where the working definition of the discipline should be recalled and applied, starting with the tripod of epizootiology and 'the gospel according to *Saint Gabriel*'[6.1]. He is not a true epizootiologists who only stops at the *echolalia* level of learning[6.50].

5.5 (b) Monitoring of diseases and other problems

Disease monitoring is usually a series of follow-up investigations, updating the facts about the nature and volume of a disease or diseases in a given group population of animals month after month, year after year, with changing seasons and other environmental circumstances etc., in a defined geographical area. Monitoring may be done with or without an ongoing control or eradication programme or to assess the effects of some control programme. Changes in the numbers and age groups in the herd may provide useful indication of the states and effects of the disease. An initial survey or prevalence study is followed by periodic incidence studies, and the establishment of a trend or pattern of occurrence, remission or reduction or spontaneous disappearance of the disease, where applicable.

One of Murphy's laws (*s.i.t.m.*) says that "Left to themselves, things always go from bad to worse". This should be regarded as largely true. But a scientist must always keep an open mind while collecting numerical and non-numerical data on whatever problem he is studying. There could well be some instances when left to themselves 'things may go from bad to good'. Human interference can sometimes aggravate a problem. Think of our environment. Facts and figures from monitoring can only yield useful information if reliably collected and appropriately processed. Remember that such processing includes descriptive, analytical and interpretation components. These are done with the right tools, making proper use of modern technology and the associated computer leverage. Today, he who cannot do computer-assisted processing and has no inkling of the power of information technology can sure not be a useful epizootiologist.

5.5 (c) Surveillance of diseases and other problems

Disease surveillance has been defined [6,67] as the continuing scrutiny of all aspects of occurrence and spread of a disease that are pertinent to effective control. It usually involves the systematic collection and analysis of data on the variable determinants of the disease, its occurrence, spread, effects, as well as its socio-economic and financial implications at every level. Uniform, practical and analytical methods and tools are used in disease surveillance. The parameters of changes in herd structure, place, local geography, meteorology, and other environmental events over time are carefully considered in surveillance activities. Those then are the topics on which surveillance data are collected and processed to determine the nature, level and implications of detectable changes.

Trace-backs are essential aspects of disease surveillance. For example, information on a group of animals brought to the local abattoir for s'aughter may need to be traced-back to the markets through which they had passed and to the farms from which they originated. Records of their health status at the beginning of the journey should always be made. Information on their exposure en-route and any increase or decrease through death or culling should also be noted as important materials for epizootiological surveillance.

Also all the tools and methods of the clinical, microbiological and pathological disciplines are usually applied in Epizootiological Surveillance as may be appropriate for each case. The holistic and peripheral aspects of Epizootiological surveillance of diseases and other problems in groups of animals or populations are the sources of information usually necessary for the control and prevention of the problems of any group of animals, whether migrant or resident in a place.

5.6 Risk Studies

5.6 (a) Introduction to risk studies

In section 7.16 of the glossary to this book we defined, classified and explained the relevance, importance, types and general concern usually accorded *risk* and the need to study risks and apply the wisdom from such studies. The wise reader would pause, refer to and peruse that section of the glossary at this point and before going any further.

However, for the purposes of necessary introduction in this section, we would like to start by observing that life itself is a risk, *and* ***risk*** means the '*probability* of an undesirable event occurring'. Here we use the word '*probability*' advisedly. We could have chosen the equally correct word 'possibility'. The reader should do well to remember that '*possibility*' is qualitative, while *probability* is quantitative. Not only should we be aware that risks may occur because they are possible, but we must also be able to measure the chances of its occurrence in given contexts and circumstances. Our findings should then be expressed as measures of probability having values between zero and 1, each meaning 'certainty' in negative and positive senses respectively. It is then from such findings and reasoning that we obtain information, which could guide our decision making and our steps in the implementation of our various projects and programmes. 'To be or not to be' will no longer remain an unanswered question. That is one of the cardinal reasons why we must study risks in qualitative and quantitative terms and as an important aspect of epizootiology.

In other words, we should be aware of risk as a fact of life. Then we must be able to identify and quantify the types of risk that may occur in the practice of our discipline, and put our thumbs on the ones that should concern us most. We should then seek optimum ways of controlling / managing inevitable and preventing preventable risks[6.42, 6.57]. Management here should mean minimizing the unpleasant effects of what may occur. And preventing should mean making it impossible or highly improbable that they would occur. And that if they in fact do occur, their effects would be neutralized by an alternative loop that would automatically take over when a component of the system fails. Note that we are now dealing in system's mode towards achieving system objectives cost-effectively and efficiently.

Now, the first set of risks that should concern an epizootiologist should be the risk of his patients, members of the human race and the environment getting into intractably problematic situations, being exposed to disease agents, being infected by them, taking ill and hopelessly dying in large numbers before their time. To this must be added the risk of not being able to make proper diagnosis of a problem/s before our patients, ourselves or our environment are overwhelmed, thus threatening our survival and putting our system's prosperity in a far distant future. All these are related to our expression of *prognosis* whenever we make our diagnosis. Therefore, we have decided to examine in some detail such new tools as geographical information system (GIS), as an example of "biological risk visualization, management and tracking tool under section 5.6(b) below.

5.6 (b) Application of geographic information systems (GIS) in risk studies

Animal health risk studies[6.119] comprise of visualization, measurement (evaluation), assessment and management aspects. GIS helps us to achieve these four effectively. Visualization aspect makes GIS technology application in epizootiology to be a more exact science. Animal health risk visualization is an example of scientific visualization. Scientific visualization is a method that incorporates computer (especially graphics) that can transform data into visual models, which could not have been seen ordinarily[6.118]. By applying scientific visualization to the study of locational and spatial data, it then becomes geographic visualization (GVIS)[6.118]. Animal health risk visualization may in turn be described as the application of geographic visualization methods to an assessment of health risk in animal groups/population at a specific location and time.

5.6 (c) What is GIS?

A GIS[6.49, 6.110] is a computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. GIS is used for handling maps meant to be definitive of the problem at hand to support decision making in planning and management of land use, natural resources, environment, transportation, urban facilities, natural risks, administrative records and in our case, animal health risk studies[6.49].

The use of GIS in veterinary medicine and epizootiology dates back to late 1970s. Canadian scientist, Dr. Rowland R. Tinline, applied GIS retrospectively to the pattern of spread of the Foot and Mouth Epizootic during 1967-68. He applied the GIS technology to generate data from which incubation period of Foot and Mouth Disease (FMD) was obtained. Thus gaining a better understanding of the disease pattern and how it spread from herd to herd[6.49]. Much was learned about FMD by using GIS and could be applied to focus the control of future outbreaks worldwide[6.49].

Capturing of spatial and non-spatial data related to animal population, distribution and their problems is a major component of a GIS project on risk study. Many countries have already established facilities for full application of the technology. For example, in the case o Nigeria, an earth observation satellite called Nigeria Sat 1, for the country was successfully launched into space on 26 September 2003 in Siberia, Russia. By this, it is hoped that there will be improvements in the availability of real-time data from satellite to enhance integration with GIS for problem solving applications in Nigeria. Nigeria Sat 1 satellite captures and records earth surface images of Nigeria on daily basis at a 32m pixels resolution. This is a low resolution equipment and is suitable for large scale mapping only.

not for detailed small scale mapping that would show individual buildings, including houses, streams, roads and built cities clearly. It may not be useful without adaptation, for precise animal health risk studies. It could be regarded as a fore-runner of our awareness of the technology.

However, in order to carry out geographic mapping of cattle herd movement pattern and therefore their problems, across Nigeria on a GIS, one would require a high resolution equipment like the Ikonos satellite capable of producing 0.5 to 1m pixel resolution images. This will effectively aid in visualization of the spatial distribution of cattle and their movement pattern across Nigeria, especially in relation to land use, vegetation cover, water resources and seasonal changes within the country and throughout a year. Non-spatial data can then be obtained and integrated with this.

In this context, it could be mentioned that a group of scientists at the University of Ibadan, Nigeria and collaborators at Iowa State University College of Veterinary Medicine, USA once designed a pilot project that would utilise data from Ikonos satellite to focus on ring vaccination of cattle against Contagious Bovine Pleuro-pneumonia (CBPP) in five cattle producing states in northern Nigeria. The selected states were those that had extensive surveillance records for the disease. The design was completed in June 2004 but could not be executed due to lack of funds. The project aimed at discovering more effective and efficient method for the control of CBPP in Nigeria [6.121] was a prototype design for GIS application in animal health risk study in Nigeria. We hope that in future funds will be available to carry out such project.

5.6 (d) Risk assessment and visualization with CommunityViz software [6.49, 6.84, 6.85]

A GIS software that was found suitable for the assessment of animal group/population health risk in a place is *CommunityViz* [6.49, 6.85]. This software is produced and marketed by the Orton Family Foundation in Bolder, Colorado, USA in collaboration with Environmental Systems Research Institute (ESRI) in Redlands, California, USA. *CommunityViz* software has a module called Scenario Constructor, an impact analysis software that works as an ArcView 3.x extension. Scenario Constructor [6.49]

[6.84] was used to analyze the potential impacts of an accidental release of biological agents on a cattle farm in form of incidence. The analysis quantified the spread of the agents and the resulting disease. It also assessed the risk involved in such a scenario. Scenario Constructor enabled an epizootiologist to estimate the number of ill cattle that would result, and to visualize the necessary decontamination area. The analyst found *CommunityViz* software to be a "suitable and efficient tool[6.84]" because of its advantages listed below:

CommunityViz GIS software has the following advantages:

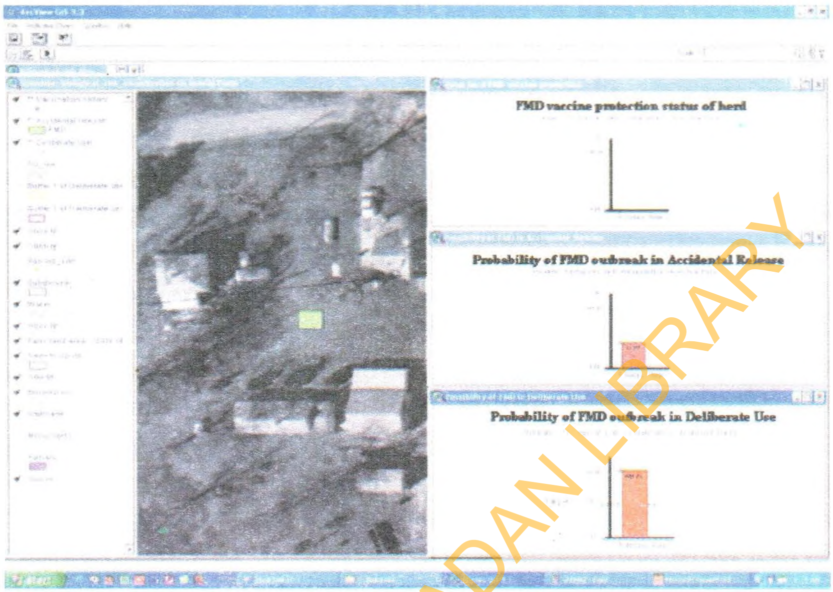
(1) Provides interactive animal health risk visual model, which is not usually available on a farm. An interactive visual model of this type is valuable both before and after an accidental release or deliberate use of a biological agent on a farm.

(2) *CommunityViz* makes impact assessment easier in that, it allows data set-up in Scenario Constructor module. It also makes health risk impact assessment simpler by its impact assessment tool. The impact assessment tool prompts user to select appropriate disease agent from options, which makes it user friendly.

(3) Since epizootiologists are always making use of observed visual information, the use of GIS will only enhance the normal process of determining prognosis and providing information needed for cost effective practices of animal health and production.

The dialogue boxes that prompt the user for values to be selected from provided options make *CommunityViz* impact assessment tool interactive and user friendly. This provision makes it simplified for individuals that have little or no previous knowledge of GIS, but are familiar with the click and drag activities, using the mouse and arrow keys on the computer. The user however would need to have adequate knowledge of infectious agents and their characteristics in order to be able to use the Scenario Constructor for impact assessment and related procedures. Users of *CommunityViz* software are still constantly coming up with new ways of putting this GIS decision-support software to work on animal health risk studies. A sample case study is presented below.

Figure 5.8: *CommunityViz* illustration of risk of disease outbreaks in accidental release of disease causing agents on a cattle farm



CommunityViz window, showing automated themes[6.84] and risk indicators associated with accidental Release of FMD on a cattle farm as an hypothetical case study. Notice the bar charts on the right side that quantify associated risks.

A case study of accidental release of FMD

In order to further demonstrate the usefulness of this system, three automated themes are shown in the Figure 5.8 above. They are (i) **Vaccination history, (ii) **Accidental release of FMD[6.74, 6.80], and (iii) **Deliberate use of FMD. An automated theme is identified based on the presence of two asterisks (**) on it. An automated theme is a theme on GIS that is able to compute needed values spontaneously from variables, constants, constraints and automated (auto) data, based on pre-defined formula that was given to it during scenario design and set-up. The result computed was called an *indicator* of the scenario outcome. The results of three indicators were displayed on the screen in Figure 5.14 above. Note ArcView GIS 3.3 on top and a title *scenario: biological risk visualization on animal farm*.

The three automated themes are:
(i) FMD vaccine protection status of herd

(ii) Probability of FMD in Accidental Release[6.84]
(iii) Probability of FMD in Deliberate use[6.84]

Conditional values for total herd FMD vaccine coverage for farms were retrieved from tables that contain vaccination status of all animals in each herd[6.84]. *CommunityViz* scenario predictive model summed up the number of protected animals and then expressed the proportion of vaccinated animals as ratio of herd population, this was presented as percentage, i.e. multiplied by 100 (Unit is %). A different arithmetic formula was used to define the needed model for determining the other two indicators, namely probability of disease in Accidental Release and probability of disease in deliberate use. The formulae were defined and set-up in *CommunityViz* Scenario Constructor Formula Wizard. For the purpose of this introductory book, details of formulae set-up[6.84] in *CommunityViz* may not be required here. It is however sufficient to note that while **Vaccination history was a point feature **Accidental release of bio-agent was made a polygon feature. A polygon feature is one that covers an area as opposed to a feature that covers a point or a line (linear) position. **Deliberate use of bio-agent was made a line feature on the map. These symbols were selected to illustrate potential spatial pattern that may be assumed when these events do take place.

5.6 (d) (i) Spatial datasets for scenario setup in CommunityViz

Set-up of a scenario for animal health risk assessment and visualization requires a number of datasets - both spatial and attribute datasets were required. Our case study[6.84] was based on an hypothetical cattle farm in Black Hawk County, Iowa State in the United States of America.

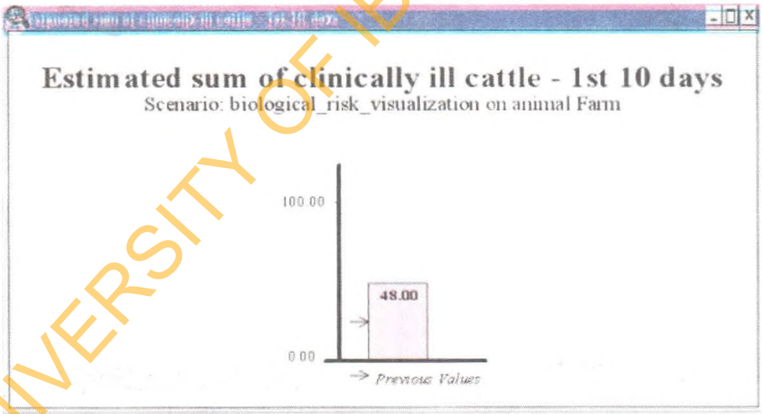
Spatial dataset of *Black Hawk County in Iowa State*
1. Aerial photograph of Black Hawk County
2. Land parcels shape file
3. Farm footprint shape file
4. Farmland area boundary shape file
5. Stream shape file 6. Sub division shape file
7. ** Accidental release automated theme
8. **Deliberate use automated theme
9. **Vaccination history

Objectives of the case study

1. To use a hypothetical cattle farm as an example
2. To design a scenario for accidental release of FMD for example.
3. To quantify the spatial spread and disease impact on a group of cattle.
4. To apply *CommunityViz* software to construct the scenario and to assess the disease outbreak impact.

An impact assessment indicator that was used to account for health risk outcome on the hypothetical farm and in the event of an accidental release of FMD virus was the estimated number of clinically ill cattle in first 10 days. Illustrations are made in the paragraphs below. The scenario assumed that the natural route of entry of FMD virus was used. *CommunityViz* allowed changes to be made to route of introduction (and spatial spread ability), and infectivity of agent so that the assessment could be refocused as necessary.

Figure 5.9: Estimated sum of clinically ill cattle during the first 10 days of exposure to FMD virus being a result generated by a predictive model set-up in CommunityViz (a GIS) software

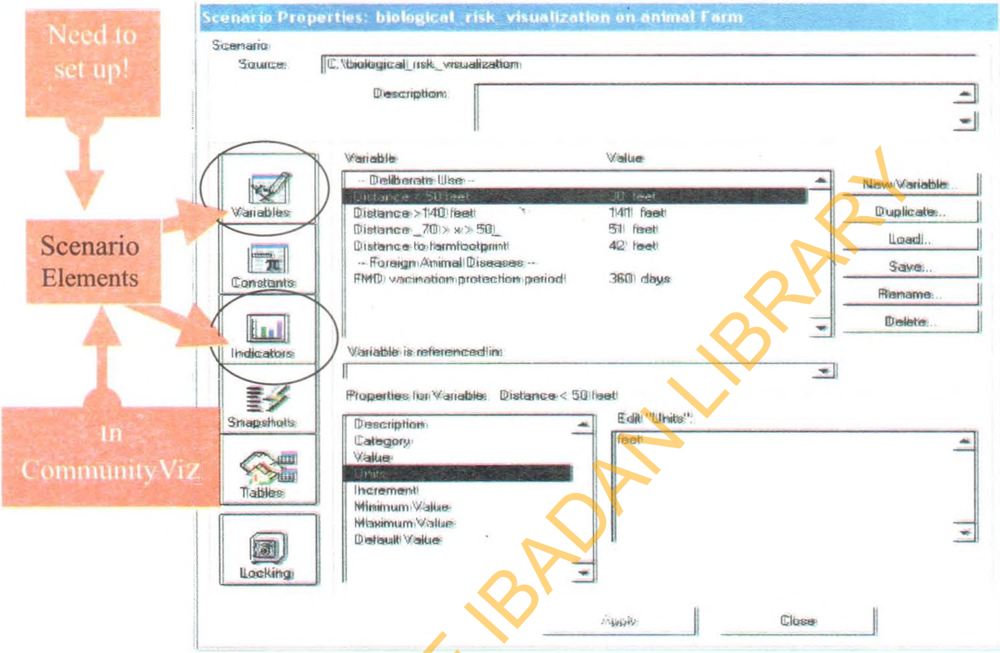


This bar chart provides a visual display of the risk impact assessment in *CommunityViz*

5.6 (d) (ii) Scenario view and scenario theme properties set-up

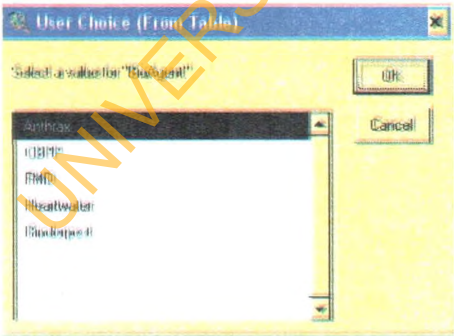
To make the indicator work efficiently in *CommunityViz*, several auto data were needed to be defined and set up in scenario theme properties of **Accidental release theme, and also in the scenario view properties (which served as the large-scale scenario property) where variables, snapshots and indicators were set up.

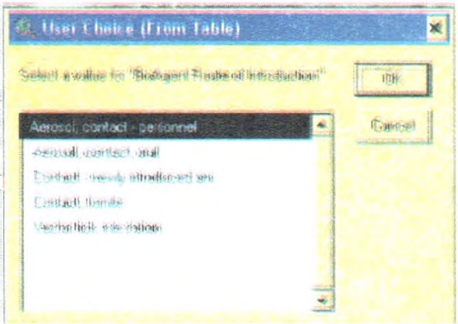
Fig 5.10: ***CommunityViz* Scenario properties window for setting up scenario elements, including variables, constants, indicators, snapshots, tables and for securing the setup with a lock**



This dialogue box enabled an epizootiologist to set up a model for prediction of outcomes based on predetermined properties of FMD scenario. The model was then saved on a central GIS.

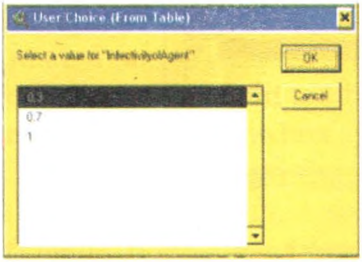
Figures 5.11 and 5.12: *CommunityViz* dialogue boxes that prompt user to select the name of the agent and the route of administration from a set of options

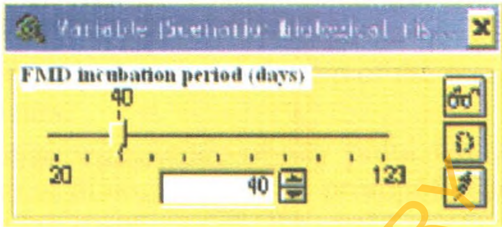




These dialogue boxes were created and were able to function because they were already set up in the scenario view and scenario theme properties. They made *CommunityViz* user friendly in risk impact studies

Figures 5.13 and 5.14: Dialogue boxes that prompt user for a value for infectivity of agent and allow user to change agent's incubation period respectively





Where the infectivity of a disease causing agent is experimentally studied to be different from what it was known to be, alternative values as a ratio of the known value may be set up and selected in *CommunityViz*. In the same way, if the incubation period varied, *CommunityViz* allows changes to be made as may be necessary.

The variables created and set-up are as follow:
Category I: Animals with Clinical Signs --
Number of Animals with clinical signs (initial value) 0

Category II: Disease Incubation Period --
FMD incubation period days 3 days

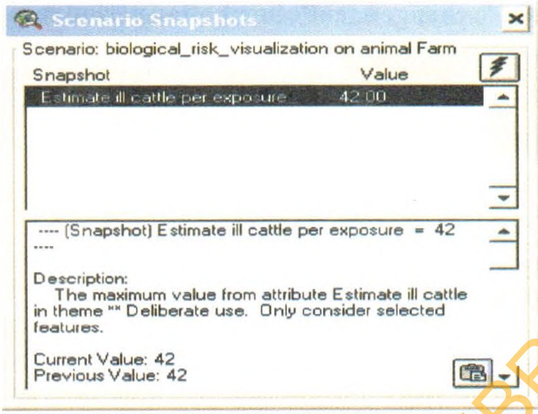
Category III: Disease agent Infectivity
FMD infectivity 1

Category IV: Sum of Animals with Clinical Signs --
Animals with FMD clinical signs (initial value) 0

General
Route of Administration (Spatial spread variability) 0.7

The snapshot defined and set-up was:
1 Estimated number of ill cattle in new exposure

Figure 5.15: Snapshot of model resources for estimating ill cattle in latest new exposure



A snapshot defined this way enable the computation of risk impact to take care of dynamic changes in initial population'

The Estimated sum of clinically ill cattle (ESCIC) in 1st 10 days is computed by the impact assessment too using the formula below:

ESCIC = [susceptible population exposed snapshot estimate of ill cattle per previous exposure] x [Agent spatial spread ability] x [Agent infectivity] / [Incubation period]

Where,
Effective population at risk in subsequent exposure is y.

Y = a b

where,
a = Initial cattle population on farm (in this case 1000)
b = Number (snapshot) of clinically ill cattle now.

The indicator formula measures overlap with features in farmland area boundary and manipulated the auto data, variables and snapshot to estimate ill cattle in the 1st 10 days.

FMD Scenario Impact Assessment procedure[6.84] (SIAP)

This means determination of impact which in this case is the estimated number of clinically ill cattle within the first 10 days of exposure to FMD virus. It entails the following steps:

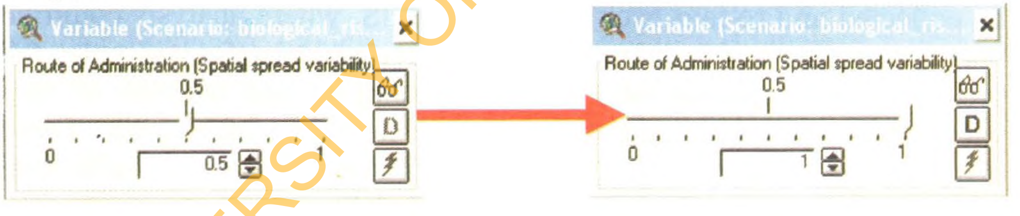
i. Make **Accidental release automated theme the active theme on the computer screen by clicking on it; it then appears raised.

ii. Click on CommunityViz on the tool bar at the screen top. A drop down menu list appears.

iii. Click on impact assessment on the dropdown menu. There appears an extended list of menus.
iv. On the new list, click on Indicator chart. The indicator window with title "Estimated sum of clinically ill cattle 1st 10 days" appears.
v. Now click on the Edit toolbox on the toolbar at the top of the computer screen. An Edit scenario box appears.
vi. Click on sketch and then draw a rectangle at any point within the farmland area boundary. A series of dialogue boxes to prompt the user to select name of bioagent, bioagent route of introduction and for infectivity of agent are then displayed. Make appropriate selections and the result will be displayed.

The scenario impact assessment in this way is flexible in that it allows modifications in the infectivity, spatial spread ability and incubation period of an agent, thereby allowing real time (spontaneous) adjustments to refocus the assessment of the estimated sum of clinically ill cattle within the 1st 10 days.

Figure 5.16: CommunityViz dialogue boxes for varying the spatial spread ability of agent



CommunityViz scenario impact assessment is flexible allowing modifications when necessary in the spatial spread ability of an agent, thereby allowing user to refocus estimation of sum of clinically ill cattle within 1st 10 days.

5.6 (d) (iii) Visualization of farm decontamination areas necessary

A simple approach to visual display of area to be decontaminated may be obtained by creating one or two commonly recommended radii around the point of administration of pathogen, the animal house and areas to which the agents have spread. This may be straightforwardly done in GIS visualization mode by defining specific distances e.g. 100 feet or 200 feet radius. This procedure is called buffer line drawing.

Figure 5.17: CommunityViz visual display of boundaries of areas requiring decontamination following exposure to disease causing agent

The circumference created in this figure depicts boundary of minimum areas for disinfection

5.6 (e) Other GIS hardware and software and their benefits to risk studies

Personal digital assistants (PDA[6.122, 6.123]) in form of hand help computers are hardware that run mobile GIS and GPS software and allow field data to be collected and re-laid back to a central GIS, where analysis could be made to update and validate risk predictive models, for example, the probability of outbreak of FMD (for example) and success of ring vaccination strategies against the disease in a part of Nigeria. These mapping tools which include laser range finders are now available with much easier user-friendly software and at much lower costs than in the past few years. The use of these devices provide a system that relies on GPS positioned control points[6.49] and a laser range finder to remotely position farms, abattoirs, veterinary laboratories, veterinary clinics, quarantine stations, and wildlife locations.

The devices enable identification of risk areas, active disease areas, and convalescent carrier animal groups or population or reservoir host animal areas across a country. This approach is intended to benefit animal health and the veterinary institutions in a country, by facilitating risk studies and implementation of disease and other problems control strategies. Two examples of mobile hardware that could be used to run GIS and GPS software concurrently are the Dell Axiom PDA[6.124] and TrembleGeoXT PDA[6.125].

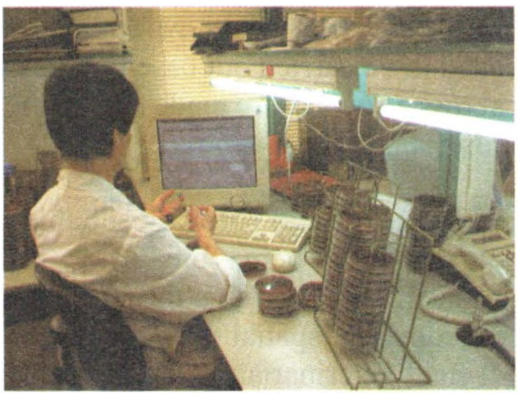
TrembleGeoXT is a rugged hand held PDA that is dust, water and shock resistant. Dell Axiom PDA[6.124] and TrembleGeoXT PDA[6.125] are capable of using Microsoft Windows Mobile 2003 operating system[6.123, 6.124] software that gives a user friendly environment for running GIS and GPS software concurrently. Suitable mobile GIS software appropriate for use on these PDAs is the ArcPad, a product of Environmental Systems Research Institute (ESRI) of Redlands, California. ArcPad[6.121] is mobile GIS software that enables PDA users to download spatial data from GPS software on the same PDA and to then insert and edit other attribute data about the locational (geographic coordinates) data collected by the GPS.

Thus, mobile GIS with GPS software on a PDA enables collection of complete spatial and attribute data on the field on a single PDA unit. In addition to this, wireless email connectivity on Dell Axiom and TrembleGeoXT each allows field data collected to be sent directly to a central GIS, avoiding the need to travel long distances to a central GIS where analysis could be carried out on the data collected to update and validate predictive models. A central GIS in this case may be a desktop computer running *CommunityViz* software on Arc View3.3 or 8.3 software. In the same way, a central GIS facility in addition to using remote sensed images to guide predictive models and make automated suggestions on risk situations in the locations from which data have been supplied, could also send out results of its predictive models to field PDA units and to guide field workers with actual GIS layers and coordinates that can make field workers to navigate to specific places where actions, such as animal vaccination are needed to be carried out based on risk predictions. In this way field workers across a country are made to become active members of a larger spatial data exchange.

Global position system (GPS) software suitable for use on the Dell Axiom PDA example mentioned here is the Pocket GPS Navigator (iGPS-360) convertible receiver. Based on this technology, a GIS/GPS facility could be used for coordinating spatial data exchange between laboratory diagnostic staff and field veterinarians involved with animal health risk studies. This facility sets in place a two-way information communication from the field to the laboratory through a central GIS and vice versa. A central GIS is needed to analyse the data supplied and to offer automated suggestions on risk impact in each location based on combined data from the field and the laboratory.

The focus of this section has not been to address issues of cartographic importance in GIS map presentation, which is assumed, would be learned elsewhere and possibly applied as part of the recommended practical exercises in this chapter. In summary, these other GIS/GPS hardware and software when used with a central GIS hardware and software like a desktop PC running *CommunityViz* on Arc View, is capable of making animal health risk studies in a country a complete work system. This may affect animal health service delivery positively at community level in a developing country. *CommunityViz* with its flexible capabilities when used in animal health risk assessment studies meets the needed learning and discovery processes required in risk visualization. Morgan and Henrion cited by Fite[6.118] recommended a flexible risk study procedure in 1990. The recommended qualities might have been reasonably attained in *CommunityViz* software as impact assessment tool coupled with data supply from mobile GIS/GPS facility. This is in the form of numerous feedback loops made available and with which intermediate results were used to restate the problem and to refocus risk impact analysis. The experience of these authors confirms the benefit of this integrated GIS/GPS capacity in animal health risk study.

Figure 5.18: A veterinary laboratory staff inputting diagnostic test results into the computer for animal health risk study



A computer terminal linked to a central GIS facility is an essential interface for integrating laboratory diagnostic findings with spatial data from the field used to carry out risk analysis.

5.7 General Nature of Model Epizootiology Laboratories

5.7.1 Introduction

Definition and description of an epizootiology laboratory

An epizootiology laboratory is a place with appropriate space requirement, suitably located in a teaching or research organisation where all the necessary equipments and reagents are housed, all the biological materials are preserved and all relevant practical laboratory exercises relating to epizootiological projects are carried out, recorded and the results analysed, interpreted and prepared for publication and dissemination. The procedures would normally include:

a). Acquisition and systematic organisation and installation of major and minor equipment, chemical and biological reagents, sterile distilled water source, bleeding needles, skin disinfectants, universal and Bijou bottles, other minor vessels and equipment needed, formats for field data collection, recording and preservation, specimen processing protocols all to be checked prior to making each field trip and on arrival from the field:

b). Deposition of materials collected from the field, prior to their processing, recording of the various types of materials, their quantities or volumes and their mode of preservation:

c). Fully identifying, recording and describing materials collected from the field and brought into the laboratory, for example, animal remains, flies, ticks, other parasites and blood sucking arthropods:

d). Actual performance of necessary tests and analysis on the materials:

e). Computer-based data processing, analysis, interpretation and initial documentation in preparation for seminar presentation:

Because of the usual nature of such materials, and the need to ensure that they would neither spread the disease agents they may contain, nor contaminate the environment or the personnel themselves, special facilities are usually provided in a typical epizootiology laboratory. Such facilities may include maximum biohazard security sections (like showerin shower-out and sterile protective clothing rooms) and safe disposal vessels etc. Each section of the laboratory would of course have its own peculiar needs. For example, a bacteriology laboratory section would not have exactly the same needs as a chemical pathology section. Needs for haematology would be different from those for serological tests of sorts, etc.

5.7.2 Three grades of Epizootiology Laboratories

For teaching and practices in all aspects of epizootiology, appropriate laboratories are one set of essential systems of infrastructure[6.52]. The others include a network of appropriate vehicles and other field requirements. We talk of systems of infrastructure as both the material (physical) and the immaterial expertise/human function components, which must be such that can maintain the functionality at cost-effective usage level for each grade of laboratory. Three grades or types of such laboratories may be described.

(a) **Type I Epizootiology laboratories** are those needed by institutes of Epizootiology. These must have in-house facilities for clinical, pathological, microbiological, parasitological, immunological (CMI and serological), and computer-based analysis, documentation and presentations. There must be a well-structured database, technical documentation, information management and communication facilities for which both the material and trained human resources are integrated for positive socio-economic jurisprudential (psej) operations:

(b) **Type II Epizootiology laboratories** are those based in individual departments of Epizootiology or Veterinary Public Health and Preventive Medicine. Such a Department needs not have the complete facilities of Pathology, Microbiology, Parasitology and Chemical Pathology, in as much as within the institute or faculty there are such Departments of Parasitology, Pathology, and Microbiology which are committed as a matter of policy, realistic and active cooperation for receiving and proper processing of specimens and returning results there-from in prompt and timely order to the epizootiologists.

Further information on the nature of the required system of cooperation can be obtained on request from the Academic Consultancy Services Unit of VetAcademic Resource Foundation[6.63] (VARF). This organisation will provide realistic information on specimen requirements and management, integration formats on request.

Such a department of Epizootiology or Veterinary Public Health and Preventive Medicine should however be fully responsible for all aspects of field specimen and data collection format design, database management, analysis, documentation, recording, reporting, dissemination and appraisal. All forms of agreement in and for maintaining ethical relationship with the collaborating departments must be established, preferably *ab initio*. Modes of sharing of resources and responsibilities should be agreed upon. Collaboration in presentation and publication must be established early on in the relationship pattern.

(c)**Type III Epizootiology Laboratory** is that of a small epizootiology or occasional project unit in any form. Such a unit may arise as providing the functions of an epizootiological intelligence project or programme. Remember that epizootiological intelligence activities (*ibid.*) may be any or all of 'group problem surveys', 'group problem monitoring', 'group problem surveillance' and result appraisal in any of the above.

Examples of epizootiological intelligence activities are:
(i) Bovine brucellosis survey in Sokoto (or in any other named) state;
(ii) Survey of the prevalence of trypanosomosis in goats in Oyo state as in any other geographically defined area;
(iii) Monitoring of contagious bovine pleuro-pneumonia (CBPP) in trade cattle coming into Ogun (or any other) state;
(iv) Prevalence studies of Canine tuberculosis in Nigeria;
(v) Pan-African (programme for the) Control of Epizootics in Africa (PACE)[6.40].
All the above are examples of epizootiological intelligence (EI) activities which may come in form of projects or programmes.

5.7.3 Physical and Functional Nature of Epizootiology Laboratories
(a) An Epizootiology laboratory should have the following space allocations and major items of equipment among others:

(i) Bench area with stools or chairs where there are leg room;
(ii) Fridge and freezer areas, each opening freely without blocking one another;
(iii) Hot and cold running water emptying into deep sinks for drainage into predetermined gutter areas without polluting the surrounding environment;
(iv) Appropriately located UV culture hoods, bacterial culture incubators, water bath incubators at 37^{0}C and 28^{0}C.

(b) An Epizootiology laboratory should have the following items of major equipment:
(i) Standard centrifuge, cold centrifuge, ultra-centrifuge, micro-haematocrit centrifuge, auto-analyser connected to an appropriate laptop PC;
(ii)Adequately spacious fridges, freezers, cold boxes, et cetera
(iii) Standard laboratory balance, analytical and chemical balance;
(iv) Spectrophotometers, radioactive counters, depending on expected nature of teaching and research
(v)Light microscope, background illuminated microscopes, dissecting microscopes, others;
(vi) Water distiller;
(vii) CO_2 and enriched O_2 tissue culture incubators, cylinders and assured sources of refills;
(viii) Glass drying oven.
(ix) Others

(c) An epizootiological laboratory should have regular supplies of the following minor equipments.
(i) Assorted centrifuge tubes for assorted heads;
(ii) Various sizes of serological test tubes with caps;
(iii) Plate agglutination test boxes;
(iv) Consignment of microscopic slides;
(v) Assorted vene-puncture (bleeding) hypodermic needles, Eppendorf syringes, others
(vi) Burettes, Pipettes, racks, assorted glass syringes, Grosses of Universal bottles, Grosses of Bijou bottles, ice packs for use in cold boxes;

(d) An epizootiology laboratory should have regular inexhaustible supplies of the following reagents;
(i) Disinfectants
(ii) Antiseptics;
(iii) NaOH, KOH, NaCl, $NaHCO_3$ crystals and salts;
(iv) Acetic and other organic acids;
(v) Nitric, sulphuric and other inorganic acids;
(vi) $KMnO_4$, Formalin, Industrial Ethyl alcohol, methyl alcohol, Boric acid, Citrate, Mucous Heparin, Methiolate, Sodium azide (NaN_2);
(vii) Agar gel, DEAE cellulose and other media for molecular sieve separation.

(e) An epizootiology laboratory should have
(i) Named specific requirements for planned projects;
(ii) Materials for collecting, preserving and forwarding tissues and other specimens for investigation in parasitology, bacteriology, histopathology, chemical pathology and serology laboratories.

(f) Bound record books for recording in-coming and out-going specimens.

(g) Duplicate and triplicate record books for field and laboratory use

(h) Forms for routine recording and reporting of processed materials.

(i) Other project-specific requirements.

5.7.4. Various types of tests and investigation in an Epizootiology laboratory
(a) Specimen identification on arrival from field trips:
(b) Presentation, processing and disposal of gross specimens:
(c) Preservation, processing and disposal of Bacteriology specimens:
(d) Parasitological investigation:
(e) Haematological analysis:
(f) Serology investigation:
(g) Analysis of body fluids e.g. CSF (cerebro-spinal fluid):
(h) Sputum culture

(i) Swabs culture

5.7.5 Charts of Standard values and interpretation of results

Charts of Standard values and interpretation of results should always be readily available in an epizootiology laboratory. Establishment of details of processes and procedures all the tests and investigations listed in this section are functions of each laboratory, according to the nature of programmes and projects envisaged when setting up each laboratory to meet identified needs then and from time to time.

5.8 Conclusion

In this chapter, some of the applications of epizootiological knowledge and intelligence activities have been briefly mentioned. Often many more examples and greater details are provided during lectures. This conclusion is meant to provide global coverage for a variety of ways for potential application of the science while maintaining perspectives for relevant areas of human endeavour. Moreover, the text is meant to help students to obtain greater insight into epizootiology during the planning and execution of their DVM projects and to provide students with community-based learning experiences during the practical exercises that usually follow each set of lectures on the subject. They will also find this training experience useful during their community service aspects of the National Youth Service Corps (NYSC) programme.

Readers should be aware of this, so that they can think of whichever meets their immediate needs and guiding them in 'living agreeably to nature'. One or the other of the following scenarios may provide thought patterns for your particular situation and circumstances at any stage. The scenarios presented have diverse composition in shared areas of work systems that may be useful to veterinary officers in government service of a country or to private practitioners [6.54]. Exploring shared areas of work systems in a community, may well be recipes for success at all levels of veterinary services.

It thus becomes easier to view the community in this context as including people or societies at private sector, institutional, local government, state, federal and national levels. All these must be considered as existing at farm, sub-urban and city areas. In any case, when we talk of epizootiology as being a multidisciplinary subject, we may here go further to emphasise its relevance to the thought patterns and visions of many other professionals. It is therefore useful to note that all applications of epizootiology blend with clear and detailed systematic wisdom about resource development and management at every critical level of organized human and natural (ecosystem) communities.

Epizootiological orientation provided in this chapter should point out to readers that wisdom for preventive medicine, and in fact for preventive measures generally have their bases in the principles of epizootiology as a branch of *episcientology*. The methods, which would often be in parallel with those of other cognate disciplines when rightly applied, will always solve relevant problems. By working within community-based veterinary public health systems, the equivalent situations are readily conceptualised and appreciated when such common language as *preventive measure* is widely applied. All are trying to prevent one problem or a system of them in natural communities or groups. For clearer understanding of community planning, interventions, building necessary systems of infrastructure, one would find out that the methods of epizootiology will often provide the necessary answers.

And when we talk of community planning[6,86] and building of infrastructure, engineers, law enforcement agents, environmental specialists and others are usually involved. The language of epizootiology will often unify their tools of thought and logic paths towards achieving the necessary preventive measures in holistic ways understandable to all concerned. Our immediate concern here however is preventive medicine, which entails understanding and control of biomedical factors, problems and their effects through the application of remedies, vaccines, hyper-immune sera, chemo-prophylaxis, as well as by veterinary *public health practice*.

Examples of teamwork experience in epizootiological projects and veterinary public health practice by these authors culminated in such publications as (i) Actualization of strategies for privatized preventive veterinary services to nomadic herdsmen in southern Nigeria[6.126] (ii) Actualisation of strategies for beef quality control in south western Nigeria[6.127], and (iii) Blueprint on infrastructure for livestock development and production, and standards of veterinary services nationwide in Nigeria[6.52]. These experiences indicate the importance of social responsibilities of veterinarians in resource development in Nigeria and in which epizootiologists are presented as model examples of bridge builders across the various expertise in resource development and their economic management.

Our immediate concern for preventive medicine includes social responsibility component. This relationship is one reason behind an interesting observation that was made and then captioned in a rhetorical question that 'Why on earth do we still have Rinderpest and what in the world is being done about it'?[6.128]. This remains an important question especially since the Rinderpest vaccine is one of the best vaccines in the world. The problem is most probably due to a neglect of social responsibility in vaccine delivery system as part of epizootiological orientation for capacity building needed in community-based practice of preventive veterinary medicine. Community and societal resistance to change may on the other hand be due to the phenomenon often referred to as 'long habits die-hard'.

Fortunately recently available technological leverage[6.49] enables us to work at solving problems related to vaccination coverage effectiveness. Remote villages, cattle kraals and some obscure locations in some developing countries may now be monitored using the evolving new GIS technology. These technologies are slowly but surely being absorbed into epizootiology and community extension programmes and projects. Professional commitment to holistic approaches of epizootiology in projects planning and implementation may prominently influence the chances of success of the various projects, which are important to most professionals.

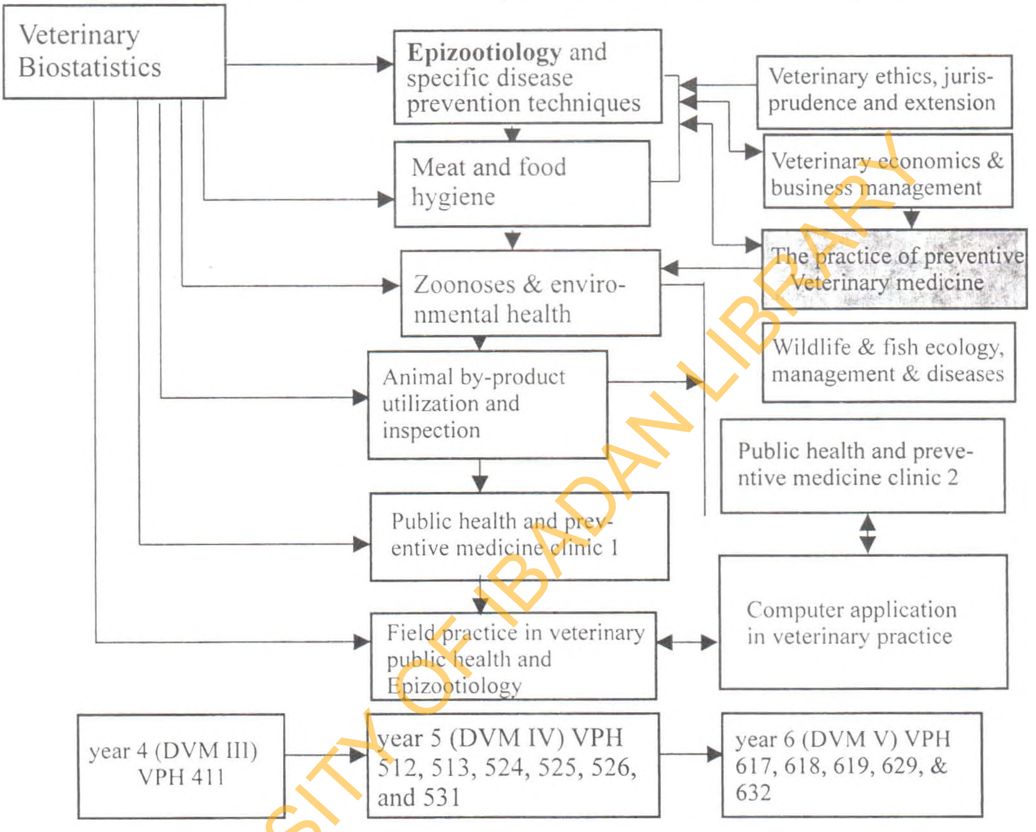
Simply by virtue of extensive fieldwork involved in epizootiological applications, there is high tendency for exhaustion. Thus, the need to fit the job to the worker and not the worker to the job has become very necessary.

Extensive fieldwork involved and ergonomic[6.129] considerations to fit the job to the worker may have culminated in the adoption of PDAs running GIS/GPS units[6.122] that are now used for animal health data collection and thematic map design in epizootiology. Where there is compromise in usage of appropriate tools, we may find a situation captioned as 'person-environment mismatch', and the job of an epizootiologist may inadvertently be laborious and sometimes compromised. Then the question may be asked 'shall we square the hole or round the peg?'[6.130]. In this connection, it has been observed that usually the most neglected and least integrated sector of the economy is the local government system, as it happens both at home and abroad [6.95, 6.96] and managing the work system challenge at this level may become a useful contribution to the practice of local government planning.

Also epizootiological study of zoonoses such as tuberculosis and rabies at local government level [6.70, 6.131] is another important area of application of epizootiological principles and method to community health system delivery and administration. Abattoir wastewater run-off at rural, suburban and urban locations with their contamination of streams [6.132] and near surface well water constitute another area of veterinary contribution to the health of people, their water systems and general environmental sanitation. These have been identified as some of the areas of veterinary contributions to public health [6.133].

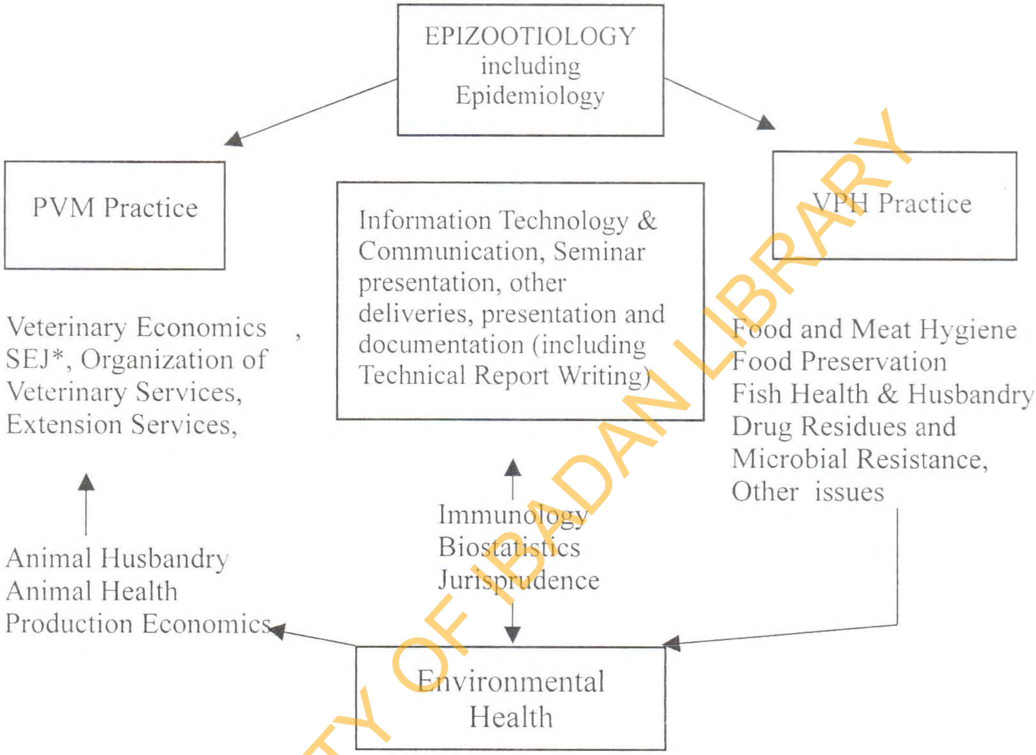
Further achievement in epizootiological orientation for students and people generally may also depend on the keenness of the individual's interest and their inquisitiveness. The approach in this chapter has heuristic value for students who are likely to be interested in later taking a postgraduate course either in Epizootiology *per se (i.e. (M.Sc. Epizoot)* or in Preventive Veterinary Medicine (MPVM), Veterinary Public Health (MVPH) and allied disciplines, which will enhance their ability to effectively and harmoniously work with other professionals, contributing to community development and realization of the people's yearnings for better living.

Figure 5.19: Internal relationship of veterinary public health and preventive medicine courses taught from DVM III to DVM V at undergraduate level in the University of Ibadan, IBADAN, Nigeria (6.134)



Starting from veterinary biostatistics, through epizootiology and up to computer application in veterinary practice, a curriculum in veterinary public health and preventive medicine permits development of knowledge and skills in geographic data management and animal health risk studies, essential for epizootiology and community planning and development. And by working with personal digital assistants that run global positioning system and geographic information systems technologies, veterinary students are enabled to acquire skills in mapping diseases and other problems in local communities such that may foster college and community connections and meet needs and aspirations of the disadvantaged.

Figure 5.20: Internal relationship of veterinary public health and preventive medicine courses in relation to Epizootiology as a common foundation course at postgraduate level[6.3]



SEJ* = *Socio-economic jurisprudence* [6.1, 6.6, 6.48, 6.52]

5.9 Recommended Practical exercises

Teachers, covering new areas and locations of epizootiological problems, should use the guidelines that have been given for the conduct of practical exercises. Projects based on disease reporting, monitoring and surveillance should be designed by each lecturer to cover current problems in the state or across the country. Survey of parasitic, bacterial and viral diseases and infections should be designed and taken to nearby cattle ranches, piggeries and poultry flocks. In Appendix V, a list of suggested project topics is provided. All that is necessary is for both staff and students to exercise gumption and thereby provide material for teaching and training in epizootiological intelligence activities.

In choosing such project topics, it should be remembered that epizootiological methods and surveillance might cover not just diseases per se but other problems of herds, flocks and groups of livestock. Nutritional surveys are relevant. Rainy season problems may be surveyed. Inadequacy of water supply during dry season may be used as a project topic for epizootiological investigation. One Example of Recommended Practical Exercises given in detail here is Epizootiological Map Design.

5.9 (a) Disease reporting map

Previous nation-wide arrangement for disease reporting should be resuscitated and taught as major topic in undergraduate epizootiology. In this connection, the epizootiology reporting map (see Figure 4.10) produced by the Federal Livestock Department should be consulted. The process should then be upgraded by the addition of GIS technology as discussed in detail in this book.

5.9 (b) Epizootiological map design

Teachers and students may start this practical exercise by identifying issues of local importance in a community and then explore avenues that may enable students to contribute to community health planning practice through a project in map design. Map design in this case should be a useful product of each one of the recommended project topics provided in Appendix V. Map design gives a reasonable sense of fulfilment in epizootiological orientation to resource development and management in a community. By establishing connection between a college (where epizootiology is taught) and a community within the same local area, students may be encouraged in the use of geographic information systems projects, thus providing the effective tools to administration and planning in the communities.

Where GIS facilities are not yet available in a community area, students and their teachers may work with interested members of the community or with other teachers and students in a school that has a department of Geography and Resource Development. The possibility of collaborating to setup a small scale GIS facility could be explored. Where the facilities already exist, the following steps may be taken

(i) *Make a project description form*

In your group project description form, provide a scope guideline to meet the following specifications: (i) small scale (ii) simple (iii) relates to epizootiology (iv) appropriate for students (v) flexible deadline (vi) specific deliverables and (vii) meets community needs[6.89].

(ii) *Prepare a digital map of the city or town*

Your city may already have an original map data in form of a simple pencil or ink drawing; simply a paper map format with various details of features on it. This paper map may then be converted to digital format on a digitizer.

The digitizer is linked to a computer, and computer software processes the information as it is received from a movable cursor. There is a menu on the digitizer surface that can be activated by the cursor and that is integrated to the software. Using these features on a digitizing tablet (small, or tabletop digitizers for small map sheets are called tablets [6.119]) allows users to create features that show spatial distribution of their original project idea on the digital map of a city.

In carrying out this step of the map preparation, the group should work with a member of the community that has knowledge and experience in the use of the digitizing tablet (see Figure 4.74). The group in so doing would learn the art of digitizing by apprenticeship.

(iii) *Show spatial distribution of your project idea on the digital map of the city*

Capturing map data and storing them into vector format means that the map components in the file are recorded in discrete points, in x-y locations in Cartesian, two-dimensional space The points, lines and polygons are possible with vector file manipulation[6.117], which is most suitable for maps containing lines (such as rivers, roads, streets, coastlines and political boundaries).

A line can be digitized in this way by selecting points along the line and by pressing a button on the cursor. Continuous digitizing may be done, and the machine is made to save the recorded features. The vector digitizing software allows for a variety of options, such as polygon development, area measurement, and others.

(iv) *Explore the map created in Arc View*

The group may now transfer the saved digital map into a GIS software such as *ArcView*[6.132]. Use this software to create simple attribute tables to include name of property owners, name of farms, roads, rivers, etc. Display the result in *ArcView* map display mode. Insert cartographic standards, such as a north arrow, scale bar, and map key. Print out the map and make a group discussion or seminar on your newly created map, explain what you learnt about relationship of features in the community studied.

6.0 BIBLIOGRAPHY

6.1 Esuruoso, G.O. (1993) Fundamentals of Epizootiology. 129pp. A mimeograph produced by Academic Consultancy Services of VetAcademic Resource Foundation (VARF) U.I.P.O. Box 14400, Ibadan, Nigeria

6.2 Esuruoso, G. O. (1994) Increasing Role and Importance of Veterinary Epidemiology and Economics in Veterinary Education, Practice and Development. Paper presented at the 31st Annual Congress of the Nigerian Veterinary Medical Association (NVMA), held at the Federal University of Technology, Akure, Ondo State, Nigeria. Mimeograph Published by Academic Consultancy Services, U.I.P.O. Box 14400, Ibadan, Nigeria

6.3 Esuruoso, G.O. (1984) Opportunities for postgraduate studies in Preventive Veterinary Medicine at the University of Ibadan: 35 pp. Printed by J. Olatunji Printers and Co. (Nig.) Limited, 4, Alhaji Oropo Street, P.O.Box 40, Ikenne-Remo, Ogun State, Nigeria

6.4 Esuruoso, G.O. (1994) Clinical Management, Veterinary Jurisprudence and Economics of Practice; pp 1-31 in Proceedings of a seminar on Effective Management of Veterinary Practice; 54pp. Held at Ikeja Airport Hotel, IKEJA, Lagos State, Nigeria on 27th April, 1994,. A publication of the Veterinary Clinician Forum, Lagos

6.5 Esuruoso, G.O. (1994) Resource management approach to education in veterinary epidemiology and economics. *Kenya Veterinarian Vol. 18 (2) 591*

6.6 Esuruoso, G. O. and Idris Abdulkadir (1984) Livestock Development in Nigeria 1983 2000, 329 pp. [A publication of the Federal Ministry of Agriculture and Natural Resources, Lagos. Nigeria] [Dealing with issues of S*ocio-economic jurisprudence* (sej).

6.7 Frost (1927) Public Health practice. Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.8 Stallybrass, C.O. (1931) The principles of epidemiology 696pp. Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.9 Maxcy, K.F. (1951) Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.10 Cockburn (1963). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90

6.11 Lowe, C.R. and Kostrezewski, J. (1975) Epidemiology: A Guide to teaching Methods; 266pp. Publ. for the Int. Epidemiological Assoc. by Churchill Livingstone

6.12 Greenwood, M. (1935) Epidemics and crowd-diseases: An introduction to the study of epidemiology. Macmillan, New York.

6.13 Paul, H. (1938). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.14 Aycock, (1943). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.15 Stamler (1958). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.16 Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.17 Reid, D.D. (1975) Epidemiological methods in the study of disease. Chapter 4 pp 44-54 In: Hobson, W. (Ed.) The theory and practice of public health. 4th Edition. Oxford University Press, London

6.18 Pemberton (1952). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.19 Gordon, J.E., Behar, M. and Scrimshaw, N.S. (1964) Acute diarrhoeal disease in less developed countries: 1 An epidemiological basis for control. Bull WHO 31: 1-7

6.20 Fox, J.P., Hall, C.E., and Elveback, L.R. (1970) Epidemiology: Man and Disease. Macmillan, London

6.21 MacMahon, B. and Pugh, T.F. (1970) Epidemiology: Principles and Methods. 131pp. Printed by Little, Brown and Co., Boston, United States of America

6.22 Sartwell, (1973) Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.23 Mausner, J.S. and Bahn, A.K. (1974) Epidemiology: An introductory text. Saunders Company, Philadelphia

6.24 Friedman (1974). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.25 Lasagna (1975). Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.26 Sinnecker, H. (1976) General epidemiology. Wiley, London United Kingdom

6.27 Mulvihill, (1972) Cited by Halpin, B. (1975) Patterns of Animal Disease 144 pp. (Publ. Bailliere Tindall, London).

6.28 Halpin, B. (1975) Patterns of Animal Disease 144 pp. (Publ. Bailliere Tindall, London).

6.29 Blood, D.C. (1985) The Role of Clinicians and Epidemiologists in the Welfare of Food Animals Perspectives and Interactions; pp. 21-32 (of the Proceedings of the 4th ISVEE, 18-22 November, 1985, Singapore).

6.30 Schwabe, C.W. S., H.P. Riemann and C.E. Franti (1977) Epidemiology in Veterinary Practice 303 pp. (Publ. Lea Febiger, Philadelphia, USA).

6.31 Bennet, F.J. (1985) Epidemiological Principles and their Application in African countries; Ch. 5, pp. 47-54 of G.O. Sofoluwe and F.J. Bennet, eds. Principles and Practice of Community Health in Africa, 642 pp. (University Press Limited, Ibadan).

6.32 Taylor (1967) Cited by Lilienfeld, D. E. (1978) Definitions of Epidemiology. Am. J. Epid. **107** (2), 87-90.

6.33 Morris, R.S. (1994) The Epidemiological Approach to Animal Health Building on Strong Foundation; pp. 1-3 of the Proceedings of the 7th ISVEE, Nairobi, Kenya. 1994. (Published by the Kenya Veterinarian, 18 (2) 15 19 August, 1994.

6.34 White, K.L., and Henderson, M.M. (1976) Epidemiology as a Fundamental Science; 235 pp. (Oxford University Press, N.Y.).

6.35 Hobson, W. (1975) The Theory and Practice of Public Health; 685 pp. (Oxford University Press, London).

6.36 Leech, F.B. and Sellers, F.C. (1979) Statistical Epidemiology in Veterinary Science; 158 pp. (Charles Griffin & Co. Ltd., London).

6.37 Ndiritu, C.G. (1994) Institutionalization of Veterinary Epidemiology and Economics; pp. 4-6 of the Proceedings of the 7th ISVEE, 15-19 August 1994, Nairobi, Kenya. *Kenya Veterinarian*; **18** (2), 4 6.

6.38 Ellis, P.R. (1985) Expanding the Responsibilities of the Veterinarian; pp. 127-132 of the Proceedings of the 4th ISVEE, 18-22 November, 1985, Singapore.

6.39 Thursfield, M. (1986) Veterinary Epidemiology. Publ. Butterworth & Co. Publishers Ltd. UK.

6.40 Catley, A and Mariner, JC, (2002). Participatory Epidemiology: Lessons Learned and Future Directions. Community Animal Health and Participatory Epidemiology Unit, Interafrican Bureau for Animal Resources of the African Union, Nairobi, 37 pp.

6.41 The Holy Bible, Authorized King James version (1957), placed by the Gideons International: St. Matthew 18; 3, p22

6.42 Esuruoso, G. O., (1980) Facts and Fallacies about the Biological Basis of Living and Dying; 320pp. The text of a University of Ibadan Public Lecture, given in three parts on behalf of the Faculty of Veterinary Medicine during 1979/80 Academic Session (University Press Stakeholder)

6.43 Esuruoso, G.O. (1985) The contribution of Veterinary Medicine to Public Health awareness in Nigeria. Pp 234-248 In: A Decade of Service to Livestock Production in Nigeria. Printed by the University Press, Ibadan published by the Faculty of Veterinary Medicine, University of Ibadan, Nigeria.

6.44 Esuruoso, G.O. (1979) Veterinary Public Health Practice and Development in Nigeria: The text of an inaugural lecture delivered at the University of Ibadan, on 10th May 1979 (Ibadan University Press).

6.45 Esuruoso, G.O. (1997) A Handbook of Technical Report Writing. 34pp. Based on the approved Post-Graduate course PVM 704, University of Ibadan, Produced by the Documentation and Desktop Publishing Division of Academic Consultancy Services, U.I.P.O. Box 14400, IBADAN, Nigeria

6.46 The Holy Bible, Authorized King James version (1982).Thomas Nelson Publishers Luke 2: 40 p690

6.47 Esuruoso, G. O. (2003) ***Triangulation,*** An introductory presentation by the chairman at the opening of the lead seminar at the 40th Annual Congress of the Nigerian Veterinary Medical Association (N.V.M.A) '*IBADAN'2003*' to guide the presenters and discussants of the various papers. 2pp [A VARF Handout Publication Ref. GOE/VARF/NVMA/IB / 17102003]

6.48 Esuruoso, G.O. and Olugasa, B.O. (1999) *Socio-economic jurisprudence* in the context of modernization of state veterinary services and privatization of veterinary functions in Nigeria. Pp 76-79 In: Proceedings of the 36th Annual Congress of the Nigerian Veterinary Medical Association held at Arewa House, Kaduna, Kaduna State, Nigeria. Published by NVMA, Kaduna, Nigeria.

6.49 Ramirez, A. Olugasa, B.O. and Bickette-Weddle, Danelle (2004) Geographic information systems and its role in biological risk management. 3pp In: Web-Based Program on Biological Risk Management. Published by Center for Food Security and Public Health (CFSPH), Iowa State University, Ames, Iowa, USA

6.50 Esuruoso, G.O. (1989) Improving teaching and learning processes in African Universities: Assessment practices. In the Proceedings of the International Symposium on Improving Teaching and Learning in African Universities, held at the Conference Center, University of Ibadan, Edited by Bajah, S.T. Ibadan, Nigeria

6.51 Susser, M. (1973) Causal thinking in the health sciences: Concept and strategies of epidemiology. 181pp. Oxford University Press, New York, Oxford, Toronto

6.52 FMA&RD (2001) Blueprint on infrastructure for livestock development and production and standards of veterinary services nationwide; 95pp. Report of a Taskforce Committee, Volume one (A publication of the Federal Ministry of Agriculture and Rural Development, Garki Area 11, Federal Capital Territory (F.C.T.) Abuja. Nigeria

6.53 Esuruoso, G.O. and Olugasa, B.O. (1997a) Social responsibilities of professionals in Nigeria. VARF Quarterly Bulletin Vol. 1 (No. 1) pp 1 28.

6.54 Olugasa, B. O. and Esuruoso, G.O. (1999) Exploring shared areas of work systems for veterinary officers and private practitioners: *A recipe for success at all levels*. Pp 71-75. In: Proceedings of the 36th Annual Congress of the Nigerian Veterinary Medical Association (NVMA). Held at Arewa House, Kaduna, Kaduna State. Published by NVMA, Kaduna, Nigeria.

6.55 Esuruoso, G.O. (1995) The practice of preventive veterinary medicine in a devastated national economy. Paper presented at the 32nd Annual National Congress of the NVMA, Held at the NVRI, Vom, Plateau State, Nigeria.

6.56 Schwabe, W.C. (1984) Veterinary Medicine and Human Health. Third edition. Waverly Press Inc. Baltimore. 608 pp

6.57 Esuruoso, G.O. (1996) Prevention and abatement of zoonotic diseases. 254-279. In: Sofoluwe, G.O., R. Schram and D.A. Ogunmekan (Edts) Principles and Practice of Public Health in Africa. Vol 1. 530pp. University Press Plc, Ibadan

6.58 Esuruoso, G. O. (1974) Bovine Brucellosis in Nigeria, Vet. Rec. **95** (3), 54-58

6.59 Esuruoso, G.O. (1989) Diagnosis of Brucellosis 30 pp. Proceedings of International Workshop on Veterinary Diagnostic Procedures 18 - 27 September 1989, Held at the Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria. (A publication of the Nigerian Veterinary Medical Association (NVMA).

6.60 Adeyemi, I.G. (2001) Epizootiological features of tsetse fly infestation of University of Ibadan Teaching and Research Farm. 267pp. A PhD thesis in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

6.61 Esuruoso, G. O. (1973) The Epizootiology, prevalence and economic aspects of bovine trypanosomiasis in Nigeria. Pp 160-175 of the proceedings of the 77th U.S. Animal Health Association meeting, held on October 13-19, 1973: St. Louis, Missouri 63101, United States of America

6.62 Joyce M. Hawkins (1985) The Oxford Paperback dictionary. 2nd Edn. 791pp. Oxford University Press

6.63 Esuruoso, G.O. Ed. (2000) Value and Integrity of scientific research and publications. VARF Quarterly Bulletin Second Special (inter-millennium) Edition: pp 1-45

6.64 Umoh, J.H. and A.A. Adewuyi (1984) Some epizootiological features of clinical bovine infectious keratoconjunctivitis in a University farm, Zaria, Nigeria. Bull. Anim. Hlth. Prod. Afr. 32, 231-235

6.65 Esuruoso, G. O., J. O. Hassan, T.O. Abegunde, J. E. Fatosin, N. Koinyan and B. A. Ajayi (1984) The investigation and Recommendations on the problems of a fast diminishing herd of Keteku at the Borgu Cattle Ranch; 46p. Being the report of an official investigation carried out at the request of the Permanent Secretary, Ministry of Agriculture, Fisheries and Natural Resources, P.M.B. 1383, ILORIN, Kwara State, Nigeria (Ref.VKW/16/Vol.III/747 of 2nd August, 1983 and Ref. GOE/VPHPM/UI /210384)

6.66 Esuruoso, G.O. (1992) Lecture Notes on Epizootiology: 92pp. A mimeograph prepared for DVM undergraduates classes in some Nigerian Universities. (Obtainable from Academic Consultancy Services, U.I.P.O. Box 14400, IBADAN, Oyo State, Nigeria.

6.67 Last, J. W. (1983) A Dictionary of Epidemiology 144 pp (Publ. Oxford University Press, New York, Oxford Toronto).

6.68 Whittaker, R. H. 2nd Edn. (1975) Communities and Ecosystems; 385 pp. (Published by Macmillan Publishers Co. Inc. New York).

6.69 Kilborne, F. (1939) Infectious diseases as parasitism

6.70 Nuru, S. (1973) Epizootiology of canine rabies and its public health significance in Kano State, Nigeria Nig. Vet. J. **2** (2), 49 - 54

6.71 Schoental, R. (1965) Toxicology of natural products. Far East Med. J. 1: 291-296

6.72 Nwude, N. (1981) Some stock poisoning plants of Nigeria. J. Anim. Prod. Res. 1 (2) 109-122

6.73 Kingsbury, L.M. (1964) Poisonous plants of USA and Canada. Prentice Hall Inc., Englewood

6.74 Walsh, S.J., Billsborrow, R.E., McGregor, S.J., Frizzelle, B.G., Messina, J.P., Pan, W.K.T., Crews-Mayer, K.A., Taff, G.N., and Baquero, F. (2003) Integration of longitudinal surveys, remote sensing, time series, and spatial analyses: Approaches to linking people and places. Chapter 4 In: Fox, J., Rindfuss, R.R., Welsh, S.J., Mishra, V. (Eds.) People and the Environment. Kluwer Academic Publishers, 101 Philip Dr., Assinippi Park, Norwell, Massachusettes 02061 USA

6.75 Adewale, G.A. and Olugasa, B.O. (2005) Geographic mapping of African swine fever 2001-2 outbreaks in southern Nigeria, Vol. 1 pp383-387, In: Wrzesien A.K.R. (Edited) Animals and Environment: Proceedings of the 12th International Congress on Animal Hygiene. Published by Warsaw Agricultural University, Warsaw, Poland

6.76 Hugh-Jones, M.E. and Wright, P.B. (1970) Studies on the 1967-8 foot-and-mouth disease epidemic: the relation of weather to the spread of disease. J. Hyg., Camb., 68: 253-271

6.77 Tinline, R.R. (1972) Lee wave hypothesis for the initial pattern of spread during the 1967-8 foot-and-mouth epizootic. In McGlashan, N.D. (Ed.) Medical Geography. 301pp. Published by Methuen and Company, Ltd, London,

6.78 Esuruoso, G.O. and Van Blake, E.H. (1972) Bovine Brucellosis in two southern states of Nigeria: 1 An investigation of selected herds. Bull. epid. dis. Afr. 20 (4), 269-274

6.79 Samson, R.L. and Morris, R.S. (1994) The use of survival analysis to investigate the probability of local spread of foot-and-mouth disease: An example study on the United Kingdom epidemic of 1967-1968. *Kenya Veterinarian* 18 (2) 186-188

6.80 Zeiler, M. (1999) Modelling our World: The ESRI guide to geodatabase design. 199pp. Published by Environmental Systems Research Institute, (ESRI) 380 New York Street, Redlands, California. 92373-8100 United States of America

6.81 Esuruoso, G.O. (1974) Bovine Brucellosis in two southern states of Nigeria: II. The incidence and implications of infection in range cattle: Bull. epiz. dis. Afr. 22 (1), 35-40

6.82 Henderson, R.J. (1969) The outbreak of foot-and-mouth disease in Worcestershire. An epidemiological study: with special reference to spread of the disease by wind-carriage of the virus. J. Hyg. Camb., 67: 21-33

6.83 Sanson, R.L., Liberona, H. and Morris, R.S. (1991) The use of a geographic information system in the .management of a foot-and-mouth disease epidemic. Prev. Vet. Med., 11: 309-313

6.84 Olugasa, B.O. (2004) Biological risk management and visualization with GIS. *Academic Vizions* - Spring 2004: The Quarterly E-Newsletter from *CommunityViz. CommunityViz* 1035 Pearl St, Suit 300, Boulder, Colorado 80302 United States of America

6.85 The Orton Family Foundation (2003) Getting to know CommunityViz, 3pp with Evaluation CD, Produced by CommunityViz 1035 Pearl St, Suit 300, Boulder, Colorado 80302 United States of America

6.86 Hoch, C.J., Dalton, L.C. and So, F.S. Ed. (2000). The Practice of Local Government Planning. Third Edition. 496pp. Published by the International City/County Management Association (in collaboration with the American Planning Association) for the ICMA University. ICMA, 777N. Capitol Street, N.E., Washington, D.C. 20002. Printed in the United States of America

6.87 Polkinghorne, John (1996) Searching for Truth: A scientist looks at the Bible; 156pp. ISBN 0 7324 1559 4 *Printed and bound in Great Britain by Biddles Ltd., Guildford & Kings Lynn] [published by The Bible Reading Fellowship, Peters Way, Sandy Lane West, Oxford, OX4 5HG England.*

6.88 Alonge, D.O. (1984) Smoke preservation of meats in Nigeria: Quality and public health implications. A PhD thesis in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

6.89 Adeitan, O.A., Olugasa, B.O., Abiodun, Y., Ogunwale, I., Oluro, A. and Soetan, K.O. (2003) Social and economic effects of African swine fever 2001/2002 outbreaks on pig farmers in south western Nigeria. Pp 637-642 In: Vol. 2, Proceedings of the 11th International Congress on Animal Hygiene. Published by Univasidad Autonoma Metropolitan, Mexico City, Mexico.

6.90 Knapp, C.L. and The Orton Family Foundation Community Mapping Program (2003) Making Community Connections 173pp. Published by Environmental Systems Research Institute (ESRI), 380 New York Street, Redlands, California. 92373-8100 United States of America

6.91 Pavlovsky (1939). Cited by Ferris, D. H. (1967) EPIZOOTIOLOGY: pp 261-320 In: Advances in Veterinary Science, Vol. 11 (Publ. Academic Press, New York & London).

6.92 Encyclopaedia Britannica (2002) Deluxe Edition

6.93 Eunice J. Gill Ed. 2nd Edn. (1979) Oxford/Philip Atlas for Nigeria; 123pp. Published by *Oxford University Press, London; in association with University Press Limited, Ibadan, Zaria, Kano, Owerri, Benin City, Lagos: Printed in Great Britain by Cook, Hammond & Kell, Mitcham Surrey*

6.94 Baldry, D. A. T. (1969) Distribution and trypanosome infection rates of Glossina morsitans sub-morsitans Newst. Along a trade cattle route in south western Nigeria. Bull. Ent. Res. **58** (3), 537-548

6.95 Falobi, O.O. (1998) Epizootiology and the use of a grazing reserve for the economic development of pastoralism in Nigeria. 145pp A PhD thesis in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

6.96 Olarinmoye, O.O. (2000). The ecological epizootiology of Bovine hemporotozoan and helminth infections in parts of Nigeria, 112pp. An MPVM project report in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria

6.97 Gledhill, D. (1981) West African Trees; 72pp. (West African Nature Handbooks, Longman)

6.98 Booth, A. H. (1977) Small Mammals of West Africa; 68pp. (West African Nature Handbooks, Longman)

6.99 Elgood, J.H. (1976). Birds of the West African town and garden. 66pp. [West African Nature Handbook, Longman]

6.100 Esuruoso, G.O. (1984) Immunology of animal trypanosomiasis: A review of current knowledge. *Nig. Vet Med. J 8 (2) 43-63*

6.101 Cansdale, G.S. (1981) West African Snakes. (West African Nature Handbooks, Longman)

6.102 Brown, L. (1965) Africa a natural history. 299pp. A Chanticleer Press Edition. Hamish Hamilton Ltd, London

6.103 Nwude, N. and Ibrahim, M.A. (1980) Plants used in traditional veterinary medical practice in Nigeria. J. Vet. Pharm. Therapeutics 3, 261-273

6.104 Gbile, Z.O. (1984) Vernacular names of Nigerian plants (Yoruba). 101pp. Published by Forest Research Institute of Nigeria.

6.105 Hubbard, C.E. (1954) Grasses. 428pp. Penguin Books, Middlesex, UK.

6.106 Philips, T.A. (1977) An agricultural notebook with special reference to Nigeria. 312pp. Published by Longman: ISBN058260768X. Printed in Great Britain by Lowe & Brydone Printers Limited, Thetford.

6.107 Ferris, D. H. (1967) Epizootiology: pp 261-320 of Advances in Veterinary Science, Vol. 11 (Publ. Academic Press, New York & London).

6.108 Smith, T. (1939) Cited by Ferris, D. H. (1967) Epizootiology: pp 261-320 of Advances in Veterinary Science, Vol. 11 (Publi. Academic Press, New York & London).

6.109 Steede-Terry, K. (2000) Integrating GIS and the global positioning system. Published by Environmental System Research Institute (ESRI) Redlands, California, USA

6.110 Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. (2001) Geographic Information Systems and Science. 454pp. Published by John Wiley & Sons Ltd. Baffins Lane, Chichester, West Sussex PO19 1UD, England

6.111 Babalobi, O. O., Ayoade, G. O., Olugasa, B. O., Oluwayelu, D. O. and Oyedele, O. (2003) Differential diagnosis of a swine epizootic of unknown etiology in Ibadan, Oyo State, Nigeria. Isr. J. Vet. Med., 58 (2/3); 86 89

6.112 OIE (2002) Manual of standard diagnostic tests and vaccines 2000. Chapter 2.1.12: African swine fever. Published by Office International des Epizootics

6.113 Olugasa, B.O., Oluwayelu, D.O., Adewale, G.A., Ayoade, G.O., Ijagbone, I.F, Babalobi, O.O. and Agbede, S.A. (2005) Confirmatory diagnosis of African swine fever outbreak by immunoblotting assay in southern Nigeria, Vol. 1 pp343-347, In: Wrzesien A.K.R. (Edited) Animals and Environment: Proceedings of the 12th International Congress on Animal Hygiene. Published by Warsaw Agricultural University, Warsaw, Poland

6.114 Pastor, M. J., Laviada, M.D., Sanchez Viscaino, J.M. and Escribano, J.M (1989) Determination of African swine fever virus antibodies by immunoblotting assay. Can. J. Vet. Res., 53: 105 107,

6.115 Ijagbone, F.I. (1995) Sero-epizootiological evaluation of Enzyme Linked-Immunosorbent Assay (ELISA) in the diagnosis of animal trypanosomiasis. 290pp. A PhD thesis in the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

6.116 Esuruoso, G.O. (1969) Health problems in the dairy herds in western Nigeria. Proc. Agric. Soc. Nig. September, 19-22, 1969: Benin City, Nig. agric. J. (6) 48

6.117 Henderson, W.M. (1970) Foot-and-mouth disease: a definition of the problem and views on its solution. Br. Vet. J., 126: 115-120

6.118 Dent, B.D. (1999) Cartography: Thematic map design. Fifth edition 417pp. Published by WCB/McGraw-Hill, New York, United States of America

6.119 Fite, R.W. (2000) Animal health risk assessment in theory and practice. JAVMA Vol.217, No 12

6.120 NigeriaSat-1 (2003) Images and operations of Nigeria earth observation satellite: NigeriaSat1.

6.121 Roth, J.A. (2004) Personal communication

6.122 Ashok, W. (2000) PDA Solution: Recent advances in GPS/GIS data collection. (www.ugic.info/swug2000/proceeding.html) In. Proceedings of ESRI South West Users Group ArcGIS 2000 Conference, November 6 9. Held at Moab, Utah, USA

6.123 Ron, R. (2003) Barebones introduction to PDA/GPS in the classroom and field. Department of Forest Resources, Oregon State University, USA 3pp. (http://oregonstate.edu/~reuterrr/NWACC/docs/pdaintro%20.docCourse)

6.124 Dell (2003) Dell Axim X30 Pocket PC Running Window Mobile 2003 Second Edition. www.pdabuyersguide.com/Dell_axim_X30.htm

6.125 TGE (2003) GPS platform for GIS field requirements. Trembel GeoExplorer Series. http://www.tremble.com/geoxt.shtml

6.126 Esuruoso, G. O. and Olugasa, B.O. (1997) Actualization of strategies for privatized preventive veterinary services to nomadic herdsmen in southern Nigeria; *Epidermiologie et Sante Animale* 31.2.22.1-3. Published by Foundation Marcel Merioux, Paris France.

6.127 Olugasa, B.O., Cadmus, S.I.B. and Atsanda, N.N. (2000) Actualization of strategies for beef quality control in south western Nigeria pp 67 71 in Vol. 1, Proceedings of the 10th International Congress on Animal Hygiene 2nd 6th July, 2000 in Maastricht, the Netherlands. Printed by *Wijid bij Vaasted*, published by Animal Health Service in the Netherlands.

6.128 Rossiter, P.B. (1994) Why on earth do we still have Rinderpest and what in the world is being done about it? *The Kenya Veterinarian 18 (2) 503-504*

6.129 Obonde, D.J. (1987) Ergonomics at work. 395 pp. Published by John Wiley and Sons Ltd, New York

6.130 Moerdyk, A.P. (1983) Person-environment mismatch: does one square the hole or round the peg? S. Afr. J. Psychol. 13(3) 66 70.

6.131 Cadmus, S.I.B., Olugasa, B.O. and Ogundipe, G.A.T. (1999) The prevalence and zoonotic importance of bovine tuberculosis in Ibadan, pp 8-10 in the Proceedings of the 36th Annual Congress of the Nigerian Veterinary Medical Association held in Arewa House, Kaduna, Kaduna State, Nigeria. Published by NVMA, Kaduna, Nigeria.

6.132 Coker, A.O., Olugasa, B.O. and Adeyemi, A.O. (2001) Abattoir wastewater quality in south western Nigeria Pp 84-86 In: People and Systems for Water, Sanitation and Health Published by Water Engineering and Development Center (WEDC), Loughborough University, United Kingdom.

6.133 FAO/WHO (1975) The Veterinary Contribution to Public Health Practice 79 pp. Technical Report series No. 573 (Publ. WHO, Geneva and FAO Rome).

6.134 Olugasa, B.O., Esuruoso, G.O. and Erhime Oghre-Ikanone (2003) Teaching animal hygiene at the University of Ibadan, Ibadan, Nigeria. pp 371-375, In: Vol. 1 Proceedings of the 11th International Congress on Animal Hygiene. Published by Univasidad Autonoma Metropolitan, Mexico City, Mexico.

6.135 Ormsby, T., Napoleon, E., Burke, R., Groess, C. and Feaster, L. (2001) Getting to Know ArcGIS desktop. 541 pp. Published by Environmental Systems Research Institute, (ESRI), 380 New York Street, Redlands, California. 92373-8100 United States of America

7.0 GLOSSARY

7.1 Introduction

This glossary is meant to provide a list, definitions and explanations of words, phrases and clauses from a growing sub-language that seeks to expound profound levels of epizootiology *sensu stricto* and of cognate disciplines (such as *epidemiology*, *epornithics/epornithology* and *epiphytology*), with common structures, methods and systematics.

Hopefully, readers will be provided with the appropriate shades of meanings that will enable them to fully grasp the principles and methods of scientific thinking about, and enquiry into group (or population) *problems* (not only diseases) and solution options for their control and prevention.

Not unexpectedly, the growth of a discipline or a science is usually inevitably associated with the coining of new vocabulary and the adaptation of existing ones to usher in new shades of meaning relevant to the new pervading and growing science or discipline. Epizootiology can never be an exception. Hence this glossary will contain new words providing tools for giving expressions to the thoughts and conceptions of the growing discipline. For example, Epi-scientology is the culmination of a group of new words based on the generic structures of existing ones, such as *Epiphytology*, *Epizootiology*, *Epidemiology*, *et hoc genus omne*. The senses in which these established and the new words are used in the text of this textbook and related lecture notes are the ones being reflected in this glossary.

7.2 (A)

(A1) Agent = an object (i.e. a living or non-living thing) that causes, instigates or precipitates action or problem e.g. a disease agent which may be a parasite, a bacterium, a virus, other microbes, toxic, carcinogenic, teratogenic, poisonous or simply irritating substance or nuisance factor.

((A2) Alibi = evidence that one is in a different location at the material time from the implicating one.

(A3) Approach = method and direction of going about a task or a problem the aim being to understand the nature of the problem and the best (optimally cost-effective) way to solve it. It should be noted here that when we speak of cost-effectiveness we are thinking in terms of social, economic, financial (i.e. socio-economic jurisprudential (sej)) and temporal terms, not just in money terms and over an unlimited duration. See asymmetrical logic paths for causal relationships.

(A4) Asymmetrical In terms of Epizootiology and cognate disciplines, asymmetrical associations are relationships that have plausible, reasonable, scientific, magnitude, directional and temporal components. Asymmetrical relationship is synonymous with "causal relationship". It is a relationship between a causal variable and its effect. If A

causes Y, then A must have existed or occurred before Y. (See Symmetrical Association/Relationship for contrast both are useful in Epizootiological scenarios).

(A5) Autecology = the comprehensive ecology of individual organisms and populations including physiological ecology, behaviour studies and population dynamics (see demecology).

7.3 (B1)

(B1) Bacteraemia = the presence of bacteria in the circulating blood of vertebrate animals. *Bacteraemia* should be distinguished from *septicaemia*. The latter term is used when the circulating micro-organism is also actively multiplying its kind while in circulation.

(B2) Biocenology/Biosociology = the ecology of the population of many species in a whole community, in an entire ecosystem (terrestrial and aquatic) (Europe) (See *Synecology* (UK).

(B3) Biology = the study of living things (plants, animals, bacteria, fungi and viruses with particular reference to their forms, functions, life cycles and their external environment (i.e. habitat). (See Botany, Zoology & Ecology).

(B4) Biocenosis = biotic community (see section 4.3 2e of these lecture notes).

(B5) Biome = a major biotic community (e.g. the savannah grasslands of Nigeria.

(B6) Biotope = the smallest area with fairly uniform conditions for supporting life (and an ecological community).

(B7) Biomedical = relating to the biology and the medical/disease implications of biological (i.e. living) activities (such as breeding, feeding, interaction with other living organisms, excretion, etc.).

(B8) Biosociology = see *Biocenology* with which it is synonymous.

(B9) Biosphere = regions of the earth's crust where living organisms are found because their surrounding will support life. The three components of the earth's biosphere are *atmosphere*, *hydrosphere* and *geosphere*.

(B10) Black box = this is the area where processes take place in a computer-based system. It is where the most reliable information about any system can be obtained. When there is an air crash people always ask for the black box; this is because the black box contains all reliable information about the flight and the operations of the aircraft and hence the clue to the disaster.

(B11) Bridge Builder = A bridge-builder is a discrete component of a diffuse system. Where human systems are involved, a bridge-builder is a specialist who, apart from having his own area of specialization also has the knowledge of the other components and how they fit into the system. A bridge-builder is the most suitable leader for the effective utilization of all the expertise of the other components for the over-all success of the system. A general manger, a senate leader, a head of a faculty or college and even a DVS (Academic) should be a bridge-builder in the appropriate system. This is a person who is highly specialized academically but can also recognize the importance and the major roles of all the other specialists across the institution.

(B12) Bamboo

(B13) Banana tree

7.4 (C)

(C1) Causal Relationship = this is synonymous with *asymmetric* relationship. It is directional and must be based on time. If A causes B, then A must exist before B. It is an important aspect of cause/effect association.

(C2) Ceteris paribus; Latin, meaning *'All other things being equal'*

(C3) Chain = in these notes we mentioned the following (I) energy chain; (ii) food chain; (iii) and production chain. It is good to remember that matter and energy can neither be destroyed nor created. They are just being transformed in a chain of events. For example, solar energy is being transformed to chemical energy working through the food chain.

(C4) Climate = Climate is the reflection of temperature, pressure, wind, light and moisture content in the atmosphere. It affects all aspects of life and living conditions in the area.

(C5) Cognition = this is the highest level of learning. It means that the learner is able to see, foresee, perceive and imagine the trends in the knowledge of things in which he is interested. Cognition is the faculty of knowing, perceiving and conceiving the true situation.

(C6) Contamination = this describes the first contact between a host and a problem agent. If the agent gets into contact with the host, many outcomes are possible, including a nil outcome, e.g. bacteria contaminating the conjunctiva of an animal may be washed away by the tears of the host. The next steps after contamination may be establishment, proliferation, toxin production or invasion leading to infection of the host.

(C7) Cost = in this text we include financial, economic and social costs. Any veterinary activity must consider the possible costs side by side with the benefits. Therefore, being cost-conscious means always considering and comparing the costs and the benefits of the events. It also means choosing the scenario that produces positive result where benefit is greater than cost in whatever term (financial, economic and social).

(C8) Congruenta naturae vivendum est = this means that it is a wise thing to live agreeably with nature, instead of trying to create one's own environment and conditions.

7.5 (D)

(D1) Death = the end of every living thing. It is relevant to note that a dead organism would naturally return its constituents into the general circulation. It is from this fact of life that the saying in Latin "*Patriam* inservindo consumur" which means when a living organism is no longer serviceable to fatherland it is consumed by fatherland becomes established. In the same breath the environmental health will be maintained if dead animals are placed in positions where their remains will enter again into circulation most readily. Recirculation is more conducive to healthy environment than dumping.

(D2) Dependent (see independent variable also) = Here Dependent means consequent upon or subordinate to. A graph is usually drawn with an independent variable in the abscissa (or x axis), while the dependent variable is in the ordinate (or y axis) position. In a frequency graph dependent variable is in the Y-axis while independent variable is in the X-axis. Examples of dependent variables are: effect, response, outcome/output. The independent variables for these include cause, stimulus, input, time, etc.

(D3) Diagnosis here means a statement or description of a problem, its nature and its probable cause/s. We emphasize here that diagnosis is a network of activities starting from the statement of either the patient or the owner in the case of animals (Esuruoso, G. O., 1989). "My calf is sick" is a basic diagnosis. Then follows the statement of the clinician who says he is sick of liver disease. Then the pathologist, who may say 'it is suffering from necrosis of the liver.' The microbiologist may then say that the necrosis is caused by *Fusiformis/Spherophorus necrophorus*. Then the epizootiologist may say 'it is an enzootic problem in calves reared inside animal houses with damaged and contaminated floors; the incidence may be up to 20%. It is to be observed that epizootiological diagnosis summarizes and makes use of all the other diagnoses listed earlier, thus providing both qualitative and quantitative information of the problem at the levels of species, groups or populations. For further details, see '*Epizootiological diagnosis*' below (*ibid.*)

(D4) Diffuse System (also see discrete system) = A Diffuse system is one in which the individual components cannot have a meaningful individual existence, e.g. the circulatory system, and an ecosystem (quod vide Section 4.3.1 of these notes).

(D5) Discrete System = A Discrete system is one in which the individual components have meaningful individual existence, e.g. in a human society system, the components are individual human beings; the faculty system the individual components are departmental.

(D6) Descriptive = Whether it is used in terms of epizootiology of biostatistics, what the advocates are describing include the population of hosts, the places of their existence (including the environment) and the time factor (i.e. when? How often? Or frequency, etc). In the study of the English Language one can write a descriptive prose. In this case it provides a description of the subject as opposed to a discourse.

(D7) Discourse = A discourse is an extensive presentation in which components of systems are not only described, but the questions why? How? And when they become what they are, will also be attempted. History is an example of Discourse in prose writing. It is different from narrative and persuasion.

(D8) Disease = A disease is an aberration from normal health caused by a specific or group of agents. It is only one of the problems of animal populations being studied by the methods of epizootiology. Diseases are not the only problems of animal populations. Deprivations and exposure to inclement weather are also problems that can be studied by the methods of epizootiology.

7.6 (E)

(E1) Ecology = this means the study of ecosystems. It is also the study of ecological communities. Ecological communities include the plant component, the animal component, the inanimate environment and its components, and the interactions among all the above. Such interactions often result in population dynamics, transformation of energy and matter, maintenance of disease chains, new creations, deaths, recirculation of matter and environmental health. All other definitions of ecological terms have been presented in the substance of the text.

(E2) Edaphic = this means relating to the soil, e.g. edaphic factors these are determinant factors of the soil that may dictate the survival of certain plants in certain areas of the earth.

(E3)Episcientology = Epi means upon or what befalls a group of things. Scientology means systematic and methodical acquisition of knowledge of. Therefore, epi-scientology means the systematic study and acquisition of knowledge of the natural problems of populations of objects, animate and inanimate. The animate component consists of plants, animals, bacteria, fungi and other micro-organisms. Epi-scientology should be seen as consisting of the following major branches:

(i) *Epiphytology* (the study of the problems of plant populations);
(ii) *Epizootiology*, which means the study of the problems of animal populations;
(iii) *Epi-inanimatology* i.e. the study of the problems of the inanimate environment and its components.

Since Epizootiology has been divided into sub-branches like *epidemiology* (the study of human population problems) *epornithics* (the study of the problems of birds) populations etc, it is conceivable that one could as well have the following: *Epi-bovidology* (the study of cattle population problems) *Epi-equinology* (the study of equine population problems) *Epicaprinology* (dealing with natural problems of populations of goats) et cetera.

(vi) Epizoology = is the study of the occurrences in the lives of animal populations, without particular reference to their disease problems. But this is sometimes taken as synonymous with epizootiology in certain sense.

(v) Epizootology = the term is sometimes used, in some schools, to mean the study of the infectious diseases of animals. But in our school, it means the comprehensive (holistic and peripheral) study of factors, events, forces and circumstances that contribute to the occurrence, distribution, intensity, volume, control and prevention of *problems* (including, but not limited to all forms of diseases and conditions) in groups (herds, flocks, droves, *et hoc genus omne and populations*) of animals in defined geographical / ecological areas (ecosystems) over stated periods of time. Under the term *factors* should be included contribution of hosts, agents, and the environment. *Events* should include definable and quantifiable interactions between the hosts and the agents, as well as those between both and the environment over time.

Epizootiologist = is someone who practices or is knowledgeable in the science, art, technology and/or socio-economic definition, cost-effective management and prevention of epizootiological problems. *(See Epizootiology)*. An Epizootiologist *sensu stricto is one who considers the social health status of all human resources involved in preventive and control measures as an essential and important aspect of the actual control activities, capitalizing on self-respecting resource-management approach.*

(E4) Epizootiological Diagnosis: Following is a gist presentation of deep thoughts relating to Epizootiological diagnosis

First, it has been said in so many words and in different places in this book, that epizootiological diagnosis is the pinnacle of systems' and systematic diagnosis. It learns from, takes advantage of, adds to and builds on other forms of diagnosis of group problems, putting everything in perspective, so that the true epizootiologist may lead the way to preventive and control/management measures (pc/mm) in their soundest and widest sense. This can never be a trivial or joking matter.

Moreover, epizootiological diagnosis fundamentally takes into account factors, forces, events and circumstances of

- groups and species of hosts, agents, *parasites*, vectors, reservoirs:
- places in geographical and ecological terms:
- time in terms of dates, seasons, hours, duration, when, since when, till when, how often and trends?
- interactions, dependence and interdependence in terms of food, nutrient, energy requirements and chains, also in terms of types of relationships; mutualism, commensalism, parasitism, chance, ephemeral or till-death-do-us-part associations, peaks and troughs, with or without climax or stability in the relevant ecosystem and in

terms of environmental health, degradation, sustenance of natural variety of species, their survival, threatened state, increasing and decreasing prosperity.

An epizootiological diagnosis may not be complete or holistic unless those issues are given due consideration, depending of course on the nature of the system being considered, the context and level at which it is being considered, the objectives of the system and that of the exercise, project or programme. Epizootiological diagnosis will always have the scope for being as comprehensive as the protagonists may choose and the resources or resource management approach adopted may permit. The human *social health factors*, as spelt out in the body of *socio-economic jurisprudence* level, and therefore including the mental and mentality, moral value indices, educational status, spiritual dimension, being either honourably law-abiding, peace-loving and promoting and security conscious or otherwise. Hence, epidemiology is only a branch of Epizootiology *sensu stricto*. As without those considerations of the effects of man's own powerful influence, the result of and from any truly scientific and holistic study cannot be predictable. Nor can we rightly and righteously equate the role of man to those of lower vertebrate species by equating a part to a whole.

Following the systematics, logic paths and tools of thought just presented, epizootiology will readily prove to be the soundest tools, not only for determining the most reliable prognosis, but in choosing from the most appropriate or optimum of solution options for control, extermination, prevention and even proper presentation of the group problem in hand or envisaged. It will also lead the way to wisdom in minimizing the adverse or undesirable effects of group problems (i.e. problems of herds, flocks, populations *et hoc genus omne*) cost effectively in financial, economic and social terms, these being issues in socio-economic jurisprudence (sej).

7.7 (F}

(F1) *Fauna* = this means animals, especially vertebrate animals in an ecosystem.

(F2) *Feral* = Feral animal simply means wild (undomesticated) animal.

(F3) *Flora* = this means the plant components of an ecological community.

(F4) *Food Chain* = this is a major aspect of ecology, in which living things are divided into primary producers, other producers, consumers, predators and preys. The green plant with its chlorophyll, in the presence of sunlight, is the primary producer of carbohydrate from simple elements and components like water (H20) and carbon dioxide (CO2). Herbivores consume the green plants to obtain the carbohydrates which they then convert into meat i.e. proteins. These are secondary producers of food. Carnivores like dogs, and omnivores like man, are consumers of both the plant and the meat of herbivores. This is the trend in food chain in nature. Food chain is linked to energy chain.

(F5) *Frederick Kilborne* = He is one of the earlier epidemiologists who showed the usefulness of ecological approaches to epizootiology.

7.8 (G)

(G1) *Garcinia kola* (Bitter kola) tree (40-90ft height) (*Orogbo*, Yoruba) C3" (7.5cm) fruit. About 4 - 6 brown seeds embedded in a pulp. Its wood is termite proof and its seeds are medicinal. Its branches are used as chewing sticks in local communities while its pulp is edible

(G2) *Geographical Epizootiology* = this is synonymous with landscape epizootiology. It means the ecological approach to epizootiology in which the various ecosystems associated with vegetational, topographical, climatic and economic regions of the earth are characterized and presented as such. In this study the nidality (and focality) of disease (as proposed by Pavlovsky) is highlighted.

(G2) *Geographic Information System* **(GIS)**
A GIS is a computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. GIS is used for handling maps of one kind or another to support decision making in planning and management of land use, natural resources, environment, transportation, urban facilities, natural risks, administrative records and in our case, animal health risk visualization and management.

(G3) *Grasses members of the family of flowering plants (Gramineae)*. They include cereal plants, reeds and bamboos, the blades/leaves of all the grazing materials that characterize the Guinea and Sudan savannah landscapes of the tropical and sub-tropical parts of Africa. See section 4.5 of this book (*ibid.*).

7.9 (H)

(H1) Hawkins 1985, Joyce M = This is the name of the compiler of the Oxford Paper Back Dictionary (2nd Edition) 1985, from which the definition of science as used in these notes was taken. By her, science means a branch of knowledge that requires systematic study and method.

7.10 (L)

(L1) Landscape Epizootiology = this is synonymous with geographical epizootiology (quid vide).

(L1) Locust is any of the various African and Asian short-horned edible grasshoppers (insects) of family *Acrididae*, migrating in swarms and consuming all vegetation of the places they migrate through and to. They are the cause of important epizootiological problems for livestock and people due to their massively destructive feeding habits. Also see **Locust eater birds**.

(L2) (L) Locust eater birds e.g Yellow-throated Long-Claw bird (*Macronyx croceus*) Elgood, J.H. (1976). Birds of the West African town and garden. 66pp. [West African Nature Handbook, Longman]

7.11 (M)
(M1) Mortality = this means the number of deaths in a given period in a stated location. Mortality rate means the number of deaths divided by the number of individuals in the same population. Details and examples are given in the body of these notes.

(M2) Multi-Stage Sampling = this is a method of picking representative members of a population according to their various stages of life and similar criteria. For example, if there is a population of cattle with 200 adults, 150 yearlings and 120 calves, one may take representative samples from the adults, from the yearlings and from the calves.

7.12 (N)
(N1) Niche = means the functional role of component of an ecosystem.

(N2) Nidality = (Pavlovsky, 1938 & 1939) = This is the theory that every disease problem has its nest, i.e. a special place where all the conditions necessary for maintaining the disease is always available. The weather is always right; the host and the agents are always on hand to interact and produce the disease. This is called the nidality (and focality) theory of disease. There is always a focus where all the conditions are rife for maintaining the disease.

7.13 (O)
(O1) Objects and Processes (OPST) = This is a logical system of viewing and considering animal population problems in such a way that no determinant factor can be omitted unconsciously. In this case O stands for Objects, and objects include animate and inanimate objects. Animate ones include plants, animals, fungi and microbe; inanimate include all the elements and rocks of the geosphere, hydrosphere and atmosphere. P stands for processes and these include building up (anabolic) and breaking down (catabolic) processes. S stands for the system into which the objects, the processes and the problems fit. For example, bacterial problems; bacterial breakdown processes could fit into human problems and human living processes. T means the Time factor in the temporal relationships appertaining to the events and processes that define the problems to be studied, controlled and prevented. Here we should recall that temporality is the most important factor in asymmetric (causal) associations.

(O2) "**Other Problems**" include
Malnutrition, (Mineral / micronutrient deficiency and lack of supplementary salt licks, Dry season starvation, Dry season water deprivation, Toxic plant poisoning, Venomous snake bites, Botulism and other intoxications, inclement weather, extremes of ambient temperature, thunderstorms, lightning stroke, other stresses and distresses, infertility, *etc*.

7.14 (P)
(P1) Prosper (vi.) To prosper is to attain a desirable level of prosperity, which is a component of human and animal well-being. The three major components of well-being are good health, happiness and prosperity. Prosperity is a state above mere survival. This is important in considering the *socio-economic* component of epizootiology. By this doctrine one cannot engage in an epizootiological study without considering and paying attention to the well-being (i.e. the health, happiness and prosperity) of the population involved and included in the study.

(P2) Protocols = One classical method of planning an investigation or a research is to design and write down a protocol of the procedures. From the beginning such a protocol is always written in imperative mood, and it is best divided into algorithms with a flow chart system. Such a flow chart will also have the necessary loops (see Appendix III).

(P3) Population = This is a group of objects (animal, vegetables, or substances) that have related or similar attributes and other characteristics but varying in parameters to a measurable extent (see Population Parameters as opposed to sample statistics).

(P4)Parasites = A parasite is a living organism that derives its livelihood from another living organism without damage to itself but with much damage to and interference with the life of the host (see parasitism, mutualism and commensalism in the text).

(P5) Prevalence = This has been defined in the text where examples are also given.

(P6) Purposive Sampling = This has been defined and listed in the text.

(P7) Population Dynamics means how the population increases and decreases, e.g. increase may be due to new births or immigration into the group. While decrease may be due to deaths and emigration out of the group. These changes have fundamental basis and effects on the health of the environment in an ecological community (q.v.).In lower vertebrate species, we talk of '*group dynamics*'; the group can be herd, flox, flight, etc.

7.15 (Q)
Quod vide (q.v.) = Latin phrase meaning, "Which you should see".

7.16 (R)
(R1) Relationship: This is synonymous with *association*. Two types of relationships are important to epizootiology. These are symmetric and asymmetric relationships. Symmetric relationships are said to be mathematical and non-causal. For example, Prevalence (P) = incidence (I) x time (t). Therefore, if the value of t changes that of P too will have to change; and if the value of I changes the value of P too will have to change. Therefore, symmetrical relationships are mathematical and can be expressed in formulae. On the other hand, asymmetric relationships are not necessarily

mathematical but they are biologically plausible. For instance, it is not always that one male and one female produce an offspring.

(R2) Risk* means *the probability of an undesirable event occurring. There are in fact ***relative and attributable risks. Relative risks*** indicate the chances of an undesirable or accidental event occurring to a sub-group due to one out of many factors being generally present and relevant to all members of the main group. Whereas *attributable risks* are measures of chances of an unlucky event occurring to any individual or sub-group. Usually the event is due to the fact that the individual or the sub-group is exposed to a *causal factor/s* to which the other sub-groups making up the main group are not exposed. The occurrence, or the level of it, is then said to be attributable to the unusual factor to which the sub-group is singularly exposed.

Following are examples of risk indications in the body of this book:

Page 9, under section 1.2 (v), (vi) of this book
(a) Associated risks and possible solutions
(b) Risk identification, evaluation and management

Page 11, under section 1.4 of this book
(a) Identification and quantification of risks

Page 32, under sub-section 3.2 (c), (iii) of this book
Group or population affected, at risk and/or exposed

Page 37, under section 3.5 of this book
Populations at risk

Page 44, under sub-section 4.2 (b) of this book
(a) Total number exposed or at risk
Over a given period of time
(b) Risk equation

Page 47 under sub-section 4.3.3 (a) of this book
Without the risk of

Page 48, under section 4.3.3 (f) of this book
(a) Jungle yellow fever is a risk
Taken by hunters or foresters
(b) The risk of saying the obvious ...

Page 49, under sub-section 4.3.4 (b) of this book
Risk to animals grazing on the fields ...

Page 51, under section 4.4.3 (a) of this book
"How many exposed or at risk?"

Page 68, under sub-section 5.4.1 (b) of this book
'... At risk ...'

7.17 (S)

(S1) *Socio-economic jurisprudence* (sej)

The term *socio-economic jurisprudence* (sej) first appeared in Chapter one of the Book, Esuruoso, G. O. and Idris Abdulkadir (1984) Livestock Development in Nigeria 1983 2000 , 329 pp. [A publication of the Federal Ministry of Agriculture and Natural Resources, Lagos. Nigeria].The author now considers that *sej* should always be part of the cardinal issues in all epizootiological and livestock development and production studies for the practice of preventive veterinary medicine in Nigeria, until the apparently intractable abysmal failures caused by nsej as the major human factor are under control nationwide.]

(S2) Sound Scientific Logic Paths (sslp)

(i) OPST approach:

(ii) Natural BIOS:

(iii) Mental exercises in the identification of relevant issues, relationships, points of integration and coordination…

(iv) Pie chart of human wisdom (that goes beyond merely acquiring knowledge).

(v) S.i.t.m. (usually written *s.i.t.m.*) means '*stuck in the mud*', i.e. the actual source of the quotation is forgotten in the time being or may no longer be readily remembered; this author is not the original source in any case.

7.18 (W).

(W1) Working definition

N.B. A working definition is the one that a diligent investigator would put before himself, and systematically plough through, obtaining relevant, accurate and adequate *data* of facts and figures on all of the variables before subjecting them to *collation*, *processing*, *summary* (i. e. descriptive statistical) *presentation*, *analysis* and interpretation of the results in a manner that could aid decision making.

POSTSCRIPT

Introductory epizootiology is meant for all students and teachers at technical and higher institutions who value systems' approach to the definition, understanding and choice of solutions to most problems that detract from the well-being of man, animals, plants and the common external environment. Thus, students of human and veterinary medicine, biology, all aspects of agriculture, industrial engineering, economics and computer science will find this text very refreshing and rewarding. This is easily appreciated for those who have consciously or unconsciously imbibed the principles of systematic thinking. Consciously, some have earlier learnt about the first author's methods in this matter. Whenever he was presented with a problem to deal with, he started addressing the issues by going through an intellectual exercise, which he described as: -

"As exercise in the identification of relevant issues, relationships, points of integration, and coordination, for the understanding and articulation of solution options for achieving systems' objectives".

Other people have adopted this and similar methods and have succeeded in readily solving group problems. In that context, anyone who sits down and asks how relevant the text of epizootiology is to his own science and profession will readily agree that epizootiology provides the soundest basis, tools of thought and logic paths for articulating (group problems') preventive measures at cost- effective levels. He would readily see the relationship of his own science and profession to that of others. He would also appreciate the essence of being a bridge-builder across the various intellectual disciplines and the learned professions. He would thereby aspire to be an epizootiologist (or an episcientologist) according to his primary professional / vocational concern and/or assignment. Whoever does so should look forward to making critical and constructive contribution to the next stage of the development of this discipline, which by the grace of God will soon come out under the title *Systematic Epizootiology.*

Teachers and learners using this book should feel free to get in touch with the authors. This would enable us to know who may be invited to contribute to further work in the immediate future development of the discipline towards various identified worthy ends. For epizootiology is often a means to logical conclusions in social, economic, financial, environmental and other matters of health, wealth, life, death, survival and prosperity for all (members of the relevant system) in whatever context.

Professor **G. O. ESURUOSO** *FCVSN* (2004)

POSTSCRIPT GIST PRESENTATION OF

EPIDEMIOLOGY AND EPIZOOTIOLOGY:

There are veterinarians who prefer the title **Epidemiology** for the study of diseases in groups of animals. Others, probably not feeling comfortable about that, the reality on ground and the associated assumptions, have chosen the title **'Epidemiology of Animal Diseases'**. Yet others prefer the title **'Veterinary Epidemiology'**. With these, one wonders whether to expect something like 'human epidemics', especially as the term '*animal epidemics*' has been used. Then, could one expect interest in '*human epidemics*'? And that is not the end.

Considering the economic relevance of animal health and husbandry, a respectable international body has the title 'Veterinary Epidemiology and Economics' (VEE). They have preferred the composite title that emphasizes the relevance and importance of economic considerations in relevant veterinary studies. Obviously, this relevance and importance of economic considerations is a glaring reality, which is also taken care of in Epizootiology.

Thus, Epizootiology here, and as conceived, designed, taught and practiced in the Ibadan school since its inception in 1975, also inculcated the relevance and importance of *social health* needs and benefit-and-cost considerations. This is in addition to the relevance and importance of economic considerations wisely canvassed by the International Society for Veterinary Epidemiology and Economics (ISVEE).

Hence, in the teaching of Epizootiology we started by saying that '*A modern veterinarian must be biomedically literate, statistically numerate and socio-economically cost-conscious*'. We named this as the gospel according to Saint Gabriel in reference to the original author of the saying and campaign.

Surely, as much contradictions in unsafe contradistinctions could be avoided, if one imbibes the natural system in which *epidemiology* is seen as a branch of Epizootiology simpliciter. That in fact is the basis for the structure of the text in this book.

The study of epizootics as in PACE (**P**an **A**frican (Programme for the) **C**ontrol of **E**pizootics) then fits in naturally; and matters of 'Animal epidemics', 'Veterinary epidemiology' and '*Epidemiology of animal diseases*' can still be used as a matter of choice and as conceived by their authors, just as astronauts and cosmonauts accommodate one another, thus cooperatively working together on earth and even in outer space, being one of the benefits of evolving global democratic practices.

Epidemiology

Branch of medical science that studies the distribution of disease in human populations and the factors determining that distribution, chiefly by the use of statistics. Unlike other medical disciplines, epidemiology concerns itself with groups of people rather than individual patients and is frequently retrospective, or historical, in nature. It developed out of the search for causes of human disease in the 19th century, and one of its chief functions remains the identification of populations at high risk for a given disease, so that the cause may be identified and preventive measures implemented.

Epidemiologic studies may be classified as descriptive or analytic. In descriptive epidemiology, demographic surveys are used to determine the nature of the population affected by the disorder in question, noting factors such as age, sex, ethnic group, and occupation among those afflicted. Other descriptive studies may follow the occurrence of a disease over several years to determine changes or variations in inddence or mortality; geographic variations may also be noted. Descriptive studies also help to identify new disease syndromes or suggest previously unrecognized associations between risk factors and disease.

Analytic studies are conducted to test the conclusions drawn from descriptive surveys or laboratory observations. These studies divide a sample population into two or more groups, selected on the basis of suspected causal factor (for example, cigarette smoking) and then monitor differences in Inddence, mortality, or other variables. One form of analytic study is the prospective-cohort study, in which members of a population are followed over time to observe differences in disease inddence.

In addition to providing dues to the causes of various diseases, epidemiologic studies are used to plan
new health services, determining the inddence of various illnesses in the population to be served, and to evaluate the overall health status of a given population. In most countries of the wor1d, public-health authorities regularly gather epidemiologic data on specific diseases and mortality rates in their populaces.

Appendices

APPENDIX I:

THE INCREASING ROLE AND IMPORTANCE OF VETERINARY EPIDEMIOLOGY AND ECONOMICS IN VETERINARY EDUCATION, PRACTICE AND DEVELOPMENT

Presented below is a previous (1994) exposition on ***Epizootiology*** and ***Epidemiology*** for historical perspectives and for promoting understanding of the basis for our choice of the title '*Introductory Epizootiology*'. In fact, other alternative titles found in literature include '***Veterinary Epidemiology***', '***Epidemiology for Animals***' and '***Veterinary Epidemiology & Economics***' (***VEE***). The details are reviewed in this Appendix I to show how each of the various authors (or groups of authors) had chosen one or the other of the titles in the context and circumstances of their presentation and application without let or hindrance. Then interested people had simply sought to understand what the authors mean, just as our readers should start by seeking to understand what epizootiology means. Moreover, we have said in the introduction section of this book, that what we consider to be the closest alternative title to Epizootiology as taught in our University is '*Veterinary Epidemiology and Economics*'. Hence, to acknowledge the relevance and importance of the emphasis in that title, also to bridge the gap of understanding and show the relationship between Epizootiology and VEE, the title of the discourse presented below is "*The Increasing Role and Importance of Veterinary Epidemiology and Economics in Veterinary Education, Practices and Development*". The major addition in our construct, teaching and practice of Epizootiology as a natural, wholesome and holistic system is the inculcation of the relevance, need and importance of *socio-economic jurisprudence* for realistic system development and cost-effective application of our science (***Epizootiology***), as presented in this book, whereby among other things it is meant to provide a pre-requisite for advanced / systematic epizootiology as well as ensuring that it provides the soundest basis for *veterinary public health* (vph) and *preventive veterinary medicine* (pvm) practices as defined (Esuruoso, G. O., 1984).

"31st Annual Conference of The Nigerian Veterinary Medical Association:
Venue: The Federal University of Technology, Akure, Ondo State, Nigeria.
Date: 24 28 October, 1994.

Theme of Symposium:
Managing our vision for the improvement of veterinary services in Nigeria.

Title of this paper:

THE INCREASING ROLE AND IMPORTANCE OF VETERINARY EPIDEMIOLOGY AND ECONOMICS IN VETERINARY EDUCATION, PRACTICES AND DEVELOPMENT

Presented by:
Professor G. O. Esuruoso (BVMS, MSc., Ph.D., MRCVS)
Chief Executive, Academic Consultancy Services, and
Professor of Veterinary Public Health and Preventive Medicine,
University of Ibadan, U.I.P.O Box 14400, IBADAN. Oyo State, Nigeria.

ABSTRACT

The art and science of Veterinary Medicine and Surgery has always had Epizootiological basis. But Epizootiology (or Veterinary Epidemiology and Economics (VEE)) was never a subject in the curriculum of Veterinary education worldwide until recently and even now it is only in a few veterinary institutions. About a century ago however, Epidemiological concepts started appearing in the educational horizon of the biomedical sciences and professions. Afterwards, about the middle of this century, Epidemiology was being mentioned in passing when teaching or considering the spread and effects of infectious diseases in human communities, as in '*populations*' of food animal species.

Today, "Veterinary Epidemiology and Economics (VEE)" is already recognized as a major (composite) discipline that should be integrated and presented as a subject in its own right and as part of the Veterinary curriculum, and existing as a separate Department of modern Faculties of Veterinary Medicine. It is now clear that any institution that, for any reason whatsoever, is slow in realizing this development may soon find itself out of date. One alternative is to have the composite discipline as a major unit of, and providing the basis for "*Veterinary Public Health and Preventive Medicine*".

This presentation is meant to bring forth the highlights of the contributions now being made, as well as new horizons being attained through the development of the composite discipline of Veterinary Epidemiology and Economics (which is the closest alternative to Epizootiology) as an essential tool for studying and controlling health and production, and related problems in animal herds, flocks or populations and in public health practice. Obviously, education in such matters is an essential first step towards improvement of Veterinary services in any country. The situation in Nigeria can never be an exception.

CONTENTS

1. INTRODUCTION

1.1 *Theme of the Conference*:
"Managing our Vision for
Improvement of Veterinary Services in Nigeria".

Where there is no vision, the people perish;
but he that keepeth the law, happy is he. (*Proverbs 29:18*)

So, this meaningful theme assumes that we have a vision. If we do indeed have a vision, it is then further assumed that this vision is a positive system's (as opposed to a negative and selfish) one. It also assumes that our vision is not just for today or tomorrow but for the foreseeable future. It is assumed that such vision can form the foundation for a better future and so can be built upon by generations yet unborn.

If the foundation be destroyed, what can the righteous do? (*Psalm 11; 3*)

That the vision does not contradict laws of nature and equity written on all sane and civilized human minds, and of natural relationships that can honourably sustain a nation; and such as does not oppose the principles and objectives of sound and healthy systems and sub-systems in which normal human beings thrive and prosper as a group. It is thus assumed that such vision is not contrary to the provisions of the country's Constitution if in fact the country has one subsisting even now. It is in fact assumed that the system in which we are interested is that of one Nigeria.

It is then assumed that Veterinary Services in this context, covers provisions for animal health, animal disease control (8.1), economic livestock production, the enthronement of humane practices, improved veterinary contribution to public health (8.2) and contribution to a nation-wide safe physical and social environment. It is assumed that our vision is an open arrangement, as opposed to a secret design or hidden agenda, that all the components of that vision will be ethical, not divisive, not selfish, not counter-productive, also not anti-social, not anti-human rights but in fact being in support of corporate diligence and efficiency in productivity (instead of encouraging idleness and the wasteful utilization of resources) in realistic and economic terms.

Finally, it is assumed that such vision will be defensible before man and God (an indication of spiritual health), Beloved, if our heart condemns us not, then have we confidence toward God. (*1 John 3:21*)

And so, the implementation of our vision would be expected to be without prevarications in all sectors of our system at local, national and even at international levels there would be transparent honesty and accountability being maintained by all and as part of our vision for veterinary services of the future in a democratized society.

What a mighty lot of assumptions? What a tall order of expectations? one may wonder. Could we really mean all that and perhaps more?

But yet, more still could be said about a worthy vision for the improvement of Veterinary services in one Nigeria. But the main point is, If we assume that these criteria are there, and we are wrong; and they are not there, then our purposes are futile and our vision puerile, thus '*making an-ass-of-you-and-me*' (ass-u-me).

And I dare say, that could never be the intention of this august gathering, nor of our noble profession, whatever the present odds, whatever the attenuating circumstances. So, we owe it a duty to let those assumptions run through our conscious minds during our wakeful existence. Let us all start thinking hard, and by that I mean thinking actively and acting thoughtful all the time.

Do not be deceived, God cannot be mocked; a man reaps what he sows. The one who sows to please his sinful nature, from that nature will reap destruction. The one who sows to please the Spirit, from the Spirit he will reap eternal life. (*Gal. 6: 7-8*). I have seen enough of this life to testify that man does not exist in body alone.

For if however, our assumptions on these criteria are perfect, clear to our conscience, and laudable in the short and the long run, then we must quickly go on to educate ourselves about the implications of such assumptions about our general and specific objectives and responsibilities and on how we would go about trying to achieve those laudable objectives, and how to discharge our responsibilities honorably.
"For the exercise of will power is in action and not rest or indolence" (*s.i.t.m.*).

The quality of a vision, in the long run, would obviously depend on the level of education and wisdom of the visionary or visionaries (and not merely on the good intentions of "some missionaries"). It would also depend on the ability of the planners to be realistic, as well as on the ability of the executors and even the developers of the vision to abide by the rules and the universally accepted conditions for sustaining a civilized society in a 'social (as opposed to anti-social) free-market economy'; you sure know where I am quoting from! The BBC of course. Those that would put into practice the improvement that we now foresee as good and possible, must be not just men of timber and calibre, but men of substance, who would be accountable to the nation (not to themselves to the exclusion of the people), not self-appointed, not dictatorial not the apostles of "the only way is our way". For these are some of the nagging evils of the day. And in this respect also, the resources (8.3) for such improvement must be realistically checked and found to be there, suitable (especially in terms of the human components), applicable and adequate before embarking on grandiose visioning and planning for which we have neither the leadership nor the followership to realize/ 'actualize'... as they now say.

The system must also be ready for the type of improvement that we envisage. The people must be clearly committed not through the barrels of guns or the evils of settlement and "egunje" for these unfortunately, are some of the prevailing realities of our present corporate existence, yes!

Managing our vision!

The word "managing" is a good one; but it may mean 'managing for the good of all', or 'managing for the pleasure of a few'. It is hoped that our assumptions on "managing" is an expression of our ambition to provide for the overall good of the faithfully toiling masses in a democratic system, as opposed to pandering to the whims and caprices and the greed of a deceiving and enslaving, idle-rich, violent, lawless and socio-economically devastating, oligarchic, self-appointing disasters as the nation continues to endure. For sure, they are obviously lost, who do not see the connection between the activities of these manipulators and the subsisting predicament of the entire nation.

"That action is best
Which procures the greatest happiness
For the greatest numbers"
(Francis HUTCHESON: 1694 1746)

Is that our corporate belief? Or would we rather continue to cope with "the fewer men, the greater share of horror" of loot? We sure need to put on our thinking cap I dare say!

We must then see "managing" at three levels, namely:
(i) At the level of individual (discrete) systems (8.4, 8.5) a matter of self-management (8.6)
(ii) At the level of the diffuse (societal) system (8.5) i.e. system's management (8.6); and
(iii) Change management at all levels (including all levels of risks and of society).

For management is a network of activities encompassing not less than eleven possible distinct components, starting from self-management (8.6), including risk management, and ending with change-management (8.6) envisaging perpetual changes while the sun lasts. And many must have learnt the hard and painful way how violent and drastic, and devastating, even flabbergasting most changes have been in the recent past in our ailing economy; as for example, the purchasing power of the national currency having been devalued to less than one hundredth of what it was only nine years ago while the trend continues. Have we then a vision for anticipating and managing that change? that persisting trend? Who does not realize that it is the value of your labour and mine and everyone else's who labours in this country that is being destroyed? And while the greedy and reckless, corrupt and shameless, the emerging and waxing idle rich thrive and prosper with glaring arrogance, the hopes of pensioners have been shattered, and that at the tail-end of their mortal existence though they had earlier served their country with accepted dedication and loyalty. And yet the band plays on courtesy of unending and violent changes, worsening mismanagement and unparalleled endurance of the toiling masses.

Tell us! Who had visions of the presents back in 1985?
- When the unfortunate turn of events was allowed.
Tell us! Who planned and who allowed the mismanagement?
- By brute force, naked violence and lawlessness
against those whose visions were sane, superior and socially enlightened.

The above is a necessary preamble, in order to show how relevant in Epizootiology the socio-political events are, how important it is for us to think clearly and realistically when we choose the term 'vision', how to manage a vision, and how we want to improve the veterinary services in the country in spite or/and in view of the on-going privations, for the lot or for a few? A careful study, a constructive meditation and a realistic drawing board approach will always be necessary in order to achieve any desirable progress at all. 'Be not deceived, beloved...' What a vision have we to tread the road that is paved with good intentions, but leads directly and surely to hell and destruction? What vision for correcting the present ills, for undoing the damages, for returning the nation to the path of sanity? Or, do we think that things will spring back to the good old days, simply by our 'young men seeing vision' and our 'old men dreaming dreams'? Das ist die Frage! Die Beantworten jetzt?

If maggots are in the flesh, and we choose to ignore the fact, If we decide for whatever reason, to pretend that they are not there, And we prefer not so much to think, let alone talk about the matter, The chances are that, they will continue unabated to destroy the flesh. Then who suffers, but the entire system of human and material resources?

1.2 Now, the title of this paper is

"The Increasing Role and Importance of Veterinary Epidemiology and Economics (VEE) in Veterinary Education, Practices and Development".

For an initial clarification, Veterinary Epidemiology and Economics (VEE) will be treated in this paper as the nearest acceptable alternative to Epizootiology. Students of Epizootiology (8.7; 8.4; 8.5) will recall that by definition, and therefore by default, Epizootiology already included more than just the biological and the statistical contents. The tripod of epizootiology (8.6; 8.8; 8.9; 8.10) consists of *bio-medical, statistical and socio-economic* components.

The increasing importance of VEE (8.11) is significant because VEE was never a subject in its own right in the syllabus of traditional education in Veterinary Medicine and Surgery. But over the last fifty years or so the subject has been found to be capable of providing the foundation for building on a good Veterinary education for all systems, all occasions, all times and for the good of many sectors of the economy. For although there are many other logical approaches, but the most useful, the most comprehensive, and the one with the most reliable logical path is the Epizootiological (or Veterinary Epidemiology and Economics) approach. In receptive, knowledgeable, wise and initiated minds, it is capable of providing a solid foundation for education, understanding, practices and development of the veterinary system of any country. This is the reason for the choice of the title about which we should all is up-dated; if indeed we are to manage our worthy vision properly and for the improvement of veterinary services in the country, for now and for the foreseeable future.

1.3 Justification

As the awareness and knowledge of any subject increase, and the nature of the relevant problems becomes better understood, the need will usually arise for modifying the procedures for tackling the problems. The development of Veterinary Epidemiology and Economics from about 1975 (8.10) has shown that the methods based on the principles of this composite discipline are capable of providing good basis for a universal approach towards the establishment of adequate understanding and control strategies for various problems relevant to the practices of veterinary medicine. Though in a limited sense or scope, one can in fact say that the various problems of animal populations have social (educational, bodily, mental, moral and spiritual) and even environmental contents, dimensions and implications. From that standpoint we can then fruitfully address, comprehensively explore and control relevant problems through epizootiological (or VEE) principles, methods, and literary and statistical logic paths. And if we agree that an epidemiologist is one who thinks in an epidemiological manner (8.12), then an Epizootiologist could be regarded as one who thinks epizootiologically, broadly, comprehensively, and in somewhat more than three dimensions and from several points of view. And through the various (literary, statistical and socio-economic logic paths) i.e. *epizootiologic* paths, a basic understanding of the art and science can be readily acquired.

It has been realized that population approach which is the basis of epizootiology, [Epidemiology, Epornithology Epornithics, et hoc genus omne], and the economic implications (the costs and benefits of the events) could provide the philosophy for tackling most population problems of health and production and of animal and human (societal) well-being (8.5). In epizootiology in particular, its comprehensive approach covers the tripod (8.8, 8.9, 8.10 and 8.5) on which the foundation of Preventive Medicine in its widest sense has been laid. This doctrine emphasizes the reality that, more often than not, prevention is not only better than cure, but that it is also often cheaper and more convenient. The socio-economic component of Epizootiology (8.6) makes provision for covering the non-biological factors, events, forces and circumstances that may contribute positively and/or negatively to the problems of populations (be those of men, or of lower vertebrate animals, of particular interest, livestock, wildlife, companion species or sports animals).

The need for improvement in the veterinary services of this country will be better understood if the more comprehensive, three (biomedical, statistical and socio-economic) dimensional approaches afforded by epizootiological thinking are adopted. It would ensure that all concerned would be properly educated for the services and have the chances of being fully aware of the envisaged or what constitutes desirable development. Hence the justification for making this presentation.

1.4 Objectives

The general objective of this presentation is to create awareness (among all concerned) of the intricate and vital changes taking place in the fields of education, veterinary services and development, towards a better future for human society. The specific objectives are to state the areas in which changes and improvements in the effective demand and supply of veterinary services and by implication, in veterinary education and development, are taking place in the international arena. Nigeria is a member of the United Nations. This is not surprising, as no lasting progress is ever made in isolation. No country exists in a vacuum. Interactions, exchanges, collaborative efforts and inter-dependence in matters of trade, livestock agriculture, education, government and the overall well-being of humanity are taking place. It is part of the objective of this paper to sensitise all concerned to recognizing identified problems in a global scene, as otherwise all our visions and good intentions may come to naught. We ought to be educated properly in these matters. We ought to be developing our human resources. We ought to maintain our continuing education oath (8.13) as veterinary surgeons.

"They know enough who know how to learn".
(*Education of Henry Adams, 1838-1918*).

2. VETERINARY EPIDEMIOLOGY & ECONOMICS (VEE) OR EPIZOOTIOLOGY

2.1a Choosing between the (*linguistic purist's* (8.12) one word "Epizootiology' (8.5, 8.7), and the four-word alternative "Veterinary Epidemiology and Economics' (VEE) (8.11), one is at least reminded (among other things) of

"Of Studie, he took most care and most heed: Nought a word speaks he more than was needed".
(*Dan Chaucer, well of English undefiled, on Fame's eternal beadroll worthy to be filed*; Edmund Spenser, c. 1552-1599); [*Cited in the University of Glasgow Veterinary School B.V.M.S. (1959 1964 Class) Year Book.]

And now, whether that* be a vice or a virtue, or simply a preference, may not always matter; but it is obviously not a matter of life and death, nor of 'nailing the coffin' (8.11) of one or the other of two well-conceived alternatives open to academics in a truly democratic and free conscience (and the much talked of '*academic freedom*') environment. But whatever the matter, 'a word is enough' will still be appropriate, at least 'for the wise', and especially for those who accept the adage, maybe according to personal inclinations and/or experiences, and perhaps of intentions, and as a matter of conscience. Everyone to his choice, and 'Epizootiology', come rain or shine, for those who thus understand, perhaps those who also believe that

"Brevity is the soul of wit." (*Shakespeare, Hamlet 1, ii 90*)

2.1b What it is all about:

Epizootiology has been shown to provide literary, biomedical, mathematical and socio-economic logic (even algorithmic and flowcharting) paths for the comprehensive and systematic consideration, study, understanding and control of all forms of problems, including infectious and non-infectious diseases, conditions, malnutrition, all forms physiological aberration, dysfunction, social-ills, natural disabilities including infirmities and deformities and other enormities in *groups of animals* and *populations of men*, and in relation to their internal and external environment, in specified locations over time. For plants, the equivalent term is *Epiphytology*; and the meeting point for both will be found in the studies of ecological communities (of plants, animals, microbes/saprophytes and the inanimate environment (or biosphere) which both plants and animals and even the saprophytes share, take from and contribute to. Many, probably due to prolonged misuse, prefer the term '*Epidemiology for animals*', which may be regarded as providing a necessary clarification and therefore an acceptable form of terminological inexactitude, having thought of the fact that Epidemiology is often being regarded and defined as 'the study of disease patterns in human populations'. Some have preferred the term Veterinary Epidemiology - probably for the avoidance of doubt. And others still "Veterinary Epidemiology and Economics" which is a further compromise simpliciter, all of which and more have been covered under the single word 'Epizootiology'. So, we now have Epizootiology (the original term (8.12), Epidemiology (long used by respected and accomplished scientists), Epidemiology for Animals (once used by some equally respected ones), Veterinary Epidemiology (a logical and acceptable compromise term), and Veterinary Epidemiology and Economics (the now de facto choice of many that spells it all out, in so many words for the avoidance of doubt and in view of the obvious compromise nature.) as alternative terms according to the choice, or the context, or even the preference or the academic politics of individuals or groups.

It is therefore not surprising that in the international community there would be people who would be grieved by the linguistic purists' approach of epizootiology (8.12). And some may even be waging war to nail the coffin (8.11) of this most productive foundation of scientific thinking on problems in biological (including ecological), biomedical, socio-economic and environmental systems.

John W. Last (8.14) and his collaborators did make a tremendous effort to produce a dictionary of epidemiology. The ISVEE further contributed to improvements of later editions. The pros and cons of the nomenclature were considered; but this may well have to remain a matter of opinion, perhaps of judgment, even of consensus when it is convenient, of following the crowd when considered safe, or taking a stand in spite of the odds, and the risks, and the raging war.

In fact, about 1978, Lilienfeld (8.15) wrote a succinct review on the definitions of Epidemiology in recent literature. He listed up to 23 such definitions. And in the discussion that followed, he seemed to have introduced three others. Today people are still defining epidemiology (and epidemiologists) according to the context of each presentation and the other circumstances appertaining to their objectives.

And now, for the avoidance of doubt, I present below, tables (A to G) which contain many (but by no means all) of the definitions that have been used or cited in recent literature for **Epidemiology**, **Veterinary Epidemiology**, '**Epidemiology of animal diseases (formerly called epizootiology by linguistic purists**', '**Veterinary Epidemiology & Economics**' and '**Epizootiology'** simpliciter.

TABLE A: Definitions of Epidemiology in terms of infectious/communicable diseases

A1. 1927 FROST (8.15)

"The science of the mass-phenomena of **infectious diseases,** or as the natural history of infectious diseases, concerned not merely with describing the distribution of disease, but equally or more fitting it into a consistent philosophy".

A2. 1931 STALLYBRASS (8.15):
"The science of the infective diseases, their prime causes, propagation and prevention".

A3. 1951 MAXCY (8.15);
"That field of medical science which is concerned with the relationships of the various factors and conditions which determine frequencies and distribution of an infectious process, a disease, or a physiological state in a human community".

A4. 1963 COCKBURN (8.15)
"The study of the Ecology of infectious diseases".

A5. 1975 (p.1) **LOWE C.R. & KOSTREZEWSKI J** (8.16):
"The study of the spread and decline of communicable diseases in human populations and the prophylaxis and control of those diseases".

TABLE B: Definitions of Epidemiology in terms of diseases, conditions, laws and circumstances:

B1. 1934 GREENWOOD (8.15):
"The study of disease as a mass phenomenon".

B2. 1938 Paul (8.15):
"Concerned with circumstances where disease is prone to develop".

B3. 1943 AYCOCK (8.15):
"Epidemiology must understand disease, not so much as it affects the individual, or as it behaves under the eye of the observer at any one time or in any one place, but as it imposes itself on groups of people, *even if they extend across boundaries set by men for economic, political and social purposes".

B4. 1958 STAMLER (8.15): Epidemiology is 'the study of disease in populations".

B5. 1958 LILIENFELD (8.15): Epidemiology is 'the study of distribution of a disease or condition in a population and of those factors which influence their distribution".

B6. 1961 REID (8.15): Epidemiology 'deals with the characteristic behaviour of such diseases within the complex matrix of human populations'.

B7. 1952 PEMBERTON (8.15): Epidemiology is 'the study of the laws governing the distribution of diseases in the community'.

B8. 1963 GORDON (8.15): Epidemiology is 'the study of disease as it occurs in nature'.

B9. 1970 FOX et al. (8.15): Epidemiology is 'the study of factors determining the occurrence of diseases in populations'.

B10. 1970 MACMAHON & PUGH (8.15): Epidemiology is 'the study of the distribution and determinants of disease frequency in man'.

B11. 1973 SARTWELL (8.15): Epidemiology is 'the study of the distribution and dynamics of disease in human populations'.

Explanations:
1. Distribution implies the selection of people for attack by a disease in relation to age, sex, race, occupational and social characteristics, and place of residence, susceptibility, exposure to specific agents or whatever other characteristic is pertinent.

2. '*Dynamics*' refers to temporal distribution, and is concerned with trends, cyclic patterns, and intervals between exposure to inciting factors and onset of disease.

3. Disease includes observed overt disease, detection of humoral antibodies, inapparent infections (lab-detected), physiological aberrations e.g. elevated temperature, high blood pressure, impaired pulmonary function, injury, genetic traits, and other health related characteristics.

(Comment: Why not simply say, "Epidemiology is the study of problems (including diseases) in populations"? (8.5):

B12. 1973 and 1975 (p.1)* LOWE & KOSTREZEWSKI (8.15 and 8.16): Epidemiology is 'the study of the factors determining the frequency and distribution of disease in human populations'.

B13. 1974 MAUSNER & BAHN (8.15): Epidemiology is 'the study of the distribution and determinants of disease and injuries in human populations'.

B.14. 1974 FRIEDMAN (8.15):
"The study of disease occurrence in human* populations".

B15. 1975 LASAGNA (8.15): Epidemiology is 'the science** dealing with the incidence, spread and control of disease".

B16. 1976 SINNECKER (14):
"Concerned with mass outbreak of disease".

B17. 1975 Brendan HALPIN (8.12): says that
(a) "The study of the patterns of disease is known as Epidemiology".
(b) "Epidemiology of animal diseases (formerly called epizootiology by linguistic purists)…"
(c) "The study of animal epidemics was at one time called **epizootiology**, as distinct from the term epidemiology, which was reserved for human studies'. "It is clear that there are not 2 separate sciences, but one epidemiology with two aspects, one dealing with diseases usually seen in man, and the other with those seen more commonly in animals (Mulvihill, 1972)".

B18. 1985 BLOOD, D.C. (8.17):
"Epidemiology is the study of diseases in groups".

B19 & B20 1977 SCHWABA et al. (8.18; p. 3)
(B19) (p.3) "Epidemiology is the study of diseases in populations".
(B20) (p.281) Alternative Definition:* "the study of the health status of populations"
Explanations*:
(a) (p.281) "1. Strict etymological considerations may not always be the best guide to word usage. If they were, epidemiology would have to be considered a special branch of epizootiology; and such other generally used terms as population and demography would apply only to a single animal species, man. Epidemiology is a more commonly used and understood word than is epizootiology, and there is no need to use different words for the study of diseases in populations of men versus populations of other animals any more than there would be to use two different words for pathology. In summary, epizootiology is not only unwieldy and often mispronounced, but also redundant. As an alternative definition for epidemiology, we believe "the study of the health status of populations" to possess considerable merit".

(b) Epidemiology is one of "three parent diagnostic disciplines", namely (i) clinical diagnosis (ii) pathology and (iii) epidemiology (see "Diagnosis of Brucellosis" (8.31)). "They complement one another, and their distinctly different tools may be applied sequentially to the solution of diagnostic problems, although use of all three may not be necessary in such instance". The epidemiological approach to diagnosis is a holistic one, which contrasts with the more reductionist's approaches of clinical diagnosis and pathology. These authors also explain that epidemiology provides the means for describing disease patterns and events in populations. They recognize that statistics is relevant and essential to the study of epidemiology.

B21. 1985 BENNETT, F.J. (8.19):
"Epidemiology has been defined as the study of the distribution, the determinants, and the deterrents of disease".

TABLE C: Definition of Epidemiology in terms of health, ill health and disease

C1. 1967 TAYLOR (8.15):
"The study of health or ill-health in a defined population".

TABLE D: Definition of Epidemiology in terms of preventive and community medicine.

D1. 1975 MORRIS (8.15):
"The basic science of preventive and community medicine".

TABLE E: Definition of Epidemiology in terms of disease and/or physiological condition.

E1. 1976 LILIENFELD (8.15):

'The study of the distribution of a disease or a physiological condition in human populations and of the factors that influence this distribution".

TABLE F: Definitions of Epidemiology in terms of observation methods, total established facts and reasoning (or philosophy) thereof and related social factors.

F1. 1978 LILIENFELD, David E. (8.15).
(p. 89) "Hence Epidemiology is a method of reasoning about disease that deals with biological inferences derived from observations of disease phenomena in population groups".

F2. Ibid. (p.90)

"Epidemiology at any given time is something more than the total of its established facts. It includes their orderly arrangement into chains of inference, which extends more or less beyond the bounds of direct observation.

F3. 1976 WHITE, K.L. and HENDERSON, M.M. (8.20).

"Epidemiology is the science** of that which is on the people".

F4. 1975 HOBSON, W. (8.21):

"Epidemiology is the study of the distribution and determinants of health and disease in populations, and part of its province is the study of the related social factors. Indeed, every epidemiological variable is in some sense a sociological variable. The factors affecting the distribution of disease in populations may be biological or environmental and both have social implications".
(Comment: Perhaps one may add that basic attributes such as age and sex are biological terms; and like marital status they also have social meanings.).

TABLE G.: Definitions of VETERINARY EPIDEMIOLOGY / simply EPIDEMIOLOGY according to context and reflecting the interest and thinking of the author/s.

G1. 1979 LEECH E.B. & SELLERS K.C. (8.22):

"Veterinary Epidemiology is a study of variable material (the recorded observations about disease) in variable hosts (the population) living in an environment in which climate, topography and nutrition define other main groups of variables. Results of such a study contribute to a "natural history o disease".

G2. 1994 NDIRITU, G.C. (8.23):

"Veterinary Epidemiology is the study of disease within livestock populations and its effect on their demography and productivity". (Livestock demography 1)

G3. 1985 ELLIS, P.R. (8.24):
"Epidemiology is the study of systems of problems of sub-optimal productivity".

G4. 1986 THURSFIELD, M. (8.25):

"Epidemiology is the study of disease in populations and the factors that determine its occurrence, the keyword being populations".
"Veterinary Epidemiology involves observing animal populations and making inferences from the observations".
The 4 approaches are descriptive, analytical, experimental and theoretical.

Notes:
Is Epidemiology a science?
- Earlier epidemiologists were trained microbiologists involved in the investigation of outbreaks of infectious diseases.
- Now the approaches of epidemiology / epizootiology are applicable to parasitological studies of life cycles and dynamics of infections / infestations by helminths, arthropods and protozoans.
- To geneticists studying inherited defects in population
- To nutritional studies investigating deficiencies and/or toxicities
- To other sciences, etc.

==

TABLE H: EPIZOOTIOLOGY: DEFINITIONS & EXPLANATIONS

H1. 1993 ESURUOSO, G.O. (8.5):

"Epizootiology is the comprehensive (holistic and peripheral) study of the variable factors, events, forces and circumstances that contribute to the occurrence, distribution, control and prevention of ill-health, diseases and other problems in animal populations, as well as the valuation and quantification of the variable factors and their contribution to the problems in each instance.

Explanations:

Epizootiology is a science of natural relationships between biological animal groups or populations, the local plant populations on which the animals depend (for food and shelter) in the universal food, nutrient and energy chains, and their external environment and its contents which they share inevitably with other living and non-living things.

H2. (Ibid) Epizootiology is a study of systems and relationships on which models of scientific thinking in operational research methodologies may be fruitfully based, for solving general and specific problems of animal groups (herds, flocks, etc.) and those of related human populations and of their environment.

H3. Epizootiology is the qualitative and quantitative study of the factors, events, forces and circumstances that contribute to the occurrence, distribution, effects, limitations, control and prevention of whatever problems may befall a group or population of animals over a specific period of time. But by far the simplest, perhaps simplistic or heuristic definition of epizootiology is the next one (H4.)

H4. Epizootiology is the study of epizootics.

Notes:
(a) Epizootiology is the natural mother of Epidemiology, Veterinary Epidemiology, Epornithics / Epornithology and other species-restricted disciplines, which are the offshoots. There should be no problem in establishing the systematics of naming such other related spheres of learning and potential application (to further the cause of being specific) as recently exemplified under "*Episcientology*" (8.5).

(b) Epiphytology is a "sibling" of Epizootiology.

(c) "Epi-Inanimatology" is potentially the other "sib" (8.5).

This approach brings into limelight the relevance, implications and importance of 'Ecological Community' (8.26) approaches, and of the inclusion of the environmental components in the universal (and comprehensive) study of health determinants and related problems (including those of the environmental problems of pollution and degradation), as well as the understanding and control of 'whatever may befall' them. It bursts the bounds (and thus breaks the bonds) of sectionalism, parochialism and isolationism demolishing the walls of misunderstanding, thus making prevarications about overlapping meanings and shades of meanings henceforth unnecessary. It also (positively) creates the bridge for transparent understanding among the various biological and biomedical, even the physical scientists and professions and also the humanities. There is no longer need for shying away from the 'purity', exactitude and subtle shades of meaning of related (but not exactly appropriate) words available for scientific and social expressions in the study of mass problems. Interested readers should see "Public understanding of science, the report of a Royal Commission, 1986, admonishing scientists to communicate by dropping jargons that are not understandable as to the public as matters of fact.

"Scientists must learn to communicate with the public" (8.27)

Obviously, consistency in the choice of exact words is one of the essential elements of proper communication of science (as it is of literature). By a simple test of association, if one says anything …zoo… the mind of any citizen with not less than average intelligence is more likely to go to a congregation of vertebrate or mammalian animals lower than man, rather than to a group of men, until the problem of mortification comes in, when he may regard the face of some of the inmates of the zoo and his own face and general anatomy in a mirror. He at once sees that epizootiology is more likely to conjure up in the simple mind 'the study of problems that befall groups of animals, including especially those which are in the evolutionary scale just lower than (but not excluding) human beings with their distinct communities. '…Simple mind… and practical too!' starting from the lower rungs of the evolutionary ladder (regarding the vertebrates and especially the mammals) and naturally going up to the 'highest' group / population of men. Simplistic! Do you think?

"Verily I say unto you, whosoever shall not receive the kingdom of God as a little child, he shall not enter therein". (S> Mark 10, 15).

By the same token, neither demography nor epidemiology would (except by a stretch of imagination of the highly learned, widely read and specifically initiated or indoctrinated few) send 'the general public' thinking of livestock let alone their problems. Rather epidemiology to the minds of the majority of common literate citizens anywhere in the world today honestly speaking, will intuitively go to "people" and "whatever befalls them", instead of to livestock and their problems. Little wonder it was recently (in 1994) observed (8.11) that "Fifteen years later..." quote he,

'Most veterinarians can by now pronounce epidemiology
and many can even spell it". It was once recently said

No wonder! Especially if one realizes that to pronounce and spell it properly, the uninitiated (like this author) may have to contend with such possibilities as "epidemiology" and "epistemology" while meaning epidemiology. And whereas, (with at most a minimum care and attention) no such confusion would arise with the more appropriate (more etymologically exact and better understood by most members of the public at cognitive level) word "Epizootiology" - - as there must be very few who are not already familiar with the twin 'oo' in the household word 'zoo'. For if the 'oo' in zoo or in epizootiology tends to get stuck between their teeth, even little children will help to put them right both in the matter of pronunciation and in that of spelling and obvious meaning.

And in any case, there must be today, in all parts of the world, scientists who would prefer to use words whose esoteric meanings may be readily derivable as a matter of fact, i.e. of common sense, without requiring such verbal callisthenics as would eventually end up with the conclusion that 'we have decided in any case'. Sure, for a group to decide is acceptable in democracy and naturally. Hence some call their space travellers Astronauts, while others call theirs Cosmonauts; and the difference has never been found to be an obstruction to peaceful co-existence, not to cooperation on earth and in outer space. Bravo! So also let it be with Epidemiologists for animals and Epizootiologists *sensu stricto*.

Finally, a positive exercise in creative etymological thinking to meet a crying need for better systematics (in scientific terminologies), would among other things, justify the introduction of the word "Episcientology" (8.5) as a "mother-discipline" (or a "root discipline" to avoid confusion with "mothers of wars") a reasonable proposition it would seem, to the cognitive mind perhaps. From such a base, every branch of the science (of "what befalls groups") would fall into its proper place without further need for continuing the futile controversy about justifying a long standing and widespread misuse of a scientifically derived term (and perhaps because the more suitable alternative tends to get between the teeth of some decent, respected, but simply unpractised individuals who should simply be advised to practise and get onto the side of universal and 'public understanding of science' (8.27). The right words (with the right shades of meaning for each occasion) will always provide the ultimate understanding, at least cost, avoiding unnecessary verbal gymnastics and obviously unfruitful contentions. Such has often been the method of ultimately sound science and durable heritage in which every word is put into its right and proper use sooner or later. Scientists are bound to follow sound scientific example sooner or later.

2. 1b CONCLUSION:

It should be noted from the above, that forth (40) different definitions have been culled from existing literature. And the list is by no means exhaustive. Thirty-three of these define Epidemiology. Four (G1 G4) of them define Veterinary Epidemiology. And two (H1 &H2) define Epizootiology (followed by relevant notes / explanation where considered necessary, for further enlightenment of the open-minded reader).

Five of the examples (A1 A5) above define Epidemiology as the study of infectious diseases in populations. Twenty-one (B1 B21) define Epidemiology as the study of diseases and/or conditions and laws. One (C1) defines Epidemiology as the study of health and ill-health. One also (D1) defines Epidemiology as the basic science of preventive and community medicine. One (E1) defines Epidemiology as the study of disease and/or physiological conditions. Four (F1 F4) define Epidemiology as observation methods, reasoning, inferences and total established facts of diseases including sociological variables.

Veterinary Epidemiology is defined in four ways (G1 G4). G1 defines Veterinary Epidemiology as the study of variable materials in variable hosts. Whereas G2 defines Veterinary Epidemiology as the study of diseases within livestock populations. G3, which is actually a definition of Veterinary Epidemiology, defines Epidemiology as the study of systems of problems of sub optimal productivity.

Many of the definitions (e.g. A3, A5, B3? B6, B7, B10 (man), B11, B12, B13, B14, E1, F3 ('the people') of Epidemiology relate to diseases and health problems in man, human populations, human community, or 'the people'. Some consider Epidemiology as a science (e.g. A2, A3, B15, F3, D1 (basic science). Whereas others thought of it as a philosophy. Others indicated that a bit of both ingredients (e.g. A1) should always be present. Some address the subject from the biological viewpoint. Most see the relevance of biomedical contents. A few agree that studies of the social (e.g. F4), and indeed the socio-economic factors and implications must complement the biomedical and statistical considerations.

Finally, Epizootiology was presented as a comprehensive study of the factors, events, forces and circumstances that contribute to all sorts of problems (including ill-health, diseases, sub optimal productivity and social, economic, cultural constraints) in biological animal populations and with particular reference to the vertebrate species of which man is the most eminent member. This definition establishes Epidemiology, Veterinary Epidemiology, Ornithology and related sciences as offshoots of Epizootiology; its sib is Epiphytology. Epidemiology and Veterinary Epidemiology (regarded as synonyms in today's usage and coverage by respected authorities) are both sciences. Economics is a social science. Therefore, Epizootiology both as originally conceived and practised and as here defined (8.5) is a science of much more comprehensive scope than either.

Science is a branch of knowledge requiring systematic study and method, especially one of those dealing with substances, animal and vegetable life and natural laws (8.28, p.591).

Economics is the science concerned with the production and consumption or use of goods and services; (8.28, p.202)

*For additional information, interested persons may consult Fundamentals of Epizootiology" (8.5) which is available from Academic Consultancy Services, U.I.P.O. Box 14400, IBADAN. Oyo State, Nigeria: Tel. 02 810 3164. GSM 0803 410 0566, 0803 408 1811.

In any case, this author considers that Veterinary Epidemiology and Economics" is an acceptable alternative title, which spells out many of the areas covered by Epizootiology and has been used for at least 15 years (8.11), except for the reasons already highlighted in the preceding sections of this text (q.v.) and the fact that epizootiology covers a lot more than either epidemiology or economics *sensu stricto*, as a matter of course, following the definitions given in table H above. And in spite of the working definition (H1 above), it should be noted that even Epizootiology admits of shorter definitions, such as in (H2) also given above. H1 may be regarded as the working definition to which constant references may be made by the beginner, so that he/she would be constantly reminded of the comprehensive coverage under that title. Whereas, the shorter definition H2 assumes some previous knowledge of the contents of H1. Definition H3 may be worthy of special note.

"Epizootiology is the comprehensive study of the factors, events, forces and circumstances that contribute (or may contribute) to the occurrence, distribution, control and prevention of ill-health (including diseases and other (biological, social, economic and environmental) problems of animal groups and/or people (or human populations) in a given area over a period of time. The valuation and quantification of the variable determinant factors and their individual and total contributions to identified problems in each instance should always form an inseparable part of epizootiological efforts. In a follow-up to such definition, the point should always be made that the study of relationships is an important aspect of epizootiology. ***Causal*** and ***non-causal*** **relationships** (John Stuart Mill cited by Susser, 1979 (8.29), also by Last, J.W., 1983 (8.14) **are** quite **relevant**. In its full blown form, and in its universal sense, epizootiology covers matters of food or nutrient, energy and disease (or problem) chains and their relationships to one another in ecological communities (8.26) and the various problems of animal groups or populations, vis-à-vis those of the associated plant communities and the common environment (or the biosphere (8.5))".

2.2 What former and increasing roles?

The former role of 'Epidemiology', 'Epidemiology of Animal diseases', 'Veterinary Epidemiology' and 'Veterinary Epidemiology & Economics' was to illuminate the understanding of the matrix of human diseases, animal diseases, animal health, the productivity of livestock, the ecology of the zoonoses, related problems, the biological and economic basis for real and conceivable control options and the overall implications of possible positive interventions and non-intervention, especially in relation to economic livestock production projects and development programmes. First, epidemiology was all about problems of infections and communicable diseases; later it included all diseases, conditions and ill-health. First it was thought of as a way of thinking; later it was recognized as a science. First it dealt with diseases of livestock; later it included diseases of public health importance.

Whereas in Epizootiology and particularly as readily obvious in Ecological Epizootiology, a natural and unquestionably sustainable system approach to established relationships was adopted. Basic similarities and glaring distinctions in the forms, functions, habitat and lifecycles between man and lower vertebrate, and most especially lower mammalian species are considered to be the essential characteristics of relationships in an epizootiological system. And this readily fits into the nature of the various ecosystems, in which the role, needs, interests and deliberate (positive and negative / social and anti-social) actions of man cannot be assumed to be exactly the same as those of the lower species, even in spite of the basic similarities. Anthropocentricity is a phenomenon in reality, but there is no way we could expect a herd of cattle to express their desire and reactions to events in an ecological community in the same manner and at the same level as man would. Therefore whatever 'befalls people' must be seen as epidemiology; and that should be seen in the light of what may 'befall' the lower animal species group members of the ecological community. You cannot in its totality equate the implications of what 'befalls' populations of people with that which 'befalls' a herd of cattle or a flock of sheep.

And so, among group members of ecological communities man is the only species that can most severely and effectively mar or make the survival or destruction of the system by deliberate effort and in minimum time, while yet recognising and being able to make the greatest and significant difference in matters of environmental health maintenance or degradation. And so also in the final analysis, the triangulation of what happens to people can never be to the same end as what happens to a pack of hounds or hyenas. But because they are both members of the animal kingdom, the study of their problems should be seen as epizootiology, leaving epidemiology for the study of people's problems, and as a branch of epizootiology. And whoever prefers to use one term or the other for all should hold on to the rationale to do so without seeking to disparage those who prefer the other, especially the natural, matters of evolutionary scale system approach and have also been called linguistic purists as if meaning to be derogatory.

2.2.1 Increasing roles

Epidemiology and Economics as a composite discipline has now grown (8.11) to be a very important tool in the study and control of problems in livestock production, livestock health and livestock development. The discipline has continued to grow, making use of and trying to catch up with developments in the powers and versatility of the modern digital computer and especially the personal computer (PC) series. The personal computer, in its various sizes, in terms of hardware and software, memory capacity and speed of operation has provided very powerful tools for epidemiological investigation, problem analysis, modelling and simulation experiments, and theoretical epidemiology (8.25) generally and aids for decision making. In particular, custom-designed application software for word processing, database as well as spreadsheets and graphics have been widely applied in Veterinary Epidemiology and Economics. Also, developments in geographical information network systems are being taken advantage of in epidemiological communication methodologies. Molecular epidemiology is new; and applications for the design and analysis of genetic engineering projects have already started yielding useful results including the generation of relevant data for epizootiological investigation and problem solving. The institutionalization of Veterinary Epidemiology and Economics into the regular curriculum for Veterinary education in the universities is being called for loud and clear (8.23). The next decade will likely see even greater revolution in the increasing role of the discipline for solving major problems of livestock health and production in very smart ways. Much more could be said about the power of the personal computer system and the advantages of applying it to Veterinary Epidemiology and Economics.

The best desirable results will however be obtained where all the elements in the tripod of epizootiology (8.5) are routinely included for careful consideration in all relevant studies. This means that certain factors, events, forces, circumstances and systems that are now being considered as having only peripheral or tangential determinant effect will soon be found to be of major importance in the determination of success or failure in major development projects in certain circumstances especially in the developing countries. I am referring in particular to the socio-economic, cultural, political, human and material resource management (8.3), all taken together and in turn in the design and evaluation of national projects and programmes. One is reminded here of one of Murphy's Laws, which states that "nature always sides with the hidden fault". For, if there is a fault in a system, and the fault is either hidden or ignored, nothing would stop it from destroying the entire system (sooner or later), however well-conceived and whatever the amount of good intentions. Identified faults of that nature include monstrous lack of socio-economic jurisprudence, gross political mismanagement and a null sense of accountability; these are some of the social (perhaps one should say the 'anti-social') factors not often considered in the epidemiology and economic analysis of development programmes in Africa. And unless the issues are realistically addressed, the problems may persist and even worsen. This is the explanations for the seemingly intractable problems of certain nations manifesting as lack of development with the attendant evils ignorance, poverty, hunger, misplaced priorities, mass idleness, persistent primitive nature, official violence and lawlessness, certain types of civil disturbances and wars, et hoc genus omne.

2.3 What importance before or now?

In the heydays of Epidemiology and Economics, its application to commercial livestock production, health and husbandry were first recognized. Now it is including its importance, not only in public health, but also in companion animal health management. The methods and principles of Veterinary Epidemiology and Economics (and better still of Epizootiology *sensu stricto* (8.5) are now being applied with fruitful outcome in the cost-effective management in each system.

Now that you've got some idea of what it is all about, that is what Epizootiology and VEE are all about in a nutshell and with at least 40 definitions and explanations, you are set on the road to making your own independent decision and choice, in a democratic way according to your own principles

3. VETERINARY EDUCATION

3.1 What it was formerly

As mentioned in the introduction, Veterinary Epidemiology and Economics (or even Epizootiology) was never established as a discipline in its own right in the traditional veterinary curriculum. It was often mentioned in passing usually after defining a disease syndrome.

3.3 What it is now

The indications for the need to recognize this discipline on its own merit have been overwhelming in the last ten years. Suggestions have been made (8.23) that Veterinary Epidemiology and Economics, as a discipline and department on its own should be institutionalized. Anyone familiar with the strides so far and its uses already established will not argue against this proposition. One could however see some viable alternatives. Such alternative is the one developed *ab initio* by the Department of Veterinary Public Health and Preventive Medicine at the University of Ibadan starting from 1975. In that programme, Epizootiology with its tripod and systematic approach was made the most important subject that should provide the soundest basis for Preventive Medicine (8.8) in theory and practices. The principles and methods of Epizootiology were found to be quite relevant and useful with additional benefits (8.9, 8.5) in the consideration of the natural history of epizootics, zoonoses and the socio-economic implications of the basis and the practices of preventive medicine (or measures) (pm); the fact that the words "medicine" and "measures" are being used interchangeably is an indication of the general applicability of epizootiological methods. Biological, biomedical, social, economic, political and cultural problems may be fruitfully investigated by epizootiological procedures. Vices in people and in domestic animals may be studied by parallel methods of the various branches of epizootiology. Thus, we sometimes talk of the epidemiology of gossip; and why not? The main questions are similar; they may include 'What group of people'? 'In what places'? 'How widespread'? 'At what times'? 'In what circumstances'? 'What are the benefits and costs'? 'What incidence rate'? *et cetera.*

3.3 Important Changes

While some members are submitting the arguments and reasons for establishing a Department of Veterinary Epidemiology and Economics in Veterinary Faculties, others tend to prefer and proffer alternatives. Such alternatives include the suggestion that there should be a unit of Epidemiology and Economics in every one of the traditional departmental units that make up the model institution or faculty of Veterinary Medicine. Others think that the establishment of the discipline may be more readily acceptable if it is part of a department of preventive veterinary medicine (or veterinary preventive medicine) or of veterinary public health and preventive medicine. Veterinary departments in Government Ministries of Agriculture are also being encouraged to have a unit or division for Epidemiology. Others think that such a unit should be based in the planning and a similar division of the ministry. The argument must surely continue in other forums. And it will be realistic to agree that such decisions would often depend on what is already on the ground, the existing organizational structure, the socio-political circumstances and personalities. What is now quite desirable and worthwhile is that the established discipline should be given its due recognition in every faculty or school of veterinary medicine and in all state or ministerial veterinary departments.

4. FORMS OF VETERINARY SERVICES

4.1 In the Past

This presentation will be limited to situations in some developing countries for obvious reasons. In the past veterinary activities were considered as social services. They were carried out by Government Veterinary Officers and supporting civil servants at lower cadres. All were in the paid employment of governments. No charges were made for the goods and services. Livestock and pet owners were in fact being encouraged, even 'wooed' to submit their animals for modern veterinary (preventive and curative) interventions. For the pets, the expected benefits are in the areas of humane values and public health. For livestock, the preservation of the natural resources and support for possible international trade in livestock products were paramount in the mind of government.

4.2 Evolving Scenarios

Good reasons have now been found to devolve veterinary responsibility largely to the private sector. Government ministries are being encouraged to concentrate mainly on regulatory and mass disease control and eradication campaign activities. The establishment and maintenance of infrastructure and livestock extension services are also to be carried out by government agents. Where the free service was formerly given, cost-recovery, commercialisation and later privatisation of veterinary services are now being considered in turn, as the three stages through which the necessary changes could gradually take effect.

4.3 Importance of Changes

When fully privatised or largely so, it is envisaged that veterinary services would be largely cost-effective (8.7) being delivered with 'increasing efficiency' (8.30). Fewer veterinarians would be expected to perform all the required duties more efficiently, as in the open (competitive) market economy for professional services generally. Such changes must be reflected in modifications in the educational system. Adjustments in the curriculum, shifting of emphasis in the schedule of lectures and types of practical and clinical training, improved use of material and human resources, retraining of some personnel these are some of the ways the faculties may attempt to cope with the evolving changes. Further details of the needs have recently been documented in the proceedings of the Lagos Veterinary Clinical Forum (8.7) copies of which are being made available at this conference. These represent the major importance of the evolving and impending changes in veterinary services especially in developing countries like Nigeria.

5. DEVELOPMENT

5.1 At National and Regional Levels

The nations in the African region are already feeling the impact of the necessary changes that must take place. Not only are the pressures on because of the seeming over-production of Veterinarians, but also because of the socio-economic predicaments of the various nations. The situation seems to be very similar in both the Eastern and Western sub-regions of Africa at least in certain important respects. In Central Africa, as well as in Southern Africa, little differences may be noted. Unfortunately, most of the vast changes and developments in Veterinary Epidemiology and Economics are being largely initiated from outside Africa. As a result, certain determinant factors peculiar to the region are not being adequately taken care of. It would seem that there should be greater scope for collaboration between scientists from the developed countries and those in Africa for the mutual benefits of their various countries.

5.2 At International Level

Development programmes initiated in Africa are usually supported by a multi-national group of staff. Most of the funding is also from donor agents from outside the African region. Therefore, the useful influences of the donor agents are encouraging the African staff to take active note of and make efforts to participate in the developments. Being biomedically literate and skilled in the use of the modern computer systems is the usual minimum being required of veterinarians in developing countries. Very often, the helping or donor countries are generous enough to provide both the equipment and the training. A little bit of enthusiasm and industry on the part of the African counterparts is often quite rewarding. The identification and training of suitable young veterinary graduates is only the first step towards a better future. Very often, the need to achieve appropriate posting and provision of necessary equipment for such motivated youngsters are the beginning of problems that lead to the mismanagement of even the human resources. There had been occasions in the past when political under-development and lack of socio-economic jurisprudence in high places are the main causes of intractable problems. Both the local protagonists and the foreign donors and their agents would do well to be aware of this leaven.

5.3 Implications of Evolving Trends

One simple fact is that any developing country, that for any excuse or even good reason fails to recognize the trends and/or to take appropriate actions will be left behind and in chaos in matters of the studies and effective control of their country's animal health and production problems. Therefore, there is the crying need for us to plan for the improvement that forms the substance of our vision being promoted at this year's conference and symposium.

6. PLAN FOR IMPROVEMENT AND DEVELOPMENT

6.1 Change Appreciation

It would seem that a clear appreciation of the changes taking place in the socio-economic environment of our country is the step towards recognizing the nature of necessary improvement in our professional services. First we must appreciate the demand and supply situation for veterinary services. We must identify the type of services (and ethics) that would improve the economy. We must then strive to provide such services with all the resources at our disposal and with maximum efficiency. We must know that paid employment opportunities are dwindling and that the purchasing power of resources available to the country is falling; what a million Naira could purchase ten years ago, may now require one thousand million. The error or judgment is continuing people thinking that their lot would improve by juggling with prices (40% increases at a time, so many times), aggravating inflation, and looting the treasury to support a few irresponsible and violent and arrogant idle rich including people of 'timber and calibre', though of little substance. Whereas, what is most needed is industry; every able-bodied man and woman should be diligently, honestly and fully employed on all working days, instead of more than half of us being engaged in money laundering, oil shifting, contract falsifying, all forms of unproductive, fraudulent practices, '*egunje*' (graft, Yoruba) and the rest covered in loud and empty talking the voice going up, but the spirit remaining low. For our part, the need for all (or at least the majority) of us to practise our profession according to the ethics to which we all swore is now, more than ever before, most urgent. Seeing this situation as it now exists is the first change appreciation we all ought to internalize on the literary, quantitative and socio-economic paths of systematic epizootiology (8.5). To ignore these things is to continue to deceive ourselves. We borrow from external sources, but make no serious effort to pay back what we owe the external benefactor and we have the gut to go around in '*baban'riga*' (flowing robes, Hausa) telling the external sources not to take notice of our wasteful and irresponsible activities. With the finest epidemiological and economic systems in the entire universe, all will still come to naught. The totality of 'what befall' us (*episcientologically*) is what we must address and then try to change our ways and methods too.

6.2 Change Management (8.7)

A lot of changes occurring rapidly in an underdeveloped environment can lead to massive confusion apart from anything else. Change management should be one of our first priorities. So, people must learn to recognize changes and also learn how to cope with them including coping with the professional implications of the violent changes. Unfortunately, these are easier said than done. The development of appropriate human resources at all levels will definitely hold the key to success in change management. This aspect thus devolves on our educational institutions, including our faculties of veterinary medicine, and the staff and authorities of the institutions the systems approach.

6.3 Change Indicators

The fact that governments are no longer able to absorb all graduating Veterinarians, not because there are no sick animals to be treated, but because of budgetary constraints, is a major indicator that changes have occurred and will continue to occur. The fact also that most of the nations that are in debt to one another are 'unable' (or unwilling) to pay even the interests to their creditors is a good indicator that changes are taking place, the magnitude of which is barely being noticed. Other major and serious indicators are wrapped up in the social, cultural and political situations in most of these countries, such as have just been described in section 6.1 above. A veterinarian cannot shut his eyes to such social, cultural and political situations and at the same time still hope to perform or prosper ethically and effectively in such circumstances. Such situations must be addressed by all of us identifying our role, correcting our inadequacies for there lies our fate whether we know it or not, whether we agree or disagree with the voice of *epizootiological reasoning* with its in-built provision for *socio-economic jurisprudence* (sej) as an essential component. Those are some of the items of change indicators. Recognize them and plan to change the undesirables.

6.4 Plans to Take Care of Changes

It would seem that the first step is education. Volumes can be written about this. But this is not the forum for that. But it may be useful to remind ourselves of the following facts.

In this country alone, there are at least five Faculties of Veterinary Medicine where suitable candidates are educated to the appropriate levels for being accepted into the profession. In each case, the curriculum has been carefully designed before approval by both the universities concerned and the National Universities Commission (NUC) with its highly dedicated Chief Executive and the staff. In addition, the Veterinary Council of Nigeria (VCN) which has the statutory professional mandate to ensure the standard of veterinary education, the suitability of the graduates to practise the profession, the registration of qualified candidates, the continual improvement in the standard of professional practices, and the maintenance of the ethics of the profession, has always been blessed with suitable and hardworking members. If anyone is in doubt as to the validity of this declaration, he had better ask questions after this paper. And better still, and for even more authoritative and up-to-date information on the various aspects of veterinary education and professional practices in Nigeria, enquiries should be directed to the authorities of the various universities, the NUC, the VCN, the Federal Ministries of Education, Information and Agriculture, or even in general matters the information section of the Academic Consultancy Services (ACS)*. Its VatAcademic Division will usually be prepared to exchange views with such interested colleagues on relevant matters. The ACS is in fact in a position to provide reasonable guidelines for programmes in self-development and self-improvement at all levels. This is a piece of useful information and not an advertisement.

Finally, it should be remembered that education has a decisive role in the development of all aspects of human society, not less so for the human resources component (8.3). Unfortunately, at the moment, all aspects of our national life and even the very existence of the majority of Nigerians are being disastrously threatened by the political situation in the country today. It is therefore the height of deception, including self-deception, to try and separate the prevailing political imbroglio from the worsening state of education including veterinary education in this country. Sound teachers are dropping their chalks and many are leaving our shores. Those that remain are being starved of funds for the tools of their jobs. Laboratories are largely empty and what remains is either unserviceable or there is no means of servicing them. Merely lip service is being paid to even the so-called "maintenance culture"; the priorities of the authorities are obviously elsewhere. They themselves are in dire need of education in what they profess to be the only authority, the only source of know-how and solutions. One wonders whether they do know this for if they do, why should they be choosing to incarcerate those with alternative views? With such posture and proclivity, they would probably never get such education, because it may well be above the present status and state of their individual and corporate mind and spirit. Among other effects, these may mean that the foundation of all our vision is effectively being threatened. Therefore, one of the questions that should be bothering our mind, disturbing our sleep and appearing and growing on our lips today must be

"If the foundation be destroyed, what can the righteous do?"
(Ps. 11:3)

Then of course, we must all work together as a team in a worthwhile system to realize our vision for the nation to manage effectively (rather cost-effectively), the problems that befall us all realistically and epizootiologically".

7. ACKNOWLEDGEMENT

The author is grateful to the organizers of this (31st Annual NVMA'94) Conference for inviting him to present this paper, which is considered relevant to the year's theme. He is also grateful to his Secretary Mr. Sam A. Ofei for typing some of the drafts; and to his two DVM (U.I.) students Mr. Babasola O. Olugasa (DVM V) and Miss Atinuke Adeduro (DVM IV) both of who helped in various ways in collating some of the materials and in projecting the slides at the presentation. His daughter Miss' Lola Esuruoso of the University of Lagos entered the text of the manuscript into the computer system. And his dear wife Victoria gave support in various ways to him. May God bless them all; Amen. And now unto God eternal, invisible but always noticeably present in my life, invincible but always effectively solving all my problems, the only wise God my creator, be all honour and glory, for ever and ever, Amen.

8. BIBLIOGRAPHY

8.1 FRN (1989) Animal Diseases (Control) Decree (No. 10 of) 1988; pp A477-A501 of Extraordinary Federal Republic of Nigerian (FRN) Gazette No. 13, Vol. 75, Lagos; 26th February, 1988 (Printed and Published by the Federal Government Press, Lagos, Nigeria: Official code: PGPL87/288/10,000).

8.2 FAO/WHO (1975) The Veterinary Contribution to Public Health Practice 79 pp (FAO of the United Nations, Rome).

8.3 ESURUOSO, G.O. (1994A) Resource Management Approaches to Education in Veterinary Epidemiology and Economics. The Kenya Veterinarian 18 (2), 591. Proc. 7th ISVEE '94, 15-19 August, 1994, Nairobi, KENYA.

8.4 ESURUOSO, G.O. (1992) Lecture Notes on Epizootiology: 92 pp. A mimeograph prepared for DVM undergraduates classes in some Nigerian Universities. (Obtainable from Academic Consultancy Services, U.I.P.O. Box 14400, IBADAN. Oyo State, Nigeria).

8.5 ESURUOSO, G.O. (1993) Fundamentals of Epizootiology; 129 pp. A mimeograph prepared by the VatAcademic Division of Academic Consultancy Services, (U.I.P.O. Box 14400, IBADAN. Oyo State, Nigeria.

8.6 ESURUOSO, G.O. (1994b) Clinical Management, Veterinary Jurisprudence and Economics of Practice; pp 1 31 of the Proceedings of a seminar on Effective Management of Veterinary Practice; 54 pp 27th April, 1994, Ikeja Airport Hotel, IKEJA. Lagos State, Nigeria. (A publication of the Veterinary Clinical Forum, Lagos).

8.7 FERRIS, Deam H. (1967) EPIZOOTIOLOGY, pp. 261-320 of *Advances in Veterinary Science*, Vol. 11 (Publ. Academic Press, New York and London).

8.8 ESURUOSO, G.O. (1984) Opportunities for Postgraduate Studies in Preventive Veterinary Medicine at the University of Ibadan; 35 pp. (Printed by J. Olatunji Printers and Co. (Nig.) Limited, 4, Alhaja Oropo Street, P.O. Box 40, Ikenne-Remo, Ogun State, Nigeria).

8.9 ESURUOSO, G.O. (1985a) Ten years of Curriculum Development for Veterinary Public Health and Preventive Medicine. 24 pp. Proceedings of the First Seminar of Deans of Schools and Faculties of Veterinary Medicine in Africa 8 13 May, 1985, Conference Centre, University of Ibadan, Nigeria.

8.10 ESURUOSO, G.O. (1985b) Veterinary Epidemiology & Economics in the Undergraduate Curriculum; pp. 430 437 of the Proceedings of the 4th International Symposium on Veterinary Epidemiology and Economics (4th ISVEE); 18-22 November, 1985, Singapore. (Published by Singapore Veterinary Association, c/o City Veterinary Centre, 40 Kampong Java Road, Singapore 0922).

8.11 MORRIS, R.S. (1994) The Epidemiological Approach to Animal Health Building on Strong Foundation; pp. 1-3 of the Proceedings of the 7th ISVEE, Nairobi, Kenya. 1994. (Published by the Kenya Veterinarian, 18 (2) 15 19 August, 1994.

8.12 HALPIN, B. (1975) Patterns of Animal Disease; 184 pp. (Publ. Bailliere Tindall, London).

8.13 VCN (1985) Veterinary Ethics in Nigeria (A publication of the Veterinary Council of Nigeria (VCN) Vom, Plateau State, Nigeria).

8.14 LAST, J.M. (1983) A Dictionary of Epidemiology; 114 pp. (Oxford University Press, Oxford, N.Y., Toronto).

8.15 LILIENFELD, D.E. (1978) Definitions of Epidemiology; Am. J. Epid. **107** (2), pp. 87-90.

8.16 LOWE, C.R. and KOSTREZEWSKI, J. (1975) Epidemiology: A Guide to Teaching Methods; 266 pp. (Publ. For the Int. Epidemiological Assoc. by Churchill Livingstone).

8.17 BLOOD, D.C. (1985) The Role of Clinicians and Epidemiologists in the Welfare of Food Animals Perspectives and Interactions; pp. 21-32 (of the Proceedings of the 4th ISVEE, 18-22 November, 1985, Singapore).

8.18 SCHWABE, C.W., RIEMANN, H.P. and FRANTI, C.E. (1977) Epidemiology in Veterinary Practice; 303 pp. (Lea & Febiger, Philadelphia).

8.19 BENNET, F.J. (1985) Epidemiological Principles and their Application in African countries; Ch. 5, pp. 47-54 of G.O. Sofoluwe and F.J. Bennet, eds. Principles and Practice of Community Health in Africa, 642 pp. (University Press Limited, Ibadan).

8.20 WHITE, K.L., and HENDERSON, M.M. (1976) Epidemiology as a Fundamental Science; 235 pp. (Oxford University Press, N.Y.).

8.21 HOBSON, W. (1975) The Theory and Practice of Public Health; 685 pp. (Oxford University Press, London).

8.22 LEECH, F.B. and SELLERS, F.C. (1979) Statistical Epidemiology in Veterinary Science; 158 pp. (Charles Griffin & Co. Ltd., London).

8.23 NDIRITU, C.G. (1994) Institutionalization of Veterinary Epidemiology and Economics; pp. 4-6 of the Proceedings of the 7th ISVEE, 15-19 August 1994, Nairobi, Kenya. The Kenya Veterinarian; **18** (2), 4 6.

8.24 ELLIS, P.R. (1985) Expanding the Responsibilities of the Veterinarian; pp. 127-132 of the Proceedings of the 4th ISVEE, 18-22 November, 1985, Singapore.

8.25 THURSFIELD, M. (1986) Veterinary Epidemiology; ISBN-0-408-10861-4 (British Library Cataloguing Data). (Publ. Butterworth & Co. Publishers Ltd., U.K.).

8.26 WHITTAKER, R.H. (1975) Communities and Ecosystems; 365 pp. (Macmillan Publications Co. Inc., New York).

8.27 The Royal Society (1985) The Public Understanding of Science 41 pp. Report of a Royal Society ad hoc group endorsed by the Council of the Royal Society. ISBN 0 85403 2576 (The Royal Society, 6 Carlton House Terrace, London SWIY 5AG).

8.28 HAWKINS, Joyce, M. (1985) The Oxford Paperback Dictionary 2nd Edn. 791 pp. (Oxford University Press).

8.29 SUSSER, M. (1979) Causal Thinking in the Health Sciences; 181 pp. (Oxford University Press, New York, Oxford, Toronto).

8.30 SCHILLHORN VAN VEEN, T.W. and DE HAAN, C. (1994) New Trends in the Organization and Financing of Livestock and Animal Health Services. Proc. 7th ISVEE '94, 15 19 August 1994, Nairobi, Kenya. The Kenya Veterinarian **18** (2), 24 25.

8.31 ESURUOSO, G.O. (1989) Diagnosis of Brucellosis 30 pp. Proc. Int. Wksh. Vet. Diag. Procd. 18 27 September 1989. Faculty of Veterinary Medicine, University of Ibadan (A publication of the Nigerian Veterinary Medical Association (NVMA).

APPENDIX II:

RESULT OF THREE WEB SEARCHES FOR "EPIZOOTIOLOGY"

Results of three web searches for "Epizootiology" are presented below. In the first search in July 2001, **2,170** documents were found, representing published scientific literature on Epizootiology of one animal group problem or the other. The second web search in November 2004 produced **17,300** documents, representing published scientific literature on Epizootiology in 2004. The third was **24,100.** This shows that, people who in 1994 ff. said that the word "Epizootiology" was archaic, redundant and is no longer being used were obviously not correct. Epizootiology remains in active or rather in very active service till this day (November 23, 2004).

Google Search: EPIZOOTIOLOGY

Web Results 1-10 of about 17,300 for EPIZOOTIOLOGY. (Epizootiology of chronic wasting disease in free-ranging cervids ..,

Click here to read Epizootiology of chronic wasting disease in free-ranging cervids in Colorado and Wyoming. Miller MW, Williams ...
www.ncbi.nlm.nih.gov/entrez/query .fcgi?cmd=Retrieve&
db=~ubMed&list_uids=11 085429&dopt=Abstract - §lDJjl~r M9 . ,,'

History and epizootiology of rabies in Canada"
History and epizootiology of rabies in Canada. Tabel H, Corner AH, Webster WA, Casey CA. Publication Types: Historical Article. MeSH
;.ww.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&
db=PubMed&list_uids=4608858?,.dopt=Abstra c;: -
Similar pages [More results fromwww.ncbi.nlm.nih.aov]

Wiley: Epizootiology of Insect Diseases
Wiley> Life & Medical Sciences> Comparative Biology> Zoology>
Epizootiology of Insect Diseases.. Related Subjects, ...
www.wiley.com/WileyCDA/ WileyTitie/productCd047187812X.html- 31k -
Cached - Similar paqes

Epizootiology definition-
Term to be defined, Definition, Synonyms & Keywords. Epizootiology, - "the study of the natural history of disease in animal populations."(B36),212.187 .155.84/.../Glossary&References_contentsl
KeywordsContents/E/Epizootiology.htm - 21< - Cached -Similar paqes

Epizootiology of canine distempr in New Jerse~ raccoon
Epizootiology of canine distemper in New Jersey raccoons. Roscoe DE. New Jersey Division ofFish, Game and Wildlife, Trenton 08625-0400. .., www..virologyj.com/pubmed/8355340 - Similar paqes

Pathology and epizootiology: Ecotoxicology EC - NWF
Pathology and Epizootiology Team is primarily responsible for documenting the impacts of chemical contaminants and other environmental stressors on organ ...
www..nwfsc.noaa..gov/research/ divisions/ec/ecotox/path.cfm -18k - Cached - Similar paoes

NCORE: ABM for Epizootiology
WebSTAT - Free Web Statistics Epidemiological computer models have classically consisted of portions of the population, or "compartments.., www.ncoremiami.org/ABM/proto_epi.htm - 9k - Cached Similar pages

Tick Research Laboratory - Lime Disease
riaes.cels.uri.edu/resources/ticklab/lyme4.html- 8k -
Cached - Similar pages

WDSV Project -- Epizootiology
Health Program Department of Microbiology and Immunology College of Veterinary Medicine Cornell University Ithaca, New York 14853-6401 Epizootiology in Feral... 7k - Cached - Similar pages

PIERC Wildlife Health Epizootiology and Control -
http://www.google.com/search?hl=en&lr=&q=EPIZOOTIOLOGY

Google Search: EPIZOOTIOLOGY Page 2 (21 Nov 2004)

http://www.google.com/search?h1=en&lr=&q=EPIZOOTIOLOGY

Return to Wildlife Health Epizootiology and Control of Avian Diseases in Endangered Forest Bird Habitat in South Kona, Hawaii. It ... Biology .usgs.gov/pierc/PMEpizootiology .htm -1 Ok - Cached - Similar paaes

Search within results I Language Tools I Search Tips I
Dissatisfied? Help improve Google Home
Advertising Programs - Business Solutions @2004

Google

With 2,170 documents, representing published scientific literature on Epizootiology of one animal group problem or the other, found in July 2001; partly shown in this appendix, it is obvious that, people who in 1994 ff. said that the word "Epizootiology" was archaic, redundant and was no longer being used, were obviously not correct, and their points of argument may appear to some as probably misleading, but challenging to epizootiologists *sensu stricto*. These are believers in the fact that, the scientific discipline called "Epizootiology" as defined, designed, structured, taught, promoted, applied and being developed since 1975 in our school (as in other places worldwide), and as presented in this book, is capable of providing the soundest basis (and wisdom) for accomplishing preventive measures in its most systematic and holistic sense. Also see the relevant parts of Appendix I above. In any case, democracy allows the choice, just as Astronauts and Cosmonauts still work together both on earth and in outer space. So why can't Epidemiologists, Veterinary Epidemiologists, Epidemiologists 'for animal diseases' and Epizootiologists (whom some described as linguistic purists) work together, instead of striving to nail each other's coffin as some said in 1994. That pronouncement could well be an example of nsej as defined in this book, as elsewhere since 1984. But, to us it was a challenge by good friends.

APPENDIX III:
KNOWLEDGE BASE: FROM BIOLOGY TO EPIZOOTIOLOGY

Biology is the study of living things,
i.e. their *forms*, *functions*, *life cycles* and *habitat** (i.e. *external environment)

Living things include members of
(a) *Plant kingdom* including unicellular, non-cellular & multi-cellular organisms
(b) *Animal kingdom* unicellular or non-cellular, multi-cellular
(c) Others

UNICELLULAR / NON-CELLULAR PLANTS AND ANIMALS

Unicellular/Non-cellular Animals	Unicellular / Non-cellular plants
1. *Amoeba species*	1. *Spirogyra* (structures mucilage cellulose cell wall pyranoid nucleus
2. *Paramecium species*	2. *Zygnema* (cytoplasm vacuoles c cell sap)
3. *Euglena species*	
4. Others	

METAZOANS
(i.e. multi-cellular animals)
can be divided into two main groups, namely

(i) *Diploblastic* (two-cell layered) coelenterates with outer (ectodernal) and inside (endodernal) cells layers, thus having ectoderm, endoderm and coelenteron, which the enclosed hollow space, e.g. hydra which is **radially symmetrical.**

(ii) *Triploblastic* (three-cell layered) coelomates with
(a) outside (ectodermal)
(b) inside (endodermal) and
(c) Middle (mesodermal) layers of cells (ectoderm outermesoderm coelom innermesoderma endoderm), e.g. flukes and tape worms which are **bilaterally symmetrical.**

Animal sub-kingdom Invertebrate
5 classes
(i) *Insecta* e.g. cockroaches, grasshoppers, mosquitoes, tsetse flies, house flies, butter flies, bedbugs, battery moths, wasps, ants, bees.

(ii) *Crustacea* e.g. crabs, prawns, wood lice, water-fleas (cyclops) and barnacles
(iii) *Diplopoda* e.g. millipedes
(iv) *Arachnida* e.g. ticks, mites, spiders and scorpions.
(v) *Myriapods*

NB
(1) Insects account for at least 70% of all animal species.
(2) Over 1000 species of cockroaches known; 2 important domestic spp are
(i) *Blatta orientalis* (oriental cockroach)
(ii) *Periplaneta americana* (American cockroach)
N.B. Their epizootiological importance will be discussed at the right level of *Systematic Epizootiology* or their relevance in *vph* and *pvm* will be discussed in the right texts to follow this one *D.V.*

Animal Kingdom ctd.
Phylum Arthropoda (Diplopoda chilopoda availinda)
Classes
- insecta
- crustaceans
- arachnida
- myriapods

Sub-Kingdom Invertebrata (insecta crustacea)

Classes
1. Insecta cockroaches, grasshopper, 1000 species known e.g. Blatta
2. Crustacea Crabs, prawns, water fleas, wood lice and barnacles
3. Diplopoda Millipedes
4. Chilopoda centipedes (hard ticks < ixodidose < soft ticks
5. Arachnida ticks, mites, spiders and scorpions

Sub-Kingdom Vertebrata / Phyla / Classes
- *Pisces* (fishes)
- *Amphibia* (frogs, toads, etc.)
- *Reptilia* (snakes, turtles, tortoise, etc)
- *Avis* (domestic and wild birds)

- *Mammalian* (domestic and wild species of Bovidae, Equidae, Swidae, Caprine, Canidae, Felidae, etc, also including sub-human primates and H*omo erectus* himself

Sub-Kingdom VERTEBRATA

The first and immediate concern of Veterinarians studying Epizootiology is to be able to protect, prevent and solve the life problems of mostly vertebrate animals, based on appropriate knowledge of what may befall them in diverse situations and circumstances, and in their relationships with other animals, plants, saprophytes and the common inanimate environment and its content (on the principles of '*Quicquid plantatur solo, solo cedit*'). Eventually the Epizootiologist would need to be familiar with the problems of other groups of animals listed as members of the animal kingdom (*vide supra*).He is concerned with herds, flocks, *et hoc genus omne* and populations in terms of what may befall them by disturbing their biological forms, functions, life cycle and their habitat (environment)

Teaching of Epizootiological Approaches in this comprehensive manner will enhance cognitive knowledge of the system.

APPENDIX IV:

HIGHLIGHTS OF SOME '*TOOLS OF THOUGHT*' AND PROCEDURES IN EPIZOOTIOLOGY (IN PRACTICE)

(1) Observe
(2) Describe
(3) Classify
(4) Quantify
(5) Summarize and present in descriptive terms (Descriptive statistics)
(6) Summarize and present in analytical terms (Analytic statistics)
(7) Interpret and present in a form that would aid decision and reasonable/desired action
(8) Disseminate outcome to likely beneficiaries or by publication or direct communication
(9) Decide / recommend on what to do next (answering the relevant "*And so what*" question.
(10) Consider, discuss and implement type of intervention that would be cost-effective
(11) Study outcome
(12) Point-Appraise
(13) Analyze and reorganize.

Descriptive, analytic, experimental, simulation/ modelling theoretical practical measures

Stop and observe
Describe (qualitatively)
- Quantify (biometrically, econometrically, sociologically, financial value-wise and impact-wise
Determine worthwhileness
Decision (no action further action observe etc.
POINT APPRAISAL
Analyze, present (in prose and in seminar), justify, recommend, seek peer assessment and publish.

ESSENTIAL SIDE ISSUES:
THINGS TO CONSIDER WHEN GOING ON AN EPIZOOTIOLOGICAL TOUR (Ref.GOE/UI/26/06/91)

First Aid Box
It is essential that you have your first aid box supplied with such things as
Wound dressings; bandages; etc
- T.B.C. /iodine tincture
- Fluid electrolyte or the proportionately mixed salts (for replacement therapy)
- Clean potable water,

Take some of your '*antis*' with you, for example: -
- Anti-pyretic
- Anti-malaria
- Anti-histaminics
- Anti-biotics
- Anti-toxins, etc

and of course things like
Andrews liver salt / Eno powder
"Entero sedith" "Entero se - what? *Et hoc genus omne*

---

*Bu/ **Appendix X:**
For detailed exposition in *Systematic Epizootiology*

(A) Recall three stages in Fundamentals of Epizootiology
The following five stages of Epizootiology

1. Awareness, identification and observation of problem, its nature and possible importance.
Ending essentially with
Systematic and methodical (i.e. scientific) observations and exercises in the identification of relevant issues, relationships, points of integration and coordination for systems success.

2. Description (Descriptive Epizootiology) of the disease/problem in the population in terms of relevant person, place and time factors (i.e. answering the questions who? Where? And when?).

3. Formulation of hypothesis about (possible and probable explanations) the occurrence and distribution of the disease/problem.

4. Testing (i.e. proving or disproving) the hypothesis by case-control (retrospective) or follow-up (prospective) studies (of events and circumstances in the population on which the hypothesis about the problem was formulated).

5. Experimentation (controlled trial) to show the validity of the hypothesis sustained (in 4 above).Followed by Conclusion, Summary and Triangulation.

(B) Essential Training before Field Practical
should include
Discussion on Epizootiology Pathways and Logic paths
Map Reading and identification of places by *Grid References*

1. **EPIZOOTIOLOGICAL FACTORS**
2. **EPIZOOTIOLOGICAL EVENTS,**
3. **EPIZOOTIOLOGICAL FORCES**
4. **EPIZOOTIOLOGICAL CIRCUMSTANCES**

1. **Factor** of disease and other problems *specific*: Other factors - *contributory* [non-specific, playing a predisposing part in production of disease and other group problems]

Intrinsic/integral factors genetic constitution: hereditary and internal environment
[causal agents are - Metabolic an integral part - hormonal of the host] - behavioural

Hereditary
- genetic structure of the animal = an abnormality of structure or function
- mutation of genes and somatic cells, caused by ionizing radiations e.g. x-rays
- some obvious, in some cases, a hereditary abnormality requires certain environmental influences for its manifestation.

Extrinsic/external factors: - - non-living agents (physical & chemical agents) & living agents

Disease is a dynamic process develops in the host examined as a result of an interaction between causal agent, the host and other factors of the environment.

Health should mean successful adjustment of body form and function to forces tending to disturb them.

Health and disease are the results of active processes disordered structure and function.

Epidemiology the study of all those factors that contribute to the etiology establishment and spread of human or animal disease, defect or disability in the individual and in the community.

Aetiology of disease study of all the factors which contribute to the production of disease
- agent
- host resistance
- factors influencing these.

APPENDIX V:
MODEL APPROVED COURSE CONTENT

FOR UNDERGRADUATE EPIZOOTIOLOGY AND RELATED COURSES

(Also See Model Approved Course Content for Advanced Epizootiology for Postgraduate Students (Esuruoso, 1984))

UNIVERSITY OF IBADAN
DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE

UNDERGRADUATE COURSES
DETAILS OF COURSES, TITLES, DESCRIPTIONS AND UNITS

Course Number	DVM Class (Year)	Course Title	Course Description	Units	Comment
VPH 401	DVM III	Wildlife Ecology, Management and diseases	Wildlife types and values; distribution of biotic communities; wildlife capturing, restraint and handling. Care of zoo animals; methods for sampling and studying of various wildlife species; organization of game animal species. Territorial aspects of distribution. Diseases of wildlife species. Also amphibians and aquatic animals other than fish and shellfish.		
VPH 402	DVM III	Veterinary Biostatistics	Veterinary recording and data types. Classification and tabulation of data, descriptive and inferential statistics, sampling methods, variations, rate and ration, mean, median and mode, normal and other distributions, standard deviations and variance, chi-square and students T-tests. Elements of vital statistics. Uses of statistics in veterinary practice and research work.	2 Units	
VPH 501	DVM IV	Epizootiology and Wildlife Ecology and Diseases	Introduction and definitions of Epizootiology and Epidemiology: History, Scope and uses in veterinary practice, research and business: Occurrence, frequencies and implications of diseases in animal populations: The epidemiology of infectious and non-infectious diseases: Wildlife (inc. Fish) Ecology	2 Units	

VPH 502	DVM IV	Food (Meat, Milk) Hygiene	Principles of Meat Hygiene, Biological and chemical bases of meat hygiene; anatomy relevant to meat inspection; ante-mortem and post-mortem inspection procedures. Descriptions of various categories of slaughter facilities in Nigeria. Basic construction principles of a functional abattoir, meat by-products; potable water; supply canning, freezing, smoking and other preservation methods. Water, meat and milk-borne diseases. Food micro flora and spoilage; food poisoning; specific food-borne diseases from beef, pork, poultry, fish and shellfish. Control of vermins; detection of residues in meat; effluents and disposal. Milk and milk products; inspection and laboratory examination for milk quality.	3 Units	
VPH 503	DVM IV	Zoonoses	Concepts, definitions and classifications of zoonoses. Study of specific zoonoses. Bacterial, viral and parasitic zoonoses. Bedsonial, rickettsial, protozoan and fungal zoonoses, with emphasis on prevention, early detection, control and eradication.	2 Units	
VPH 504	DVM IV	Veterinary Preventive Medicine, Extension	Prevention of diseases in zoological gardens, prevention of zoonotic diseases. Mass action against diseases; chemoprophylaxis, chemotherapy, seroprophylaxis, serotherapy and immunization procedures in Preventive Veterinary Medicine (PVM). Prevention and control of occupational hazards to Veterinarians, farmers and butchers. Protection of Consumers organization and function of veterinary services in State and Federal Ministries. Veterinary private practice; aims and functions of FLD, NLDC, NSPCA, NVRI, NAPRI, NITR, NVMA; Veterinary and Animal Health Schools. Introduction to Veterinary Jurisprudence in Nigeria. Laws and legislations; Diseases of animals Act (Laws of Nigeria Chap. 54 of 1958; the Pharmacy Act of 1966 amendments the Federal Veterinary Public	2 Units	

APPENDIX VI:

SOME EXAMPLES OF EPIZOOTIOLOGICAL PROJECT TOPICS FROM WHICH STUDENTS MAY CHOOSE

In the choice of final year's projects, students often require their tutors to guide them on possible project titles. Therefore, we suggest below, a sample list of useful titles from which the students may be advised to choose. But in any case, their supervisors would still have the last say in the final choice of each student who wants him to supervise his final year project. Therefore, the list given below is only to give some idea of possibilities.

1. Ecological Epizootiology of a University Teaching and Research Farm:

2. Ecological Epizootiology of Eruwa Field Station:

3. Epizootiology of disease and other problems of groups (herds, flocks, etc) of livestock (including cattle, sheep, goats, pigs, poultry, rabbits) and other animals (dogs, cats, horses, donkeys, camels) in geographically / ecologically defined areas (e.g. township, village, farm, forest reserve, game reserve, range and according to management practices, such as intensive, semi-intensive and extensive system:

4. Epizootiology of disease and other problems in local, resident, trade and migrant cattle and other livestock in control posts and/or abattoirs and in the premises of slaughter slabs:

5. Study of animal, human and environmental health risks and problems in a local abattoir:

6. Surveys of hydatidosis, brucellosis, tuberculosis, trypanosomiasis, trichinellosis, salmonellosis, anthrax, et hoc genus omne in named local abattoirs:

7. Descriptive presentation of benefit/cost situations in named local poultry flocks
(a) for breeder projects
(b) for broiler projects
for layer projects
and the types of measures being taken and quality of results being obtained by the owners:

8. OTHERS **to be suggested by the lecturers** according to the priorities of epizootics of economic and public health importance in the area and at the time - with cost-implications in social, economic and environmental quality or level of degradation terms.

In the case of ASF 2001, eleven Doctor of Veterinary Medicine students that actively participated in this exercise eventually developed topics for their DVM project reports based on the exercise.

Titles of their project reports are listed below:

(1) OLUFEMI Ayowale Olugbenga (2002) The use of immunoblotting technique in the diagnosis of African swine fever in clinically ill and convalescent pigs 44pp Being a project report submitted to the Department of Veterinary Pathology in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(2) LAWAL Omowumi (2002) The application of immunoblotting assay in confirmatory diagnosis of African swine fever in Oyo State of Nigeria. 39pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria

(3) ADEITAN Olatunde (2002) Sensitivity and specificity of 4-chloro-1-naphtol in detecting African swine fever antibodies in an immunoblotting assay 56pp. Being a project report submitted to the Department of Veterinary Physiology, Pharmacology and Biochemistry in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(4) ABIODUN Yetunde (2002) Binding pattern of protein A-Peroxidase conjugate to pig immunoglobulins in African swine fever immunoblotting assay. 55pp Being a project report submitted to the Department of Veterinary Physiology, Pharmacology and Biochemistry in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(5) ADEOYE Keji (2002) A review of neutralizing antibodies against African swine fever virus with a case study in Ibadan, Nigeria. 40pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(6) OLURO Akindele (2002) Preparation of the digital map of African swine fever outbreaks in Ibadan southwest local government area of Oyo State Nigeria. 79 pages. Being a project report submitted to the department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(7) OGUNWALE Ibironke (2002) Preparation of digital maps of African swine fever outbreaks in Ibadan North Local Government area of Oyo State, Nigeria. 60pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(8) ADEWALE Gbenga Adeniyi (2004) Description of a decision support system for the control of African swine fever in Oyo state of Nigeria. 91pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(9) SANGOSANYA Adepeju (2004) Implementation of a decision support system in the control of African swine fever outbreaks 2001-2002 in Oyo state, Nigeria. 94pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(10) AGBAJE Michael (2004) Determination of the viral carrier status of African swine fever convalescent boars at the University of Ibadan Teaching and Research Farm 2001-2002. 64pp Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN, Nigeria.

(11) OBELAWO Ayodeji Michael (2004) Determination of antibody titre in African swine fever convalescent sows and their progenies at the University of Ibadan Teaching and Research Farm in 2001 and 2002. 43pp. Being a project report submitted to the Department of Veterinary Public Health and Preventive Medicine in partial fulfilment of the requirements for the award of Doctor of Veterinary Medicine (DVM) degree of the University of Ibadan, IBADAN,Nigeria.

APPENDIX VII:
EPIZOOTIOLOGICAL INTELLIGENCE FORMS

One of the approaches of epizootiology is to ensure that data collection is systematic, methodical and recorded in a manner that would aid processing and reporting. Therefore, some frameworks for data collection are provided in the following sample forms for usual epizootiological intelligence activities.

When visiting a cattle herd, some descriptive herd statistics that should be gathered include details provided in the following forms. The forms should therefore be duly completed, starting with whether this is a beef, dairy or dual-purpose herd?

1. Type of Herd
2. Name of Owner/ Company
3. Location / Address
4. Officer in charge
5. Date of this data collection

6a. Veterinary Doctor/ Research Officer (in charge/collecting data)
6b. Organization and Address

NB: An evaluation of the students' report should provide materials for at least part of the continuous assessment of the students' performance at the end of the course.

Forms for collection of data on Breeding Cattle Herd Statistics
Form X1: Un-organized Cattle Herd Statistics NOT RECOMMENDED

Sub-Groups	Numbers	Sub-total	Remarks
Young Cattle			
Adult Cattle			
Old Cattle			
Castrates			
Total			

Form X2: Organized Cattle Herd Statistics - RECOMMENDED

Age Group	Numbers	Sub-total	Remarks
Male calves			
Female calves			
Male Yearlings			
Yearlings female			
Young bulls			
Service bulls			
Heifers			
Empty Cows			
Pregnant Cows			
Nursing Cows			
Castrates/Fatteners			
Old/Spent Bulls			
Old/Spent Cows			
Total			

Form X3: Live weights of the various age groups

It is often useful to have some clear idea of the live weights of animals for various reasons. For the administration of drugs, estimation of growth rate, evaluation of nutritional efficiency or weight loss due to various reasons, calculation of financial worth of the animals. There are many ways in which the live weight of animals may be obtained. The most accurate is by actual weighing of each or groups of animals. Next is the measurement of heights at the withers and around the flank and then converting to estimated weight by calculation using a conversion index. This is useful where there is no farm-weighing machine. Yet another way is by informed opinion of experienced veterinarians and farmers. This is obviously unacceptable in strictly scientific communications. Therefore, it may be difficult to complete form X3 in an extensive system of husbandry.

Form X3: Live weights of individuals in the various age groups

Serial No.	Age group	1	2	3	4	5	Weight Range (kg)	Mean live weight (kg)
1	Male calf							
2	Female calf							
3	Male yearling							
4	Female yearling							
5	Young bull							
6	Heifer							
7	Service Bull							
8	Empty Cow							
9	Castrate/ fattener							
10	Pregnant cow							
11	Nursing cow							
12	Spent/old cow							
13	Spent/old cow							
14	TOTAL							

Calf = One year old and under
Yearling = Older than one year, but less than two years
Heifer = Female of two to three-and-half years old
Young Bull = Male of two to three-and-half years old
Service Bull = Male between three-and-half and ten years old
Cow = Female that has calved at least once, usually aged between 41/2 and ten years old
Old Bull = Male above ten years old
Old Cow = Female above ten years old
Castrates = Male that has been neutered

Form X4: Total live weight of each age group

We can summarize the data in forms two and three above in such a way as to obtain the sum of live weights in each cattle age group on the herd. This is calculated by multiplying the number of individuals in an age group with the corresponding average weight for that age group. The result is recorded in the form provided below (Form X4). This is a summary of the herd's total live weight. The benefit of this lies in the fact that one can compare different farms on their stock carrying capacity. Also the result will provide cogent statements for the remarks column in form 2, e.g. 'so much weight would be available for sale in the month of August, 2002'.

S/No.	Age Group	Mean live weight (kg)	Total count	Total weight kg (Mean x Count)
1.	Male calf			
2.	Female calf			
3.	Male yearling			
4.	Female yearling			
5.	Young bull			
6.	Heifer			
7.	Bull			
8.	Cow			
9.	Castrate/fattener			
10.	Pregnant cow			
11.	Nursing cow			
12.	Spent/old cow			
13.	Spent/old cow			
Gross total live weight of herd				

When this form 4 has been completed, the student and instructor would obtain a good idea about the carriage capacity of the farm herd. This piece of information may be interpreted in terms of the financial worth and economic implications of the herd. This is a reason why one International Group of Veterinarians and Scientists call this discipline Veterinary Epidemiology and Economics. Epizootiologists however refer to this aspect of Epizootiology as the socio-economic component of Epizootiology.

Form X5:
Milk production capacity data-sheet is the fifth recommended form for cattle herd statistics practical. The form is as shown below:

Form X5

Cow Identity No.	Week of lactation	Daily Milk yield (kg)	Calf intake of milk(kg) (morning)	Off-take of milk (kg) (morning)	Calf intake of milk(kg) (evening)	Off-take of milk (kg) (evening)
No. 1						
No. 2						
No. 3						
No. 4						
Total						

*Morning and evening milking

It should be noted that when the epizootiological investigation is at an abattoir, the following table would be useful for economic assessment, because we already know that epizootiology has economic basis and implications. The individual weight of parts of the body of a cattle breed is provided for in Form 6. A weighing scale is carried along to the slaughter house. Each butchered part is picked, weighed and recorded.

Form X6a: Weights of slaughtered cattle and the various parts thereof

Cattle wt.	Live wt. (kg.)	Head (kg.)	Neck (kg.)	Right	Left	Right hand	4 legs (kg.)	Lungs (kg.)	Heart (kg.)	Liver (kg.)	Spleen (kg.)	Intestines	Skin kg.	Udder kg.	Pennis &	Stomach	Utenus (Kg)	Total dead	
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

*Produce 6b Standard average obtained from Figures in a place.

It is always very useful for students of epizootiology to be informed about the individual dead weight of food and non-food animals and the weight of their body parts. The students should then be given the opportunity to collect such data on a format designed by themselves. Necessary calculations (in the form of descriptive statistics) should then be carried out to show that the data collected are meaningful, providing summary presentation of the group of carcasses or animals.

Forms for collection of data on Herd health statistics

Having determined the farm herd carriage capacity, then, each of the three epizootiological approaches namely:

(i) Medical detection approach
(ii) Ecological approach and
(iii) Mathematical epizootiology would now be practically applied to collect data on the following factors in relation to the herd health, husbandry and hygiene status.

1. The influence of environmental factors (climate, water, soil, feeds etc) on a herd of cattle in terms of their health and productivity;
2. Measures to prevent the formation and spread of diseases and other problems in the herd;
3. The keeping, feeding and care condition which correspond to cattle species-specific peculiarities, age and purpose of keeping the herd, so as to equally guarantee the welfare and high productivity expected of the herd.

In the case of medical detection approach to epizootiology, a clinical examination of ill cattle and those performing sub-optimal (all picked at random) is physically done to determine and characterize the present indicators of disease and related problems. The clinical signs, symptoms and pathological lesions of the type of ill health that is present in the herd are identified and recorded in a specified epizootiological data form (Form 7).

Form X7:

Cattle identification	Breed	Sex	Age	Case History	Clinical Findings	Diagnosis	Recommendation
NO. 1							
No. 2							

In form 7, column 8 a list of differential diagnoses and then a tentative diagnoses should be clearly separated and underlined in the column on diagnosis. The recommendation in epizootiology may include, isolate the cattle, collect specific samples for laboratory examination, treat to cure, cull, condemn (i.e. slaughter and burry), vaccinate the entire herd against the envisaged problem. A second form to be completed in medical detection approach (form 8) is on mortality, morbidity and case fatality rate. See below.

Form X8: Herd health statistics

Data should be collected to show the following
(a) Description of the problem/disease
(b) Number of animals in the herd at the beginning of the problem (State date)
(c) No sick among each age group Since the problem started)
(d) No dead among each age group since the problem started

- When more than one visit has been undertaken, one can then compare increase in no sick, no well, and no dying as proportions of the total number of animals in the herd.

There are many other possible tables according to type of herd or flock, purpose of keeping the herd and history of the herd. Therefore, the number of these tables are not exhaustive; more may be added during lectures and training of students. For each type of problem encountered during the training, appropriate forms for data collection should be designed, discussed, produced and taken along for completion on the farm when visiting to observe and evaluate the nature and extent of the group problem. Grid references, topography, vegetational type and status, ecological and meteorological conditions of the location should also be noted and recorded. Evidence of human activities in the area should also be noted and recorded.

All such records, in words, tables, pictures and sound should be kept in such a manner as would readily be amenable to meaningful statistical processing. Numbers should be accompanied by units of measurement of whatever parameters are being recorded.

(A) Example of Cattle Herd Statistics of Animals Examined and Sampled

Cows and mature heifers (years and above)	19
Heifers (over 2 years and under 4 years old)	12
Yearling Heifers	5
Heifer calves	Nil
Total females (sub-total for herd)	36
Mature Bulls (4 years old and above)	1
Young Bulls (2 years and under 4 years)	5
Yearling Bulls	1
Bull calves	Nil
Total males (sub-total for herd)	7
Grand total (number of animals examined)	43
Cows and mature heifers (4 years and above)	19
Heifers (over 2 years and under 4 years old)	15
Yearling Heifers	11
Heifer calves	Nil
Total females (sub-total for herd)	45
Mature Bull (4 years and above)	1
Young Bull (over 2 years and under 4 years old)	6
Yearling Bulls	1
Bull Calves	Nil
Total males (sub-total for herd)	8
Grand total (No. of animals in the herd)	53

N. B. Such statistics provide intelligence information on the productivity status of the herd

(B) Examples of Tables of Herds Statistics

	Adult female cattle (19)	2-4 yr. Old (young) females (12)	Yearling females (5)	Heifer calves	Adult bulls (4-8 years) (1)	2-4 year old bulls (5)	Yearling bull (1)	Bull calves (-)
Mean rbc counts X106 / mm3	6.04	6.40	7.35	-	-	6.82	8.61	-
Mean % PCV	36.64	37.08	36.2	-	43	37.83	34	-
Mean % Hb** (gm %)	58.68 (8.22)	62.92 (8.81)	63.8 (8.93)	-	71 (9.94)	58.33 (8.16)	64 (8.96)	
Mean wbc counts X103/ mm3	7.86	7.73	9.73	-	-	7.77	9.95	-
Mean % Lymphocyte counts	76.83	78.55	82.80	-	75	79	75	-
Mean Neutrophil counts	19.17	15.45	14.60	-	25	16.40	13.67	-
Mean N/L** Ratio	0.25	0.29	0.12	-	0.33	0.21	0.51	
Standard deviation of N/L** Ratio	0.37	0.39	0.43	-	0.31	0.28	-	

Key: (i) N/L** Neutrophil/Lymphocyte ratio
(ii) (14gm) Hb* = 100% Haemoglobin

APPENDIX VIII: "SENSITIVITY AND SPECIFICITY (IN A FOUR-FOLD CLASSIFICATION) TEST"

Sensitivity (S1) and specificity (S2) tests and their interpretation are presented here as used in epizootiology.

(S1) ***Sensitivity***: Biological tests may vary in their sensitivity. A very sensitive test will ensure that all truly affected or diseased individuals will be picked up by the test as positive. But almost invariably borderline or even some negative individuals may also be picked up as positive by a super sensitive test. There are usually some underlying biological reasons for such reactions. Nevertheless, it is important to be able to quantify the sensitivity of commonly used screening and diagnostic tests. Mathematically the formula for calculating the sensitivity of a test (S) is

$$\textit{Sensitivity}\ (S1) = \frac{\text{No. of true positives}}{\text{Total number of diseased individuals}}$$

Specificity(S2): A non-specific test is one, which will produce a lot of false positives; and this would be misleading in various circumstances. But specificity can be viewed as a matter of degree; some tests may be more specific than others. Mathematically (i.e. for the calculation of specificity), the formula is

$$\textit{Specificity}\ (Sp) = \frac{\text{number of truly negative individuals}}{\text{total number of non-diseased individuals}}$$ *(See 2 x 2 contingency table)*

2 x 2 Contingency Table

Result of Diagnostic or screening test	True Status of Animals Diseased	True Status of Animals Non-diseased	Total
Positive	a	b	a+b
Negative	c	d	c + d
Total	a + c	b + d	a + b + c + d

$$\textit{Sensitivity} = a / a + c = \frac{(a)}{a + c}$$

$$\textit{Specificity} = d / b + d = \frac{(d)}{B + d}$$

Interpretation of specificity and sensitivity test results

From results thus obtained, and depending on the particular disease and the objectives of the test operator, one may want to know the *predictive value* of positive and negative test results.

The formulae for these are: -

(i) *Predictive value* of positive test result $P_{v+} = a / a + b = \frac{(a)}{a + b}$

and

(ii) *Predictive value* of negative test results $P_{v-} = d / c + d = \frac{(d)}{c + d}$

One objective may be that we want the test to pick up all positive cases, even if some doubtful or negative cases will be included. We want to leave no chances of retaining any case that would have the remotest probability of being positive. Then the higher the sensitivity the better. On the contrary, one may prefer a very specific test so that only truly diseased animals are picked up (even at the risk of missing some of them). Both are measures of probability.

"Sensitivity and Specificity (in a Four-Fold Classification) Test"

Test results	No. of Diseased Animals	No. of Non-Diseased Animals	Total No. of Animals
Positive	(a)	(b)	[a + b]
Negative	(c)	(d)	[c + d]
Total	[a + c]	[b + d]	a + b + c + d

Sensitivity = a/a + c

Specificity = d/b + d

Predictive value (of positive test) = a/a + b

Predictive value (of negative test) = d/c + d

"*Sensitivity and Specificity in a* **Four-Fold (Classification) Test**

Test results	Diseased Animals	No. of Non-Diseased Animals	Total No. of Animals
Positive	A	B	a + b
Negative	C	D	c + d
Total	a + c	b + d	a + b + c + d

Example

Test results	Diseased Animals	No. of Non-Diseased Animals	Total No. of Animals
Positive	a = 20	b = 5	a + b = 25
Negative	c = 1	d = 125	c + d = 126
Total	a + c = 21	b + d = 130	a + b + c + d = 151

a (true positive) = 20
a + c = 21
Sensitivity = 20/21
=20/21 x 100 = **95%**

d (true negative) = 125
b +d (total non-diseased) =130
Specificity = d/b+d = 125/130
= 125/130 x 100 = **96%**

APPENDIX IX:

SOME EPIZOOTIOLOGICAL DATABASE MATERIALS FOR NIGERIA

A: Common Trees in Lere Local Government Area of Kaduna State And Bassa Local Government Area of Plateau State, Nigeria

No.	Hausa name	English name	Botanical name	Sampling location
1	Aduwa	Desert date	*Balanite aegyptiaca*	Bassa LGA of Plateau State
2	Alilliba	-	*Cordia abyssinica*	Bassa LGA of Plateau State
3	Ararrabi	Frankincense tree	*Boswellia dalzielli*	Bassa LGA of Plateau State and Lere LGA of Kaduna State
4	Uwar Magunguna	Violet tree/wild wistaria	*Securidaca longipedunculata*	Bassa and Lere LGAs
5	Bagaruwa	Egyptian thorn tree	*Acacia nilotica adansonii*	Bassa and Lere LGAs
6	Bagaruwan namiji	-	*Acacia nilotica nilotica*	Bassa and Lere LGAs
7	Farar kaya	White thorn tree	*Acacia sieberiana*	Bassa and Lere LGAs
8	Bauren kiyashi	Fig tree	*Ficus spp.*	Lere LGA
9	Bauren rafi	Fig tree	*Ficus spp.*	Bassa LGA
10	Cediya	Fig tree	*Ficus thonningii*	Bassa and Lere LGAs
11	Dabino	Date palm tree	*Phoenix dactyliflora*	Bassa and Lere LGAs
12	Doka	Doka tree	*Isoberlinia doka*	Bassa and Lere LGAs
13	Doka rafi	Doka tree	*Berlinia grandiflora*	Bassa LGA
14	Dorawu	African locust bean tree	*Parkia clappertonia*	Bassa and Lere LGAs
15	Dufuwa, sarkakiya	Rope Acacia	*Acacia ataxacantha*	Bassa LGA
16	Durumi	Fig tree	*Ficus polita*	Bassa LGA
17	Dushe (shrub)	Acacia tree, shittim wood	*Acacia seyal*	Lere LGA
18	Karkara (Kumbar Shaho)	African catechu tree	*Acacia polyacantha carpylacantha*	Lere LGA
19	Farin baure	Fig tree	*Ficus capensis*	Bassa LGA
20	Farin baushe	Fig tree	*Terminalia laxiflora*	Bassa LGA
21	Farin doka	Fig tree	*Isoberlinia dalzielli*	Bassa LGA

22	Gamii	Fig tree	*Ficus platyphilla*	Bassa LGA
23	Gardaye	Acacia tree	*Acacia macrostachya*	Bassa LGA
24	Gawo	Apple Ring Acacia	*Acacia albida*	Bassa LGA
25	Gwanno	Acacia tree	*Acacia macrothyrsa*	Bassa LGA
26	Giginya	African fan Palm	*Borassus aethiopum*	Bassa and Lere LGAs
27	Gwandar daji	Wild Custard Apple	*Anmona senegalensis*	Bassa LGA
28	Janganye	Red Leafed Tree	*Combretum hypopilinum*	Lere LGA
29	Kadanya	Shea Butter tree	*Butyrospermum parkii*	Lere LGA
30	Kaikayi	-	*Parinari polyandra*	Lere LGA
31	Kawuri	Fig Tree	*Ficus kawuri*	Bassa and Lere LGAs
32	Kokiya	-	*Strychnos spinosa*	Lere LGA
33	Kuka	Baobab Tree	*Adansonia digitata*	Bassa and Lere LGAs
34	Kurna	Christ's Thorn	*Zisyphus spina-christi*	Bassa LGA
35	Mandaci	Mahogany Tree	*Khaya senegalensis*	Bassa LGA
36	Madacin dutse	Mahogany spp.	*Ekebergia senegalensis*	Bassa LGA
37	Madobiya	African Teak	*Pterocarpus erinacius*	Bassa LGA
38	Madobiyar rafi	Teak spp.	*Albizia zygia*	Bassa LGA
39	Malga	Cassia Tree	*Cassia arereh*	Bassa LGA
40	Namijin kade	Scrubby Oak	*Lophira lanceolata*	Bassa LGA
41	Nonon giwa	Sausage tree	*Kigelia aethiopica*	Bassa LGA
42	Rimi	Silk cotton Tree	*Ceiba pentandra*	Bassa LGA
43	Sai da jini	-	*Mimosa pigra*	Bassa LGA
44	Sharan labi	Jerusalem Thorn	*Parkinsonia aculeata*	Bassa and Lere LGAs
45	Shiwaki	Bitter leaf	*Vernonica amygdalina*	Bassa and Lere LGAs

Olarinmoye, A.O. (2000)

APPENDIX X:

RECOMMENDED ATTENDANCE REGISTER FOR ALL LECTURES AND PRACTICAL EXERCISES IN EPIZOOTIOLOGY

UNIVERSITY OF IBADAN
DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE
[Ref. GOE/DVPHPM.UI/ 03031977]
RECORDS OF UNDERGRADUATE AND POSTGRADUATE TEACHING
[Essential for monitoring lectures and practical training given and attended]

Class: Session: .... Date: .... Period: ....
No & Title of Course:
Lecture/Practical/Tutorial/Seminar:
Main Topics Covered:
....
....
....
Tutor's Name: ....
Signature:.....................Date:.................

ATTENDANCE REGISTER*:
[*Recommended model, used by DVPHPM.UI since 1976]

S/No	Candidates' Names (Surname in capitals)	Degree/s Held	Matric. No.	Degree in view	Signature	Date
1						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

[Students should record below the attendance sheet (here) their Questions, Comments, Remarks and Requests (related to the Lecture / Practical/ Tutorial), for which there is no time to give immediate answer]

INDEX

* See glossary section of this book for details.

Professor Gabriel Oluwole ESURUOSO (BVMS, MSc, PhD, MRCVS, FCVSN) Academic and Animal Health Consultant and Director of Academic Consultancy Services (ACS). Also Founder and Executive President of Vet. Academic Resource Foundation (VARF), U. I. P. O. Box 14400, Ibadan, Oyo State, Nigeria.

Dr. Ighodalo Folorunso IJAGBONE (FISLT, Cert. Immuno (Lond); M.Sc. (Parasit), M.Sc. Epizoot.), Ph.D (Ibadan). Lecturer, Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

Dr. Babasola Oluseyi OLUGASA (D.V.M., M.Sc. (Epizoot.) (Ibadan), Lecturer, Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan. Nigeria. Visiting Scientist/Research Scholar, Center for Food Security and Public Health, College of Veterinary Medicine, Iowa State University, Ames, Iowa U.S.A. (2003-2004).

ISBN 978-38270-4-9

9 789783 827042