THE IMPACT OF IMPROVED RURAL WATER SUPPLIES ON THE HAMAR AND HUMR TRIBES OF SOUTH-WESTERN KORDOFAN - A GEOGRAPHICAL ANALYSIS.

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A B S T R A C T

This thesis attempts geographical analysis of the impact of Sudan's deep bore programmes on water-deficient and under-developed South-Western Kordofan; it is based partly on existing published materials and partly but more importantly on extensive field investigation.

The main finding is that deep bore programmes have helped to transform South-Western Kordofan socially and economically. Chapter one of the thesis outlines the various mechanisms through which this transformation has been achieved. In the analysis, use is made of Knetsch's approach of comparing conditions in two culturally and physically similar areas, one of which has been provided with a change-inducing factor, and of attributing any observed differences between the two areas to its operation.

Chapter two contains a short account of the resources of South-Western Kordofan, both physical and human. Particular attention is paid to solid geology, on which the occurrence of subsurface water depends, to the nature of the superficial deposits, and to rainfall and vegetation.

Conflicting principles of need and balanced exploitation of resources have characterized the allocation of boreholes in space and time. Chapter three examines the implications of such conflicting principles for the distribution pattern of deep bores in South-Western Kordofan. In this chapter the concept is introduced of 'usable land', which is a function of the availability of water; an attempt is also made to determine hypothetically what should be the appropriate maximum distance between one borehole and another that would make for the optimum exploitation of agricultural land

and grazing of South-Western Kordofan.

The impact of the deep bore programmes on South-Western Kordofan's major economic activities is dealt with in three chapters. Chapter four explains why pastoralists may continue to be migratory even when adequate perennial water supplies are available; it also suggests how the deep bore programmes may create more grazing problems unless accompanied by well organized pasture management. Chapter five shows that the cropped area has increased considerably since the borehole programmes began, but because attitudes towards cultivation vary widely it is not possible to determine the precise contribution made by the deep bore programmes to the expansion in the area under cultivation. The increase in cropped area has led to a reduction in the area under 'gum-gardens', but this has not been accompanied by a decline in gum production. Chapter six explains why and asks whether the Arabs will continue to invest their efforts in gum tapping if other and more rewarding sources of employment are open to them.

The distribution of services is strongly influenced by the availability of water. Since the population size of a settlement is limited by the amount of water it can provide in the dry season, the question is posed in chapter seven whether every deep bore settlement will possess population large enough for the optimum use of all essential services.

The thesis ends with a short chapter which reviews the role which the deep bore programmes can and should play in the future development of South-Western Kordofan.

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There are no hotels in South-Western Kordofan, and the few non-catering rest houses built for touring government officials who travel with servants are unsuitable for lone researchers. I was therefore forced to seek shelter among the natives. Special thanks are due to all the Sudanese, particularly the tribal leaders, village heads and teachers who gave me accommodation and food.

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CHAPTER ONE

CONCEPTUAL FRAMEWORK AND METHODOLOGY

Introduction.

Barbour has suggested four roles which geographers can play in the planning and evaluation of the performance of rural development schemes. These are:

(i) the role of geographers in preliminary investigation teams;

(ii) the employment of geographers in planning teams of a statutory nature;

(iii) the role of geographers as independent observers; and

(iv) the objective study over a number of years of an area in which a new project has taken place to determine whether the authors have been right in their assumptions and expectations.[1]

It is the fourth of these activities - the role of geographers in evaluating the expected positive effect of rural development schemes - with which this thesis is concerned. For this, the government of Sudan's policy for the provision of rural water supplies with particular reference to South-Western Kordofan has been chosen for detailed examination.

The Problem.

Physically and culturally, South-Western Kordofan belongs to "Central Sudan"[2] where there has been little economic and social development.

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1. Barbour, K.M., 1967, A Survey of the Railway Extension in Nigeria - A Geographical Audit, The Journal of the Geographical Association of Nigeria, Vol. 10, No. 1, pp.11 - 28.

2. The area geographically designated as "Central Sudan" stretches from the extreme western boundary with Tchad Republic to the extreme eastern boundary with Ethiopia between latitudes 10 degrees North and 15 degrees North.

This belt is characterised by poor rural population, perennial shortage of drinking water, low population densities, large tracks of level or gently undulating land with high agricultural and grazing potentials, and total dependence on subsistent crop production and animal husbandry. Of the factors responsible for the general poverty of Central Sudan, perennial shortage of drinking water has been identified as the most crucial, for it acts as an effective constraint on resource utilization and hence, on development. The Sudan government has recognised this fact, and conscious of the necessity either on purely social and humanitarian grounds, or on those of political expediency, of improving of living conditions of the rural population - which forms well over 90 per cent of the entire population of the country[3] - it has been investing a substantial proportion of its revenue on provision of rural water supplies. Up to 1966, government expenditure on the provision of rural water supplies stood at £S6,013,776, and in the 1966/67 Financial Year, government launched a ten-year £S15 million scheme to harness and control both surface and sub-surface water.[4]

The forms which the programmes for the provision of rural water supplies take differ from one region to another. This is due to areal variations in geological structure, terrain, pedology and the amount of precipitation. In areas with ground water, the programmes concentrate

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3. Krotki, K.J., 1958, First Population Census of the Sudan, 1955-56: 21 Facts About the Sudanese, pp. 35-37 (Ministry for Social Affairs, Khartoum).

4. El Bushra El Sayed, 1967, The Factors Affecting Settlement Distribution in Sudan, Geografiska Annaler, Vol. 49B, No.1, pp. 10-24.

on drilling wells and equipping them with pumps. Where there are relatively flat terrains dotted with isolated _jubal_ (hills) and soils with very high clay - content, provision of rural water supplies is through _hafirs_ (artificially excavated surface reservoirs). Places which possess favourable conditions for neither deep bores nor _hafirs_ are provided with "artificial catchment water tanks." Finally, areas not suitable for deep wells, _hafirs_, or catchment tanks, are supplied with water by lorry tankers.

The Objective.

It is now about a quarter of a century since the government of the Sudan adopted as a matter of official policy the assistance of rural development through the provision of improved rural water supplies for both human and livestock consumption.[5] Before and since then, much has been written and published by scholars, planners, and politicians about what the provision of rural water supplies could do to stimulate economic and social development of the water crisis zone. Lebon[6],

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5. In 1944, following the publication of the Soil Conservation Committee's report, this policy was adopted officially. Before this time, however, several water points had been created in the Sudan, though in a haphazard manner.

6. (i) Lebon, J.H.G., 1956, Current Development in the Economy of the Central, Sudan, _International Geographical Union_, Lodon, pp. 57 - 66.

   (ii) Lebon, J.H.G., 1965, Land Use in Sudan, _The World Land Use Survey_, Monograph No.4, Chapter II.

Bayoumi[7], Barbour[8] and El Bushra[9] have commented generally on this topic. They unanimously hold the belief that the fortunes of settlements and the prosperity of the rural populations of Central Sudan are dependent on the availability of adequate rural water supplies. Harrison[10] sees the multiplication of water points as a significant step towards the settling of the nomads, but recognises the need for adequate pasture for the nomads' stock. On the other hand, Cunnison, Asad and Hill[11] have rejected the theory that the only way to effectively and economically exploit the land and grazing resources of the water-deficient areas of the Sudan is to sedentarise the nomads through the provision of improved rural water supplie Mahdi[12] holds similar views as Cunnison, Asad and Hill. These writers, in spite of their disagreement on objective, are unanimous in their views - based not on any serious and proven scientific investigations, but based

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7. Bayoumi, A.K., 1962, The Effect of Nomadism on the Economic and Social Development of the People of the Sudan, Proceedings of the Tenth Annual Conference of the Philosophical Society of the Sudan, pp. 68 - 69.

8. (i) Barbour, K.M., 1950, Dar Hamar, Pamphlets Sudan, No. 13.
(ii) ____________, 1961, The Republic of the Sudan, Chapter II.
(iii) ____________, 1964, Population, Land and Water in Central Sudan, in (Ed.) Barbour and Prothero, Essays on African Population, pp. 137 - 156.

9. El Bushra El Sayed, 1967, op. cit.

10. Harrison, M.N., 1956, Report on Grazing Survey of the Sudan, Ministry of Animal Production, Khartoum.

11. Cunnison, I., Asad, T., and Hill, L.G., 1966, Settlements of Nomads in the Sudan: A Critique of Present Plans, in (Ed.) Shaw, D.J., Agricultural Development in the Sudan, Proceedings of the 13th Annual Conferenc of the Philosophical Society of the Sudan, Vol. 1, pp. 102 - 125.

12. Mohi El Din Mahdi, 1962, The Effect of Nomadism on the Economic and Social Development of the People of the Sudan, Proceedings of the Tenth Annual Conference of the Philosophical Society of the Sudan, p. 37.

partly on hearsay and partly on intuition - that availability of water is a pre-requisite for rural development to take place.

The problem of evaluating the performance of Sudan government's rural water supplies programmes - on the lines suggested by Barbour in his geographical audit of the Bornu Railway Extension in Nigeria[13] - in effecting rural transformation has, however, received little academic attention. Certainly, no detailed study of the impact of deep bores on the economies and populations of the *goz* (sandy) areas of Central Sudan has yet been undertaken. The only detailed geographical study that has attempted an examination of the impact of the rural water supplies programmes is by Graham.[14] This study was confined to the analysis of the effects of *hafirs* on the settlements of Gedaref District. The only work that has studied the impact of the exploitation of sub-surface water on economic development has been done outside the Sudan, such as ~~This is~~ the work of Bowden on the "Diffusion of the Decision to Irrigate" in the Northern High Plains of Colorado, United States of America.[15] Here, the sinking of deep wells has been by private individuals and for a different purpose (for irrigation rather than for purely human and animal consumption). Bowden has approached his study of the acceptance or rejection of the decision to irrigate by

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13. Barbour, K.M., 1967, *op. cit.*

14. Graham, A.G.S., 1963, *Rural Water Supplies and Settlement in Gedaref District, Sudan,* Unpublished Ph.D. Thesis, University of London.

15. Bowden, L.W., 1965, Diffusion of the Decision to Irrigate, *Department of Geography Research Paper,* No. 97, Chicago.

the farmers of the Colorado Northern High Plains by applying the principles of physical possibility, economic gainfulness, legal permissibility and social acceptability.[16] These principles have with some modifications, been applied to the study of the impact of deep wells on the economy and people of South-Western Kordofan.

This study attempts to evaluate the contribution made to the socio-economic improvements of South-Western Kordofan by boreholes. It seeks to make an assessment of the effects of deep wells on both the nomadic and settled populations of this zone. It tries to identify what changes are induced by mechanical wells, and how the inhabitants adjust to these changes. Finally, the study attempts to predict the pattern of social and economic organisation that would emerge when the optimum number of deep bores had been reached.

The conclusions of this study, based as they are on data from a limited selection of villages, might not be able to claim universal validity for all the water deficient areas and all types of economic organizations in the Sudan. A comprehensive analysis of these, based both upon broad statistical surveys and on adequate number of detailed studies is yet to be made. It is hoped, however, that present analysis, along with few others directly related to this subject,may serve as a guide for further research. Similarly, the information presented herein may be of some use to those directing planned programmes of regional/rural development in the Sudan.

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16. Bowden, L.W., 1965, op. cit., p.XX.

Some Definitions:

It is necessary to define at the onset a number of words and expressions that have been used frequently in the thesis. The word nomadism is used to describe the mode of life of people who wander about and have no fixed homes. A man who practices pastoralism and wanders about with his animals and has no fixed home is a pastoral nomad. If he combines pastoralism with arable crop farming, but still wanders about with his stock at one season or another and has no fixed home, he is referred to as a semi-pastoral nomad. A man who lives in a seasonally water deficient village and goes away to spend the dry season in another village with permanent sources of water supplies is referred to as a semi-migrant; this term is employed whether he lives solely on arable crop farming, or whether he combines arable crop farming with livestock husbandry. Usable land refers to all land within a specifically defined radius of a water point, since in the region studied, usability is determined by availability of water. The extent of usable land varies with land use type. Thus, all land within radii of 8 km. and 16 km. of a deep bore irrespective of the size of population or volume of water, is assumed to be usable for crop production and grazing respectively.

Economic development has become a common place expression in political, sociological, economic and geographical writings, and has thus acquired a very wide variety of connotations; consequently, it has become necessary to state in precise terms, what the expression means whenever it appears in any literature. In this thesis, economic development refers to a partial or complete elimination of what Hodder, B.W.[17] lists as "features associated with economic and social organization of poor communities". These features include low life expectancy at birth, high infant mortality rates, poor health and illiteracy, low per capita productivity, and subsistent dominated production. Others are non-diversified economies which are geared to primary production; little manufacturing industry, traditional methods of production, and narrow markets. The elimination of all or most of these features which will eventually lead to a rise in the output per capita is achieved through structural changes in the pattern of both the economic and social organizations of the area being studied. Thus, in the words of Mountjoy, "development involves not merely economic changes, but also social and institutional ones."[18] In short, economic development as used in this thesis denotes an increase in the per capita income which results from increased per capita productivity, accompanied by improved social and economic organizations which allow a greater and more efficient use of resources.

Social improvement is used here to mean among other things, a rise in the consumption propensities of the population. It also means an increase in the number and range of, and a greater and more efficient use of services and amenities provided. These should have resulted directly from changes in attitudes and perception.

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17. Hodder, B.W., 1968, Economic Development in the Tropics, p. 4.
18. Mountjoy, A.B., 1969, Industrialization and Under-developed Countries, p.27.

In Kordofan Province, of which South-Western Kordofan forms a part, agriculture is easily the most important economic activity. This is because about 93 per cent of the working population is engaged in primary production, that is in agriculture including hunting and gum collecting, and in livestock raising.[19] In a situation like this, according to Brokensha, "any increase in the standard of living, as well as any substantial progress towards industrialization, depends on an increase in agricultural output."[20] Under arid conditions, substantial increase in agricultural production is impossible without water development. In the study region, it is underground water that is being developed. Resources in this thesis therefore, mean agricultural land, grazing, gum trees and sub-surface water.

Conceptual Framework.

In a water - deficient environment with high resource potentials, provision in the right places, of adequate and perennial sources of water is regarded as the single most important factor which can be used to stimulate economic and social development.[21] Where such an environment lacks minerals and manufacturing industries to provide the population

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19. For more information on the occupational structure of the Sudanese See (i) Krotki, K.J., 1958, op. cit., pp. 32-34; and (ii) Shaw, D.J., 1963, A Note on Sudan's Ten Year Plan of Economic and Social Development, Agricultural Economics Bulletin for Africa, No.3, p. 58. ECA - FAO Joint Agriculture Division, Addis Ababa.

20. Brokensha, D., 1965, Ecology and Economic Development in Tropical Africa, p. 2 - Research Series No. 9, Institute of International Studies University of California, Berkley.

21. El Banna Sayed Magdoub, 1961, Problems of Land Use in the Central Rainlands and the Grazing Zone of the Northern Sudan, Surveying for Development in the Sudan, Proceedings of the Nineth Annual Conference of the Philosophical Society of the Sudan, pp. 35 - 46.

with gainful employments, any growth in the economy has to depend on growth in the agricultural and pastoral economies. Consequently, economic development which in South-Western Kordofan implies rural development becomes a function of natural resource exploitation which, in turn, is a function of availability of water, its nature, amount and duration.

In such an environment, the exploitation of the grazing resources is in the hand of pastoralists, whose mode of life is bound up with the basic needs (grazing and water) and well-being of their animals. Their main concern is to satisfy these needs, while at the same time, they strive to avoid anything - especially water-logging and disease-bearing insects - that cause discomfort or death or both to their animals. The seasonal and spatial prevalence of discomfort and disease-bearing elements, and the shortage of water and grazing have been identified as major factors which influence the pastoralists in their choice of nomadism as a way of life. This is because nomadism is seen as an adaptation - in a primitive manner - to an environment which is lacking in certain basic needs.[22] It is being assumed, from the fore-going discussion, that

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22. For detailed information on factors of nomadism in the Sudan, see:
    (i) The Effect of Nomadism on the Economic and Social Development of the People of the Sudan, in Proceedings of the Tenth Annual Conference of the Philosophical Society of the Sudan, 1962, particularly papers by Hassan, I.H., (pp.22-28); Baashar, M., (pp.51-69); Randell, J.R., (pp.70-79); Berry, L., (pp.80-85); and Cunnison, I., (pp.103-11

    (ii) Johnson, D.L., 1969, The Nature of Nomadism: A Comparative Study of Pastoral Migrations in South-Western Asia and Northern Africa, pp.82-83, University of Chicago, Department of Geography Research Paper, No. 118.

    (iii) Fisher, C.P., 1944, Note on the Livestock of the Sudan, Soil Conservation Committee's Report, pp.117-120, Sudan Government, Khartoum.

making available adequate and perennial sources of water supplies to a water-deficient environment which is free from seasonal water-logging conditions and the menace of discomfort and disease-bearing insects should assist in finding appropriate answers to this very important question: Do the pastoralists move because they must, because they are used to it, or because they like it?

Where all the needs of the animals can be satisfied within an area without any threats to their well-being, the raison d'etre for nomadism will disappear. This will happen only if the animal rearers have been compelled to move by unfavourable environmental conditions. Thus in a seasonally water-deficient region that possesses high grazing potentials and that is not seasonally water-logged or infested by insects which are deadly to livestock, nomadism has been imposed on the pastoralists by shortage of water. In such an environment, if the pastoral migrants are assured of adequate and perennial sources of water supplies for themselves and their animals at terms that do not seriously conflict with their traditional grazing and watering practices, they may become settled. The decision to settle by pastoral nomads who water their stock at the bahr at no financial cost may be assumed to mean acceptance of watering at deep bores and the consequent restrictions imposed on grazing practices and the limitation on the size of stock either by the amount of water or grazing or both. Implicit in the above exposition is the postulate that the provision of deep bores will effect the settlement of nomads, which is regarded as the best path to rural economic and social development. This veiw is, however, not shared by Cunnison, Asad and Hill.[23]

While the exploitation of the grazing resources is in the hands of pastoral nomads, agricultural land is worked by peasants. At the present level of technology, the peasants' productivity depends upon the quantity and quality of labour force they can mobilize for cultivation. Lack of water results in a sharp reduction in the quantity of labour available for crop production. The reduction arises from the following situations.

First, a substantial proportion of the labour force which should be used on crop production is spent on fetching water. Secondly, lack of water results in delay in the sowing of seeds. Preparation of land for sowing, clearing and harvesting is often dependent upon chance accumulation of storm water in pools. Soon after harvest, the inhabitants of waterless villages have to go to spend the dry season at water centres. They do not return until the beginning of the rains. It is then they start clearing their fields hurriedly. In some cases, the seasonal migrants do not return until the rains become effective enough to guarantee adequate and regular supply of water from the pools. This leads to a reduction in the period available for cultivation, and hence the size of the family farm is much smaller than the potential labour force can cultivate. In addition, working days are shortened, as workers cannot live in temporary camps in cultivation areas which have no water. Since

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23. Cunnison, I., Asad, T., and Hill, L.G., 1966, op. cit.

the average family farm size is smaller than the potential labour force can work, one can legitimately claim that there is under-employment of agricultural labour.

Furthermore, during the cultivation season, a fairly long period of drought may be experienced during which pools on which cultivators depend for their water supplies dry up. Should this happen, the labour force is depressed, for labour is withdrawn from cultivation and diverted to fetching water. This is a critical period for the cultivators. For one thing, the size of the family farm is more often than not determined by the volume of the labour force available to take on weeding. Any family which wants to maintain the full strength of its labour force can do so only at considerable financial expense incurred on bringing water from long distances by hired animals or lorry tankers. However, not many families can bear such heavy costs, as the cultivation period coincides with the hungry season when all available cash will be needed to buy food to feed the family. Worse still, the end of the annual rain may occasionally come too early for harvesting to be completed before pools dry up. If this happens, harvesting becomes haphazard, and in some cases, and especially among the semi-nomadic population, crops are left unharvested. Finally, the thought that crops may not only fail in the event of very bad rains, but that in a year of relatively good rainfall, a good grain yield may be left unharvested because of lack of water is enough to discourage potential farmers from taking on crop production.

The provision of water at the existing centres of cultivation, it is expected, will liberate the labour hitherto spent on fetching water. Among rational economic men, the labour thus liberated will be siphoned into cultivation by increasing the size of their farms. This will lead to increased agricultural productivity, assuming that gross or per capita volume of agricultural produce in a similar environment and among people at the same level of technological attainment, is dependent on the size of the area under cultivation. Similarly, those who have been reluctant to cultivate because of the hazards associated with lack of water, would take to farming and increase both the number of cultivators and the area under crop production.

The extent to which the situation conceptualized above would be true to reality depends on the number of water points, the quantity of water at each water point, the size of the population and the per capita daily minimum water needs, as well as inter-water points distances. The quantity of water available at any water point determines the size of the population and hence the proportion of usable land that can really be utilized.

In most deep bore centres, the whole populations are served at one point only. Where water is unlimited, control on the size of population is exercised by the size of usable land. Since usable land has been defined as a function of distance from water point, distance, and hence the time spent on fetching water, or travelling to and from farms daily become crucial to population size. Because most of the inhabitants of water centres are farmers, the control which distance and time exercise on population size is going to be achieved via cultivation, and will be reflected in the manner in which farm size, lengths of continuous cultivation and fallow vary with distance from water points.

Farmers in settled villages spend considerable time travelling daily to and from their farms. To minimise the distance to be travelled, and thus the loss in working hours, cultivators tend to site their farms as near as possible to their settlements, and to continuously cultivate the land near water points for much longer period and rest it for shorter period than the land further away from water points.

Provision of water will not only stimulate increased resource utilization, it will also introduce balance and rationalism into the manner in which the resources are employed. In an environment plagued by large-scale shortage of water the few areas fortunate enough to have perennial sources of water supplies become centres of large concentrations of both human and animal populations. In these centres, the resource-population ratio is small. Consequently, the limited resources are over-employed and suffer from serious deterioration, whereas many areas with high resource potentials are left unused.[24] The provision of water in such waterless areas will serve two purposes. First, it will halt out-migrations. Secondly, it will preserve the already hard-pressed resources from further pressure and may even relieve

24. For more information on this, see: (i) Heady, H.F., 1965, Rangeland Development in East Africa, (Ed.) Brokensha, D., op. cit., p. 77. (ii) El Banna Sayed Magdoub, 1961. op. cit. (iii) Sudan Government, Khartoum, 1944, Soil Conservation Committee's Report, pp. 10-19.

pressure on the resources by inducing some of the migrants to return to their places of origin to take advantage of the newly provided water supplies. Implicit in the situations described above is the possibility by government to use its rural water supplies programmes to re-distribute population.

The prospecting for underground water, the drilling of deep wells and the installation of water-yards are financed by government. It is therefore possible, at least in theory, for government to use its deep bore programmes not only to influence the location of settlements and the distribution of population (by siting wells where it wants poeple to settle), but also to control the size of settlements (by limiting the number of wells, and thus limit the volume of water), and to rationalize resource exploitation (by manipulating the distance between deep bores). If it is assumed for the moment that sub-surface water is every where present in a region, government's objective then becomes the crucial factor in siting wells. If deep bores are sited on the principle of needs, one would expect to find a positive correlation between the number of wells and population size assuming that all the functioning wells have been sited at existing settlements. If, on the other hand government's objective is to achieve a balance utilization of resources, the spaces between deep bores should be fairly equi-distant, on the assumption that resource-wise, all areas are equally endowed. Under a situation as postulated above, one would expect to find a number of settlements that post-date their deep bores.

The provision of water supplies can also be taken as the base on which the infrastructure of rural development and modernization is to be built. Migratory populations are poorly served by educational and medical facilities because they can only take advantage of mobile schools and health centres, which government finds both difficult and expensive to provide. Already, it has been postulated that nomads in a seasonally water-deficient environment may be encouraged to become settled by the provision of water supplies. If, and once they are settled, expensive mobile facilities hitherto serving them will become concentrated at their water-point settlements with two welcome results. First, the services will now be put to greater use. For example, it has been claimed that nomads are reluctant to send their children to school because they are averse to education. This aversion has been blamed on the nomads' socio-economic system which is organized around the family and of which the children form an economically valuable part. Consequently, nomadic people cannot afford to leave their children in schools hundreds of miles away from their temporary abode.[25] Furthermore, pastoral nomads have rejected formal education, for the "schooling of children would interfere with their training in nomadic techniques".[26] With the provision of deep bores, these objections would

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25. El Hadi El Nagar and Baasher, T., 1962, Psycho-Medical Aspects of Nomadism in the Sudan, The Effect of Nomadism on the Economic and Social Development of the People of the Sudan, Proceedings of the Tenth Annual Conference of the Philosophical Society of the Sudan, p.31.

26. Cunnison, I., Asad, T., and Hill, L.G., 1966, op. cit. p.114.

be removed. Once the nomads become settled as postulated above, the training of children in techniques of nomadism, but not in those of animal rearing which offers employment to a large proportion of the working rural population, becomes obsolete, and as most of the settlements with permanent water-base have schools, it is possible for children to attend school and still live with their parents. Secondly, services are now provided more cheaply, and the savings made enables government to increase the number and range of its services to the populations.

Services are meant to benefit populations, therefore, centres of population concentration should be service centres. Already, it has been hypothesized that in an environment where water is lacking populations would crowd around centres fortunate to have permanent sources of water supplies. If this hypothesis is proven government should, as a matter of sound policy, locate services at settlements with perennial water-base to ensure maximum use by populations. The ease with which this objective is achieved depends on the optimum number of men and animals that a water point can serve. This number is itself dependent on two factors; namely, the daily yield of the water point, and the per capita daily minimum water need of the populations. The optimum population size which a borehole is capable of supporting is important for two reasons. First, it provides an indication of the optimum number of water points that would be needed to satisfy the water needs of the population at any point in time. Secondly, it determines whether every water point would possess population of the optimum size to foster economic utilization of services. Since availability of water is a crucial factor in siting services, and since the existing water points had been created at different dates, it is here being postulated that areal differences in the number and range of services could be legitimately explained not only in terms of the number but also in those of the age of water points.

The creation of water points has also become a mechanism through which various forms of interactions are effected. This is because settlements with permanent water-base attract both populations and services, and as such are functional central places. Consequently, water-points become meeting grounds for people of diverse modes of living, culture, and attitude to exchange not only their products, but also ideas and information of various forms. Thus, availability of water, by fostering inter-personal contact, not only encourages the spread of information about, and adoption of innovations, but also leads to cultural and attitudinal modification and change, all of which are essential to rural development.

The intensity of cultural interaction can be defined as a function of the ease and frequency of inter-personal contact through meetings, which can be greatly facilitated by road transportation. This is because all deep bores centres must of necessity be linked to the national ports either directly or indirectly by motorable tracks which are essential for conveying to the well sites the wholly imported equipment for drilling the wells and for their installation and operation. Where such tracks are not in existence, their construction is necessitated by the decision to drill deep bores. From the fore-going situation has been suggested the postulate that in a water-deficient area, the degree of road connectivity is dependent upon the density of water points.

Once constructed, the tracks become the chief means by which the people maintain increased contact with the "outside world". They also become the channel by which the indigenous population gain knowledge of and access to a wide range of "foreign" goods. Overtime, the people may develop a liking for the consumption of those goods. To obtain them, the people may have to sell part of their own agricultural products and livestock. With time also, their propensity to consume foreign goods may rise, and to meet the resulting increased demand for the goods, their level of income must go up. This can be achieved through increased productivity, assuming that the level of prices for their products does not change. In the type of environment under consideration, increased productivity may be achieved in any or combination of three ways, viz: increased crop production, increased exploitation of forestry resources and increased livestock production. Resulting from the above exposition is the hypothesis that the provision of rural water supplies helps to expose the population to exchange and monetary economy in a greater manner than hitherto known, and that this will be made manifest in increased crop and livestock sales, and increased awareness on the part of the population of the economic benefits to be derived from gum tapping.

The pastoralists' reactions to this exposure, however, and its effects on the livestock industry and the grazing resources would be determined by the extent to which the pastoralists' traditional attitude to their animals and to cultivation has changed or been modified. Where aversion to cultivation has disappeared, but the traditional attitude of regarding size of herd as a "status symbol", as among the pastoral Fulani of northern Nigeria, still persists, the animal owners would continue to strive to increase the size of their herd.[27] Participation in crop production offers them immense opportunity for achieving this objective. Under such a situation, the animal population would grow rapidly and out of proportion to the available water and pasture. On the other hand, the animal owning population, such as the Fula of Guinea,[28] may have both their traditional attitude to cultivation and pastoral ideas substantially modified. In addition, their demand for "foreign goods" may outgrow their earnings from cultivation. Should this happen, the trade in livestock among such people might reach such a high proportion as to threaten the continued existence of wealth in livestock form. In this sense, exposure to exchange and monetary economy, desirable for rural development as it may, could produce either of two results, which if care is not taken, could put the future of the livestock industry into jeopardy.

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27. Dupire, M., 1965, "Trade and Markets in the Economy of the Nomadic Fulani of Niger (Bororo), Ed. Bohanan, P. and Dalton, G., Markets in Africa, pp. 353 - 354.

28. Ibid., p. 361.

Set out above is the theoretical framework within which the problem of evaluating the performance of the rural water-supplies' programmes of the Sudan government in bringing about rural development has been considered. In specific chapters, the thesis has set out to examine each of the several postulates that have been put forward, and to note how far they have been true to reality in our environment.

Scope of The Study.

The conceptual framework for the study having been presented, it is necessary to outline the basis for appraising the impact of the deep bore programmes on the social and economic organizations of South-Western Kordofan. Appraisal of the impact of the deep bore programmes on the people and their economy has not been based solely on either (a) the number of new settlements that have been generated by the multiplication of water centres, (b) the number of nomads that have given up nomadism as a way of life for sedentarism, or (c) the amount of surplus grains and/or the volume of groundnut and gum arabic marketed. Nor has the impact of deep bores been measured solely in terms of social welfare if it does not effect substantial structural changes in the organization of economic activities. The appraisal is carried out within the concept of benefits from investment in the project vis-a-vis to the society. In other words, the author's assessment is based not only on the direct benefits but also on the indirect economic and social benefits generated by the new deep bores.

These "intangible benefits" to which monetary value cannot be assigned, are determined by employing such indices as (a) the level of health of the community measured by the number of health centres and general attendance; (b) the level of education measured by the number of all grades of schools, the number of pupils on roll and the proportion of them resident in boarding houses; (c) the standard of living of the population determined by the general level of production and consumption; and (d) the degree of accessibility measured by the density of motorable tracks. In this thesis, government's deep bore programmes in South-Western Kordofan would be regarded as successful if two things happen. First, if there is a significant increase in the per capita income. Secondly, if the rise in income has been achieved through higher per capita productivity made possible by changes in attitude, perception, mode of living and patterns of organization of economic activities.

To satisfactorily appraise the impact of bore holes on the economy and people of the study area, this thesis has attempted to make enquiries about the following:-

1. Settlements:

   What changes have taken/are taking place in the number, size, pattern, population and the geographic location of settlements since the deep bore programmes began?

2. Deep Bores:

   What factors determine (a) the location, (b) the number and capacity, and (c) the distribution of deep bores in space and time?

3. <u>Human Activities and Land Use.</u>

(i) <u>Pastoralism.</u>

What proportion of the population engages in animal rearing? What proportion of the livestock-owning population practises nomadism/semi-nomadism? What are the patterns of and the reasons for the pastoralists' movements? What animals are reared? What proportion of the livestock-owning population depends wholly or largely on their animals for subsistence? What factors determine the size of individuals' livestock? Is there any correlation between livestock size and mode of living?

Have the deep bore programmes modified the watering practices of the pastoralists? What proportion of the pastoral population went/goes to the <u>bahr</u> before and since the beginning of the deep bore programmes? In the dry season, what factors determine(d) the choice of watering and grazing sites by the livestock owners before and since the deep bore programmes began?

In what ways have boreholes modified the traditional attitude of the pastoralists to their animals? How do the livestock owners respond to the economic opportunities created by the large population concentrations at centres with deep bores? Why are the pastoral nomads willing/unwilling (i) to become sedentarised, and (ii) to take to cultivation? Do the pastoral nomads see any significant differences in their living and working conditions and those of the cultivators?

(ii) Cultivation:

What proportion of the population engages in crop production? What crops are grown? Have there been any shifts in emphasis on crop types determined by the area sown to each crop since the deep bore programmes began?

What factors determine(d) farm size in the pre-and post-deep bore eras? Are there any correlations between (a) family size and farm size, and (b) farm size and distance of farm from permanent water points?

(iii) Land Use:

What factors determine the proportion of land devoted to grazing and crop production? How and why do land use types and intensity vary with distance from permanent water points? Are there any differences, and why, in land use patterns and intensity around settlements with permanent water-base and those without?

4. Markets and Marketing facilities.

What factors determine the type, number and location of markets? What arrangements are there for marketing surplus grains, livestock and livestock products and export crops particularly groundnut, and gum? What factors determine the amount of milk , the number of livestock and the quantity of grains offered by the population for sale? Are there any significant differences in livestock and grains sales between settlements with permanent sources of water supplies and those without?

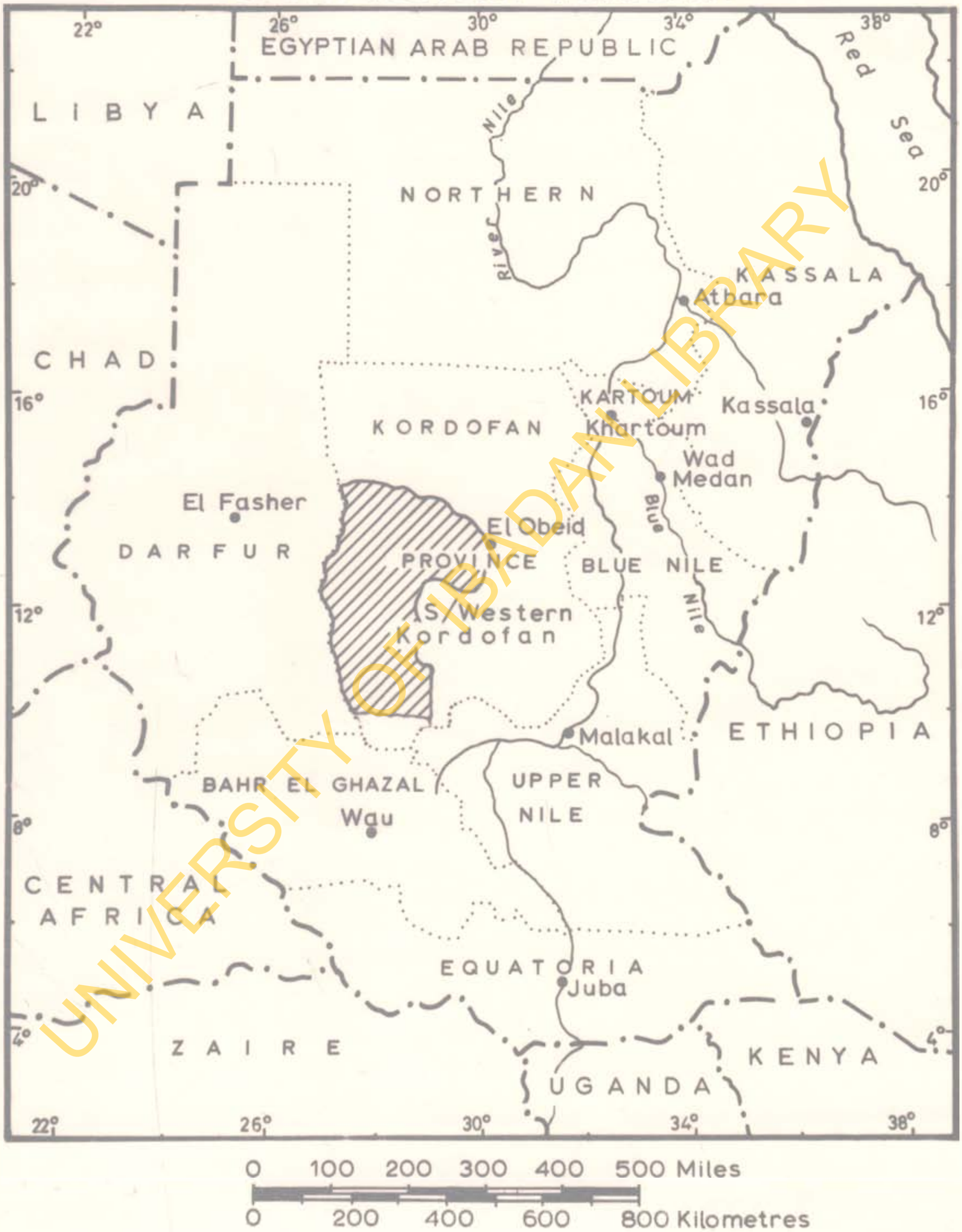
5. **Services:**

What social services and amenities are available to the rural population? What factors determine the number and range of these services in any one settlement? To what extent do the people take advantage of these services?

The Study Area: Reasons for Choice:

The Republic of the Sudan has been chosen because its rural water supply programmes are not only older but also more comprehensive in scope than those of any other African country, except perhaps, South Africa. Within the Sudan the nature of water shortage varies from the arid north (where it is acute and perennial), to the semi-arid Central Sudan (where it is seasonal). The area chosen is thus South-Western Kordofan, which lies in the central western part of Central Sudan (Fig. 1). Here the prospects of the success of the rural water supplies' programmes in fostering rural development are pretty high for the following reasons. First, the nature, amount and duration of its rainfall are such as to make rainfed crop production possible. Secondly, the grazing resources are excellent. Thirdly, the region is endowed with people who have the

Fig. I.
LOCATION MAP OF SOUTH-WESTERN KORDOFAN



capability to exploit its agricultural and grazing resources; for the Humr and Hamar, the two main tribes who inhabit this region, are by tradition pastoralists, and by forced circumstances, cultivators respectively. (See chapter two where the claims made have been elaborated upon).

Methodology.

To evaluate the impact of any investment on an area, comparison of social and economic conditions of the area before and after the investment could be made. This is the approach adopted by Schutjer and Hallberg[29] in the study of the "Impact of Water Recreational Development on Rural Property Values in the United States of America". This approach allows a more thorough assessment of the impact of investment on the development of similar areas and provides a basis for examining what changes, if any, have taken place in the socio-economic life of the area.

This approach requires adequate and precise knowledge of pre-investment conditions. However, it is difficult to reconstruct the situation as it would have been in the absence of the investment. An alternative approach, exemplified by Knetsch[30], has been followed in this

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29. Schutjer, W.A. and Hallberg, M.C., 1968, "Impact of Water Recreational Development on Rural Property Value, "American Journal of Agricultural Economics, Vol. 50, No.3, pp. 572 - 583.

30. Knetsch, J.C., 1964, "The Influence of Reservoir Projects on Land Values," Journal of Farm Economics, Vol. 46, pp. 231 - 243.

study. This method requires one to examine and compare conditions around area "X" where an investment has been made with conditions in area "Y" without any investment, and to assume that any differences between these two areas are attributable to the investment. This approach presumes that areas "X" and "Y" are similar with respect to physical and cultural characteristics.

Investment in the area under study is the provision of water which is achieved by sinking deep wells. Following Knetsch's approach, twelve centres representing four stages of development with regards to water availability have been chosen. The twelve centres are Abu Zabad, El Odaiya, El Muglad, Ghubeish, El Khuwei, Wad Banda, Et Tibbun, Abu Bittikh, El Bashama, Mumu, Marbuta and Iyal Bakhit. Stage one is represented by Abu Zabad and El Odaiya. They are centres that have always had permanent sources of water supplies. El Odaiya has a well-field while Abu Zabad, situated very near the valley of Wadi El Ghalla, has a large pool locally known as <u>turda</u>, in the bottom of which shallow wells are sunk in the dry season. The water from this <u>turda</u> has now been supplemented by water from a borehole. Although these towns are Hamar settlements with respect to administration, they are watering centres for the Baggara and their cattle in the dry season.

Stage two comprises El Muglad and Et Tibbun (Dar Humr), Ghubeish, El Khuwei and Wad Banda (Dar Hamar) - centres that were once water deficient but that have been provided with deep bores for at least fifteen years. El Muglad is the headquarters of the Humr and the 1955/56 census put its population at 3,735.[31] It had its first deep bore in 1923. Et Tibbun is now a railway centre, and the 1964/66 population survey estimated its population at 2,300.[32] Though it is located in the Humr territory, the majority of its inhabitants are from the Ma'alia tribe who are settled cultivators. Its deep bore was sunk in 1952. Ghubeish, El Khuwei and Wad Banda are inhabited mainly by Hamar settled farmers. They had their first boreholes drilled in 1928, 1938 and 1942 respectively.

Abu Bittikh, El Bashama and Mumu are centres that have had permanent sources of water supplies for less than a decade; they represent stage three. The existing deep bores in Abu Bittikh, Mumu and El Bashama were sunk in 1962, 1964 and 1967 respectively. Finally, centres in stage four are those that are still without permanent sources of water supplies; respresenting this stage are Marbuta and Iyal Bakhit.

After this division into four groups, conditions in centres in each group are compared in turn with conditions in the other(s) as

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31. Sudan Government, Khartoum, 1958, First Population Census of Sudan, 1955/56 - Notes on Omodia Map, p. 53.

32. Sudan Government, Khartoum, 1968, Population and Housing Survey 1964/66, Kordofan Province.

follows and with the following objectives in view:

(a) centres in stage one with those in stages two to four to determine what conditions in the latter stages would have been if they had had permanent sources of water supplies;

(b) centres in stages two and three with those in stage four to determine what conditions in the latter centres would be if and when provided with boreholes, or what conditions in the former would have been without deep bores;

(c) centres in stage three with those in stage four, and centres in stage two with those in stage three to determine the rate of occurrence of changes.

In these comparisons which are referred to as "between groups" comparison, human influence is assumed to be either nil or uniform. Therefore, differences in conditions between one group of centres and another are attributed to deep bores. Also, conditions within a centre in a group are compared with conditions in another centre within the same group, but within group differences are assigned to human factors.

Selection of the centres was made by using stratified random sampling. For stage one villages, all centres with permanent natural sources of water supplies were listed serially, and using a table of random numbers, two centres were chosen from the list. Similarly, all the centres with "functioning deep bores" which were at least fifteen years old were listed and five centres chosen. The same process was repeated while selecting three and two settlements to represent stages three and four respectively.

A three-stage investigation was carried out in every centre. First, once the author arrived in a village, and throughout his stay there, he observed very carefully and made notes on certain physical and human features. Such features include the areal size of the settlement, its general layout, market and housing conditions, general appearance of the inhabitants and the condition, quantity and quality of grazing. Secondly, general information about the settlement was obtained from the Nazir (the head of a tribe), or the Omda (the head of an Omodia - an administrative unit comprising a number of sheikhships), or the Sheikh (the head of one or more settlements or a section of a settlement), or any other influential members of the community. In every settlement, information was sought about the sources of water supplies, and the number, range and age of services and facilities available there. Thirdly, information about individuals was obtained by personal interviews.

In each of the twelve settlements sèlected for detailed study, thirty people were interviewed. Persons selected for interview were chosen via their farms by systematic random sampling. Selection at random of a certain number of tax payers and their household was not possible, for all the followers of a Sheikh do not always inhabit the same geographic place, particularly among nomadic communities. Where the register of tax payers were available, its use would show a biased result in favour of the livestock-owning population as it contained the names of only those who owned livestock and paid tax on them. Worse still, there is no comparable register containing the names of all arable farmers, as only those who produce surplus grains or grow export crops and make them available for sales in the local market pay ushur (crop tax) and have their names recorded on any register.

The thirty informants in each settlement were chosen as follows. Very early in the morning, the writer and his guide would go to the market, which in most cases is usually located in the village centre, and travel eastwards until the farthest limit of cultivation was reached. Distance of limit of cultivation from the village centre was initially determined by timing, and later converted to linear distance.[33] On the onward journey, the number of farms would be counted and recorded, while on the homeward journey, between seven and eight farms were selected and their owners interviewed. The sampling fraction thus varied with land use intensity and density of farms. On the completion of interviews in the east, the same process was repeated in the northern, western and southern parts of the village in that order. The use of this approach has rested on the assumption that in the absence of any major physical obstacles, intensity of land use, and hence distribution of cultivators' farms would be fairly uniform around a deep bore.

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33. From constant practice, the author knows he can cover a distance of three miles (4.8 km.) in one hour under normal circumstances.

In the interviews, the author solicited for and obtained the assistance and cooperation of the Nazirs, Omdas and Sheikhs for it was generally realised that if these functionaries were convinced of the value of this study, the battle for the collection of data for this thesis would be half won. Capital was made out of the general and almost universal shortage of water—a matter of great concern to all the people. Emphasis was thus laid on the fact that the sinking and efficient location of future boreholes, and on which planning for other improvements such as building of new schools and dispensaries depends, hinges ultimately on knowledge of the existing living conditions. It is delightful to state that on several occasions, the author and his guide were accompanied by either the Omda or one of his Sheikhs on their trips.

Preparatory Work:

The author spent a total of twelve and a half months - 13th October, 1968 to 26th October, 1969 - in the Republic of the Sudan. During this time he was attached to the Department of Geography of the University of Khartoum. While in the Sudan, he made three trips (1st December, 1968 to 15th February, 1969; 20th March, 1969 to 23rd June, 1969 and 1st July, 1969 to 28th September, 1969) to parts of Kordofan Province. During the first two trips made in company of the Social Investigation Division of the Rural Water Development Corporation, all the nine district councils in Kordofan Province except two - Southern Jebels and Tegale - were visited to obtain general information about the water situation.

The third trip was made by the author alone, though he was always accompanied by a guide. This trip was confined exclusively to the study area.

In all the trips, the author was armed with letters of introduction from Dr. H.I. Hassan, Head of the Geography Department of Khartoum University, to Local Government Officers, who in turn gave him letters of introduction to the Nazirs, Omdas and Sheikhs informing them of the nature of his duty and requesting as much assistance as possible from them in the way of transport, and accommodation, and cooperation of the local poeple.

Dates and Duration of Survey:

The nomads have always presented a serious problem for survey work in view of the fact that they cannot easily be reached. Seasonal migration is inevitable for them, as they depend wholly or largely on livestock for their subsistence. This is especially so in a land subject to the geographic and climatic conditions of the Sudan. The alternating seasons of rain and drought are reflected in movements of nomads with their animals in search of grazing and water. During the Kharif (rainy season), water is plentiful, the determining factor in migration, is the search for grazing. In the seif (dry season), permanent sources of water become the all important consideration. At this time of the year, the Baggara are at Bahr al Arab in the south. The rains start about June (south), or July (north), and once they come, the cattle have to be moved northwards to avoid biting flies and the mud.

On their way to Babanusa, they stop for a while at El Muglad to sow their grains. When the flies reach El Muglad the nomads move to Babanusa, where they stay until they are driven south again by lack of water and/or grazing. This happens about January. Meanwhile, the sedentary farming population migrate seasonally to centres with permanent sources of water in the dry season. They leave about January and in May, that is, when the rains are about to begin, they return to their settlements to cultivate. It was therefore appropriate to squeeze the individual interviews of the population to the cultivation period - June to September - when both the purely farming and the nomadic/ semi-nomadic populations could be met on the farms.

<u>Administration of the Questionnaire</u>.

The questionnaire is in two main parts. Part one deals with information of a general character about the village selected for detailed study. Part two, on the other hand, deals with individual farmers and/or livestock owners. Information under part one was given by the <u>Omda</u> and/or <u>Sheikh</u> or any knowledgeable person. During the interviewing process, others gathered not only to answer the questions but to show hospitality to the visitors. Though their presence could at times be embarrassing, at times, it might be a blessing by preventing the informant about whom the persons present know so much from over or understating his facts.

Difficulties encountered:

Apart from the problems of unsuitable and monotonous diets of 'durra bread', 'asida' (porridge) and 'kisra', and poor accommodation - which are not worth describing and with which the author had successfully put up - three major difficulties were met with. These were transportation, language and "identification".

Transportation posed a very serious problem, especially in Dar Humr. Settlements are few and far between, and the roads, better described as "paths", linking these settlements are all seasonal. And the fact that the personal interviews were conducted during the rains accentuated this problem. At this time, the only fairly regular and reliable means of travelling about is by the twice-weekly, but very slow and crowded Khartoum - Nyala, and Babanusa - Wau train services. On more than two occasions when the writer and his guide missed their train, they were obliged to cover a distance of thirty six kilometres (Fara'a al Habil - Abu Rufai - Et Tibbun) on foot in two days. Transportation conditions between Rigl el Fula (the administrative headquarters of the Messeriya Rural Council) and Babanusa, a distance of only 50 miles, can be used to further illustrate this problem. The only means of travelling from the latter to the former is via Mumu, a distance of 76 miles. But transport is available from Rigl el Fula to Mumu - 26 miles away, only once a week, that is on the market day. In the Hamar territory, transportation conditions are relatively much better. All major settlements are linked by motorable tracks, but travellers still have to ride in open, seatless, crowded and slow but fairly regular trucks, otherwise, they have to ride on donkeys or camels. To enable the author to move about fairly quickly over short distances, he learned how to ride the donkey and the camel.

Language also posed a real problem. This problem had been put in its proper perspective by no less a person than Henin when he wrote, "Although the Baggara used Arabic, their dialect was completely different from that of the interviewers (who are Northern Sudanese Arabs - words in parenthesis are the author's) and it took the latter quite some time to understand them and make themselves understood.[34] The magnitude of this problem to a non-Arabic speaking researcher, who had spent less than two years acquiring a working knowledge of Arabic could thus be appreciated. However, the author was lucky in having as guides, natives who are teachers and able to speak English fairly well.[35]

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34. Henin, R.A.M., 1966, "Fertility Differentials in the Sudan, With Reference to the Nomadic and Settled Population", Ph.D. Thesis, London School of Economics and Political Science, p. 44.

35. While in Dar Humr, between July and August, 1969, the author had as his guide, one Mr. Hassan Dahwy, A Baggari from Abu Bittikh. He was an elementary school teacher at Fanjak, Upper Nile Province but was at home on a three months' vacation. In Dar Hamar, the headmaster of the boys' primary school in the chosen settlement always assigned one of his teachers to accompany the writer on his trip.

The other major problem realted to the "identification" of the researcher. He was always looked upon, at least initially, with suspicion for he was taken for a "southerner". But once his identity was proved, the inhabitants cooperated very readily. In this, the author was very much helped by his professing the same religious faith with them. He lived among them, ate with them, and regularly joined in their five daily prayers. This practice very much endeared him to the hearts of his hosts. He was therefore promptly given whatever he demanded, for he was regarded as a "brother".

CHAPTER TWO

THE STUDY AREA - PHYSICAL AND CULTURAL CHARACTERISTICS

Site and Location.

An area of about 32,675 sq. miles (83,200 km^2) has been selected for study. This area is situated in the South-Western part of Kordofan Province. It lies between latitude 10° and 14° north and longitudes 27° and 29° east. It comprises the whole of Dar Hamar (tribal territory) and the Humr section of Dar Messeriya.

Physical Features.

A satisfactory geographical analysis of the present organization of economic activities in the study area demands a thorough understanding of its physical and cultural attributes for they offer some explanations for the form and direction of resource utilization in the area. In view of this obvious fact, it has been deemed necessary to present here a description of the area's physical characteristics, and later in this chapter, its cultural features, in a somewhat detailed manner.

Admittedly, however, several works have been published on the geology and physical geography of the Sudan. Andrew[1] has written a summary of the geology of the whole Sudan. Kleinsorge and Kreysing[2]

1. Andrw, G., 1948, Geology of the Sudan in (Ed.) Tothill, J.D. Agriculture in the Sudan, pp. 84 - 128.

2. Kleinsorge, H. and Kreysing, K., 1959, Geology and Hydrogeologic Research in the Arid and Semi-Arid Zones of the Western Sudan Part II.

have published a report of their researches into the geology and hydrology of Western Sudan. On their part, Rodis, Hassan and Wahadan[3] have produced a more comprehensive account of the ground water geology of Kordofan Province. Finally, the climate, soil and vegetation types of the Sudan have been described at varying depths in various works by Harrison[4], Jackson[5], Barbour[6], Lebon[7] and Cunnison[8]. In writing this description therefore, the author has relied heavily on materials from these works.

Geology.

The study area is underlain by rocks of the crystalline basement complex formed during the precambrian time. These rocks are virtually impermeable and therefore, are poor in underground water supplies,

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3. Rodis, H.G., Hassan, A. and Wahadan, L., 1964, Ground Water Geology of Kordofan Province, Geological Survey Department Bulletin, No. 14

4. Harrison, M.N., 1955, op. cit.

5. Jackson, J.K. and Harrison, M.N., 1956, Ecological Classification of the Vegetation of the Sudan. Forestry Department. Khartoum, First Bulletin, New Series, No.2.

6. Barbour, K.M., 1961, The Republic of the Sudan, Chapters III - V.

7. Lebon, J.H.G., 1965, Land Use in Sudan, The World Land Use Survey Monograph, No.4, Chapter II.

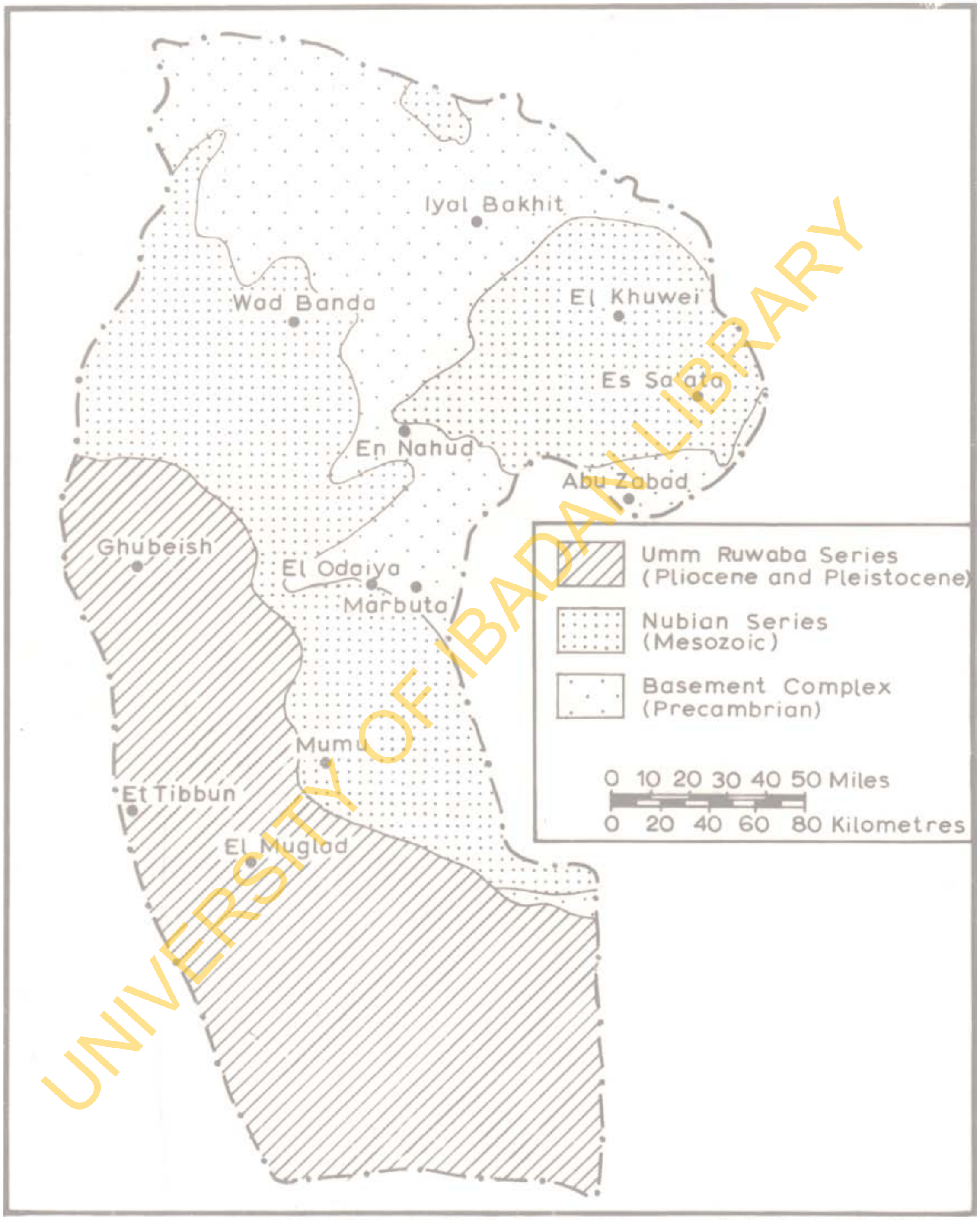
8. Cunnison, I., 1966. Baggara Arabs - Power and the Lineage in a Sudanese Nomad Tribe, Chapter 2.

except in places where "water occurs locally in the weathered and creviced zones".[9] However, the area had experienced cycles of erosion on at least three occasions during which three major types of rock-forming sediments were laid over the basement complex. These were the Nawa, the Nubian and the Umm Ruwaba series, (Fig.II). The strata of these series are flat-lying and are composed mostly of mudstone, sandstone and conglomerates which are highly permeable.

Of these three rock types, only two, the Nubian and the Umm Ruwaba series are of any significant importance as far as underground water supplies are concerned. The Nawa series, laid down during the late Paleozoic time when parts of Kordofan Province were invaded by shallow seas, had been removed almost completely by erosion. This happened when the area was uplifted at the close of the Paleozoic geological era. When in the Mesozoic period, much of the area was covered by shallow continental seas, the sediments of the Nubian series were laid over the Basement Complex. Also, towards the close of this period, the sea receded, the sediments were uplifted again and the area was subjected to prolonged sub-aerial erosion which removed most of the Nubian deposits except those occupying deep basins. Finally, during the late Tertiary time, tectonic movements resulted in the formation of structural basins in the Nubian and basement complex rocks. Throughout the Pliocene and early Pleistocene age, these basins were filled with fluvial and lacustrine

9. Rodis, H.G., Hassan, A., and Wahadan, L., 1964, op. cit., p.26

Fig. II.
GEOLOGICAL MAP



Adapted from Rodis H. G., Hassan A. and Wahadan L., 1964. Ground Water Geology of Kordofan Province, Geological Survey Department, Khartoum. Bulletin no 14, fig. 4 deposits that now comprise the Umm Ruwaba series. Since then, the Umm Ruwaba series have been overlain by a virtually continuous mantle of aeolian deposits of sand in the north and lacustrine deposits of black clay in the south.[10]

In the Southern part of the study region, extensive areas of Umm Ruwaba series overlying the Nubian series are found. Since both sedimentary rocks are permeable, they possess high prospects for underground water supplies if either of two conditions or both obtain. First, if there is adequate precipitation which is the ultimate source of all sub-surface water supplies. Secondly, if the alignment of the water table is such as to allow underground inflow from adjoining wetter regions. These two conditions are satisfied in the southern part of our region. As will be seen later, there is adequate precipitation in this zone, which also receives underground inflow from adjoining Darfur Province to the West.[11] On the other hand, the northern part of this area is not as fortunate as the south. Areas underlain by the Nubian or Umm Ruwaba series or both are restricted. The north receives lower precipitation and does not benefit much from lateral inflow of underground water from outside the region. Consequently, prospects of underground water supplies in the north are limited. In the Nubian and Umm Ruwaba series, water is obtained from the more permeable

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10. Ibid., pp. 18 - 22.
11. Ibid., p. 46.

sandstone and conglomerate beds where these lie within the zone of sturation. The depth to the zone of saturation in the Umm Ruwaba and Nubian aquifers, which are generally confined, ranges from about 151 feet (46 metres) and 197 feet (60 metres) to more than 502 feet (153 metres) and 525 feet (160 metres) respectively.[12] Exploitation of water at such great depths requires more than the level of traditional technology, skill and organization needed for sinking shallow wells. To make the deep-seated underground water available for human and animal use, deep borings are needed. These call for not only adequate knowledge of the underground water geology, but also investment of relatively large capital both of which the natives lack. In fact, at the present level of development, not only in the study area, but also in the Sudan as a whole, only the government seems capable of providing the financial resources, the technological skill and organization for rendering the underground water in South-Western Kordofan usable to man. Consequently, the exploration for sub-surface water supplies and the drilling of deep bores to tap them, had had to await government initiative. This it had started to provide officially and in an organized manner since 1947.

Relief and Drainage:

The land surface of South-Western Kordofan, as elsewhere in Kordofan Province, except the Nuba region, is largely a plain of low relief, broken

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12. *Ibid.*, pp. 32 and 35.

occasionally by a lone protruding *jebel* (isolated hill), or by small clusters of *jubal* (hills). The altitude of the surface over most of the area ranges between 1,100 feet (335 metres) and 2,000 feet (610 metres) above mean sea level. Perennial steams are completely absent. All the *wadis* (water courses) in the area are ephemeral and carry run-off during the short rainy season only.[13]

Climate.

South-Western Kordofan enjoys moderate summer rainfall and marked winter drought. Rains usually begin in May, but do not set in in earnest until July, while by the end of September, they are almost done.[14] The study area falls within El Tom's annual rainfall duration belts of four months (June to September) and three months (July to September) in the South and north respectively.[15] Rainfall is mostly convectional and comes in storms, often violent, of short duration. In the study area mean annual rainfall ranges from about 8 inches (200 mm.) in the north to about 36 inches (900 mm.) in the south,[16] (Fig. III). The mean variation is high, according to J. Oliver, the co-efficient of variation of annual rainfall at El Obeid (which is representative of South-Western Kordofan), over the period 1921 - 50 is 28 per cent.[17] The mean

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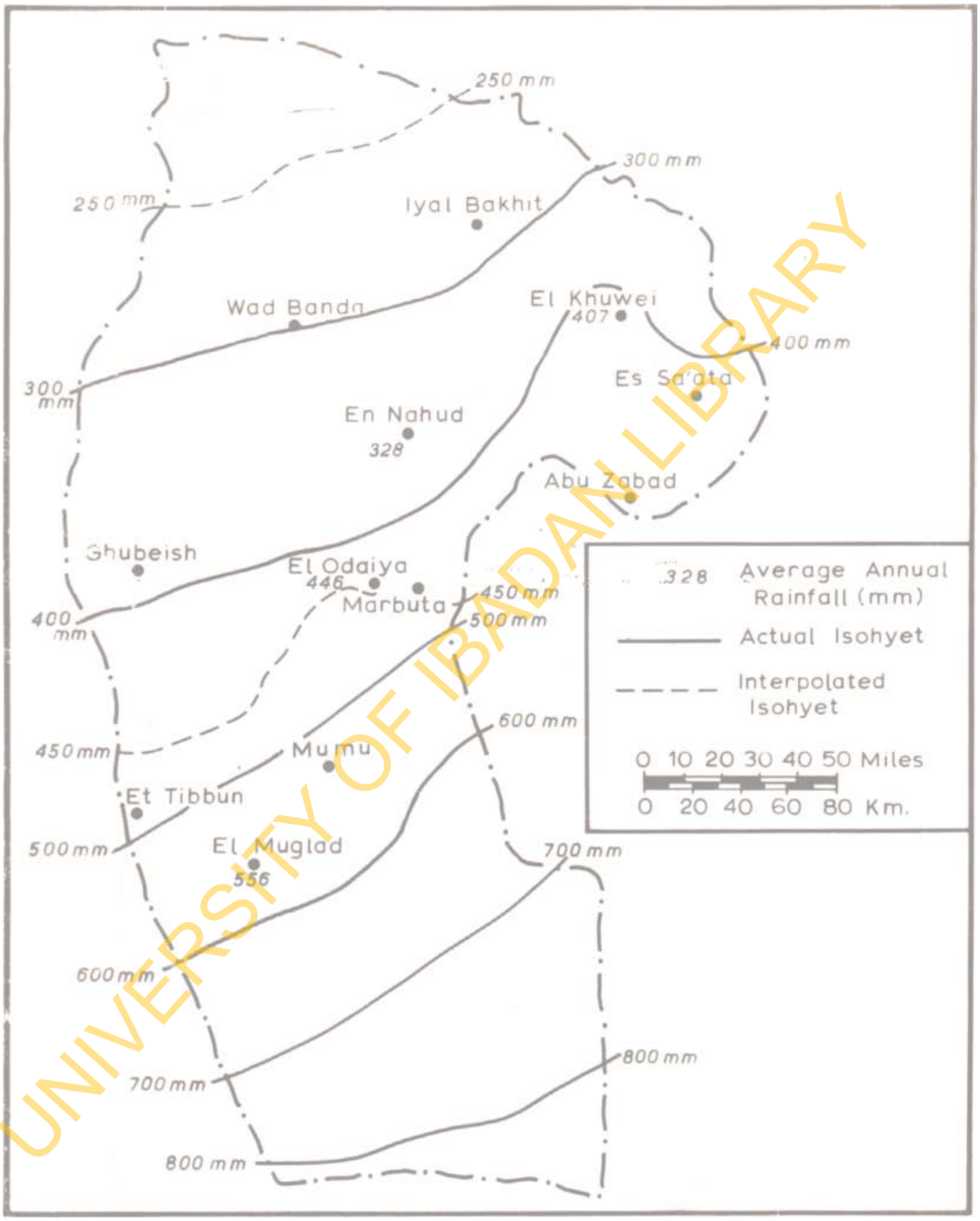
13. *Ibid.*, p. 11
14. Barbour, K.M., 1950, Dar Hamar, *Pamphlets Sudan*, No. 13, p.2.
15. El. Tom, M.A., 1966, *Some Aspects of the Annual and Monthly Rainfall over the Sudan*, Unpublished M.A. Thesis, University of Durham, p.68.
16. Rodis, H.G., Hassan, A. and Whadan, L., 1964, *op. cit.*, pp. 14 - 15.
17. Oliver, J., 1969, Problems of Determining Evapotranspiration in the Semi-Arid Tropics, Illustrated with Reference to the Sudan, *The Journal of Tropical Geography*, Vol. 28, p. 71.

Fig. III.
RAINFALL



Adapted from the average Annual Rainfall map of the Sudan 1931 1960 drawn and Printed by Sudan Survey Department, Khartoum, New Edition 1965 Topo. No. S. 911 annual temperature is 80°F (27°C) with temperature extremes of 50°F (10°C) and 115°F (46°C). The mean monthly relative humidity also shows wide seasonal variations; it ranges from as low as 21 per cent in the dry season to as high as an average of 75 per cent in the rains.[18]

Soil.

The soil cover of South-Western Kordofan derives directly or indirectly from superficial deposits - stabilized aeolian sands in the north and centre, and lacustrine deposits in the extreme south and locally in troughs - all of which have no direct relationship with the underlying parent rock, (Fig. IV). Resulting from this situation there are two main soil types. The whole of Dar Hamar and the northern three-quarters of Dar Humr are mantled by goz (sandy soils), mostly fixed sand dunes except in local depressions which are veneered by silt or clay. Qardud (non-cracking clay) and silts), and a complex pattern of goz and qardud known as the Baggara Repeating Pattern, cover most of the southern part.[19]

Vegetation.

South-Western Kordofan lies almost entirely within Harrison's vegetation Belt of Low Woodland Savanna on Stabilized Dunes.[20] Exceptions are the extreme northern portion of Hamar District which lies in the southern limit of the Semi-Desert zone and the extreme southern Humr territory, which has the Baggara Repeating Pattern type of vegetation,[21]

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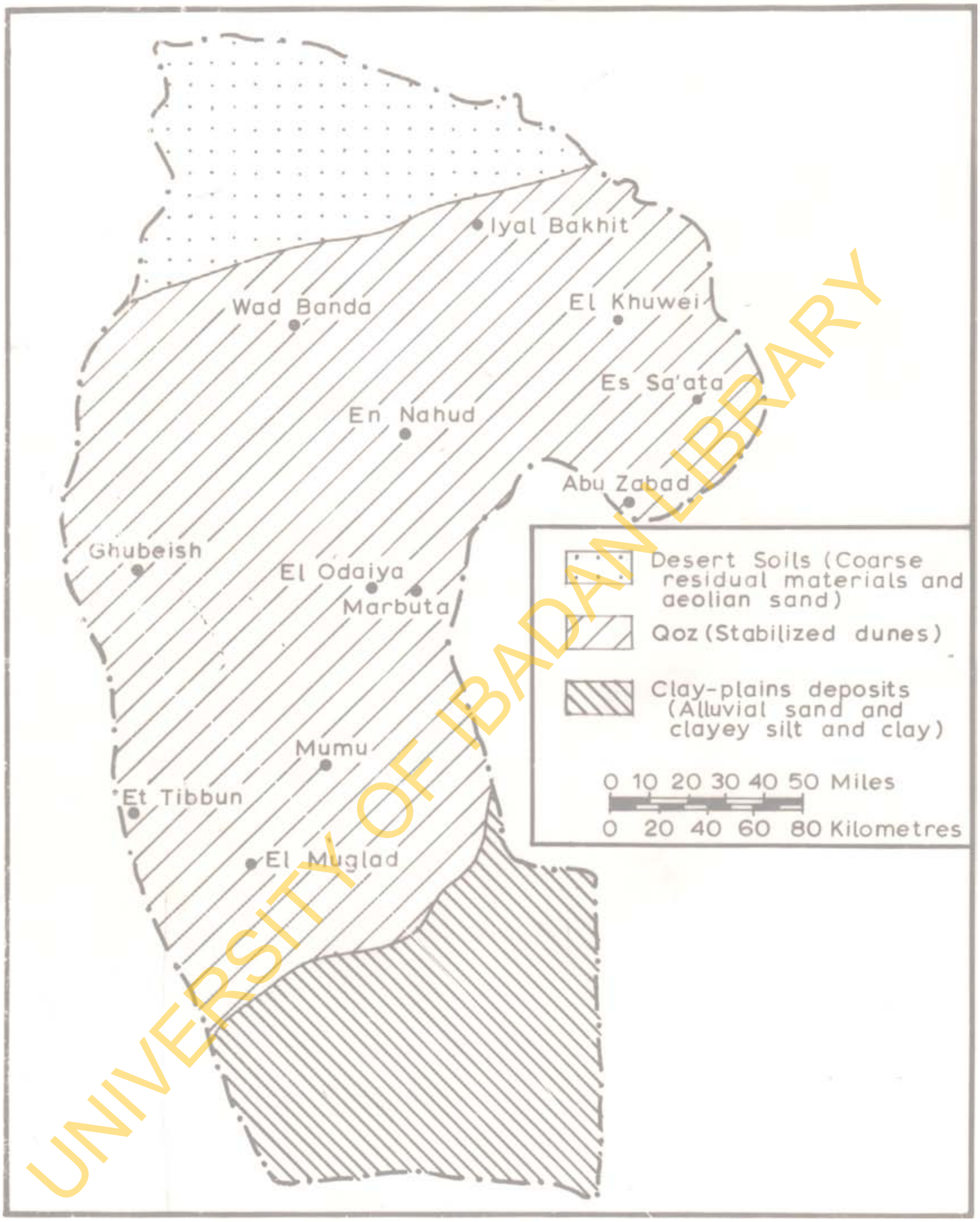
18. Rodis, H.G., Hassan, A. and Wahadan, L. 1964, op. cit., p. 14.
19. (i) Ibid., p. 12. (ii) Lebon, J.H.G., 1965, op. cit. p. 33.
20. Ibid., pp. 31 - 32.
21. Ibid., pp. 32 - 34.

Fig. IV.

DISTRIBUTION OF SUPERFICIAL DEPOSITS



Adapted from Rodis H. G., Hassan A and Wahadan. L, 1964, Ground Water Geology of Kordofan Province. Geological Survey Department, Khartoum, Bulletin no 14. fig. 2.a

(Fig. V). In the Semi-Desert zone, Short Grassland alternates with Acacia Thorn Scrub with Short Grass. The Short Grassland zone, which was originally mantled by a mixture of the grasses of the Aristida genus especially bayad (A plumosa), and shrubs including bagheil (Blepharis spp.) and guru (Monsonia senegalensis), may be without trees or shrubs or may contain but limited individuals. Where grazing has been more intense, pure stands of the sedge (Cyperus conglomeratus), unpalatable to grazing animals have become more widely spread. Elsewhere, the coarse, tufted heavy perennial grass (Schmidtia pappophiroides), the annual haskanit (Cenchrus biflorus), the tufted annual banu (Eragrostis tremula) with some Aristida species provide grazing of less value. Kitr (Acacia mellifera) is the most common shrub of the Thorn Scrub. In some places, it is accompanied by Acacia radiana and Maerua crassifolia. All three are browsed by camels and sheep.

According to the totals of mean annual rainfall, three main vegetation belts have been recognized in the Low Rainfall Woodland Savanna on stabilized Dunes.[22] In the first belt, rainfall ranges from about 11 inches (280 mm.) to 18 inches (450 mm), the 18 inches isohyet coinciding with the southern limit of Dar Hamar. This is the region par excellence of hashab (Acacia senegal), the producer of gum arabic. Acacia senegal, which may occur in almost pure stands over wide areas where cultivation has been allowed to revert to bush, offers immense opportunities for

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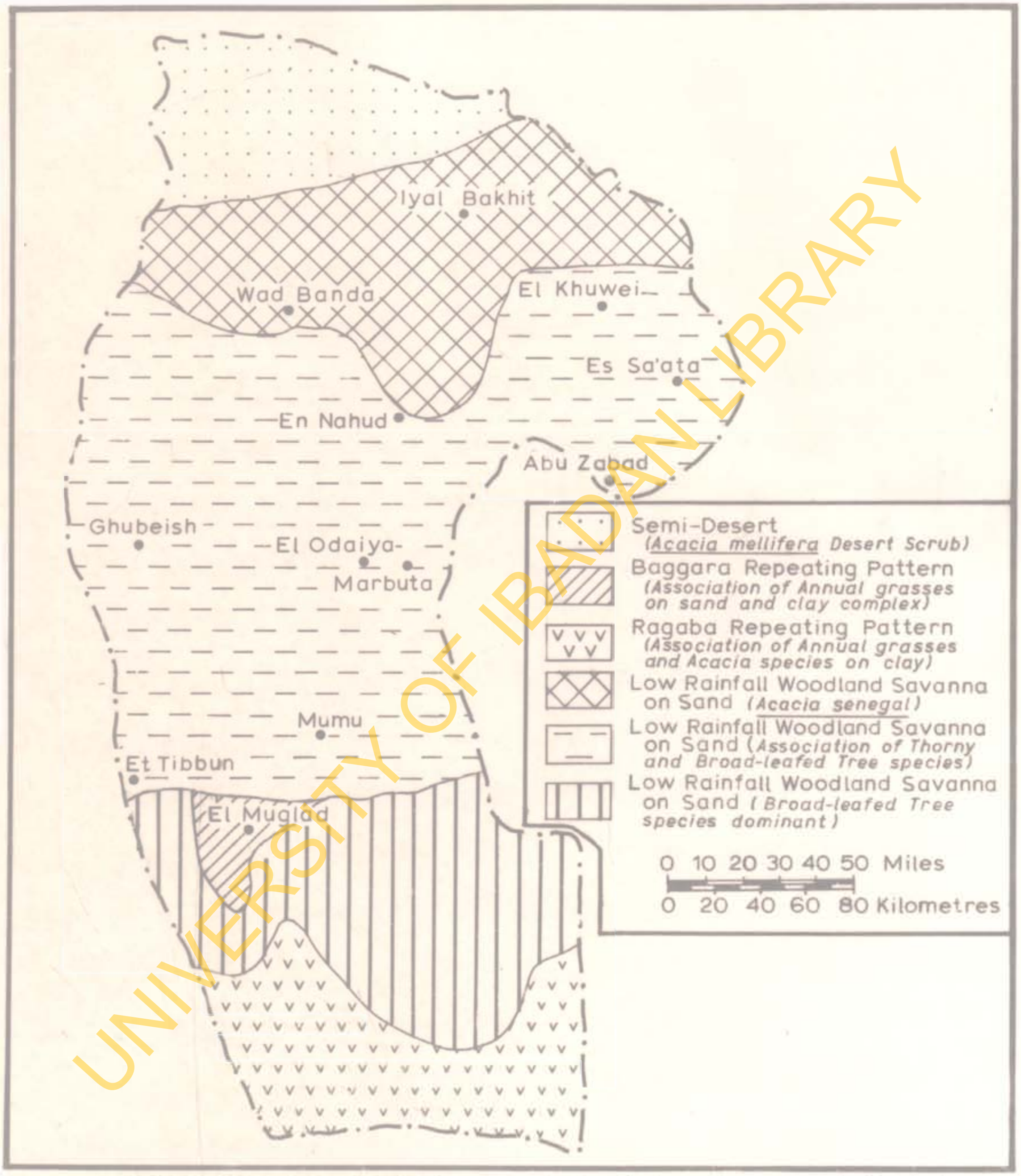
22. Barbour, K.M., 1961, op. cit., pp. 67 - 69.

Fig. V.
VEGETATION



Adapted from the Vegetation map of the Sudan Drawn and Printed by Sudan Survey Department, Khartoum, Topo, No. S. 923·55 the inhabitants to earn cash during the dry season when they would have been idle. The tebeldi (baobab tree or Adansonia digitata) grows in the depressions where some clay is mingled with sand and forms rather spaced-out groves. The tebeldi is a tree of great girth and often tapering trunk, with smooth, shining greyish-purplish bark. It may grow to a height of between 60 feet (18.6 metres) and 80 feet (24.4 metres). The interior of the trunk after being hollowed out, is used as a water reservoir. The dominant annual grasses are "Aristida pallida" which often forms pure stands over great areas, banu (Eragrostis tremula), sometimes found in hollows surrounded by "Aristida pallida". Haskanit (Cenchrus biflorus) is often abundant in cultivated areas.

The second belt lies within the 18 inches (450 mm.) and 24 inches (600 mm.) rainfall region. Here, acacias and the thorny species begin to give way to broad leafed trees except on special run-off sites. Generally, umm dajog (Combretum cordofanum) and rubeigh (Guieria senegalensis) are found on the softer sandy sites, while babanus (Dalbergia melanoxylon), and 'Albizzia seriocephala' occur on harder sites. Grasses are similar to those in the first belt.

In the third belt where rainfall exceeds 24 inches (600 mm.) per annum, the transition from acacia to woodland is complete. This is where the best developed type of Low Rainfall Savanna Woodland is to be found, and resembles closely the High Rainfall type of the south-west. This belt is often distinguished by the different soil type, the slightly poorer variety of trees, and the admixture of annual grasses with the perennials. In addition to the dominant trees, "Tamarindus indica" may be found, and "Acacia senegal" in the drier parts. The commonest grasses are "Hyparrhenia confinis", abu rakhis (Andropogon gayanus) and patches of "Pennisetum pedicellatum."

The "Baggara Repeating Pattern" consists of frequently alternating patches of two contrasting types of soil; namely, flats of non-cracking clay, and slightly higher areas of stabilized sand dunes. The smooth hard surfaced non-cracking clay, almost impenetrable to water, generally has a scanty grass cover while some areas are completely bare of vegetation and other areas have poorly developed trees and bushes. On the transition zone between the naga'a (depressions) and atamur (ridges), kitr (Acacia mellifera), talh (Acacia seyal), "Acacia hebecladoides", and "Lannea humilis" appear. These are accompanied by the perennial grasses "Sporobulis marginatus", "Brachiaia", and some "Chloria specias" and "Digitaria gayanus." These periphery grasses are known to be salty. They are much esteemed by cattle-owning nomads whose animals thrive well when this type of grazing is plentiful. Atamur bring forth the same annual grasses as the Gum Arabic Scrub and Low Woodland Savanna to the north, probably as a consequence of soil porosity and grazing. The trees found here include all those characteristic of the three sub-divisions of the stabilized Dunes and Woodland Savanna.

However, within the Humr territory alone, four sub-regions have been distinguished. These are known locally as the Babanusa, the Muglad, the Goz and the Bahr.[23] And the Humr move in a regular seasonal cycle through the four distinct regions.

The Babanusa which takes its name from the prevalence of babanus (Dalbergia melanoxylon), a kind of ebony is a relatively small sandy area in the north and east of the Humr homeland. Rainfall, which varies from 18 inches (450 mm.) to 24 inches (600 mm.) is highly seasonal and collects in clay-bottomed pools. Although rainfall may start in April, it is not until July or perhaps even August that adequate water can be guaranteed. The Babanusa can be used only in the rains as it lacks "natural sources" of water and verdure in the dry season. Grazing is generally good, but the grasses lack important salts. It is suitable for the cultivation of groundnut and dukhn (bulrush millet). The Babanusa fits in perfectly well into the first belt of the Low Rainfall Woodland Savana of Harrison.

The Muglad, a region of about 300 sq. miles (750 km^2), is a well-watered plain with red gardud (non-cracking clay) which is gluey and slippery when wet and from which it takes its name. It has a plentiful water supply which could probably support the men and their cattle for much of the year. The grazing is excellent, for it is said to be salty,

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23. Cunnison, I., 1966, op. cit., pp. 14 - 19.

though somewhat scanty, being usually finished by December. It has cultivable soil. In the rains, it has troublesome insects which do not spread north to Babanusa. The consequences of the conditions described above are that, although most Humr have their farms in the Muglad region, cattle sojourn there for two short periods only, in June and October - the beginning and end of rains respectively.

The Qoz is a large area with some good grazing. It is situated between the Muglad and Wadi el Ghalla in the north and the river system in the south. It is the transition zone between the rains area and the dry-season areas. It is insect-ridden in the rains and it lacks the plentiful water of the Muglad to the north and the Bahr to the south, and the insect-free conditions of the Babanusa.

The Bahr which in Arabic means river is the name which the Humr give to the whole of the "dry season watering country". The Bahr provides ample water supplies throughout the dry season. As the water courses dry out, water collects in pools in the deeper parts of them. Meadowland is also flooded at first. As all surface water disappears, wells are dug in the water-course beds. The Bahr also supplies good grazing, the succulent birdi grass (Echinochloa spp.) fills the water courses, and after being grazed away, it shoots up again and can be grazed a second time. The meadowland provides excellent grazing as well. Towards the end of the dry season, the position becomes difficult and cattle have to survive on "standing hay". But rain falls early in April in the Bahr, the area is at once infested with numerous insects, and the land has clay underfoot, which makes going difficult after the rains have started.

From the account of the physical environment of Dar Humr given above, it is obvious that the four regions within this territory have great but varying resource potentials. The utilization of these resources are, however, limited by factors that vary both areally and seasonally. This fact has tended to make the resources of the four regions complementary. Consequently, for the population, especially the cattle-owners, to benefit from the resources of all the regions, they have to be migratory. Thus, it is clearly seen that the practice of nomadism by the Baggara Arabs of Dar Humr is a traditional way of adjusting to the seasonal and areal vagaries of their environment.

The People.

South-Western Kordofan is inhabited by the Hamar and the Humr, two distinct tribes with different modes of life. The Hamar are a group of settled Arabs who live in the northern part of the area of study. They number just under 270,000 persons according to the 1955/56 census.[24] They were until the beginning of the last quarter of the nineteenth century prosperous camel-owning nomads. During the Mahdiya, their numbers were much diminished by fighting, capture and famine and they lost all their animals to the Kababish and other enemies. They were therefore obliged to turn to cultivation and gum collecting to support themselves.[25] Today,

24. Sudan Government, Khartoum, 1958, First Population Census of Sudan, 1955/56 - Notes on Omodia Map., p. 52.

25. Macmichael, H., 1912, The Tribes of Kordofan Province.

the Hamar are successful farmers. However, they still accord pride of place to wealth in livestock. It is therefore the wish of every Hamar to own animals, and determined efforts are made to achieve this objective. Already, many Hamar have successfully rebuilt their stock; and in addition to several thousand Hamar who now combine crop farming with animal husbandry, over 13,000 Hamar are entirely dependent upon animal rearing.[26]

The over 63,000 strong[27] Humr tribe belong to the so-called Baggara (cattle) nomadic tribes, numerically, the most important nomadic tribe in Kordofan Province. The Baggara are part of the Messeriya who were reported to have crossed to the Sudan from the north in the 12th century, were initially camel-owning nomads. But by the 18th century, they had become cattle nomads. This was the result of a fierce and protracted war with neighbouring Khuzam tribe which began about the 15th century and during which they disintegrated and lost their camels. They were subsequently forced to move further south, to an environment which is too wet for camels, but provides suitable conditions for cattle breeding.[28] In response to their environment, the people turned to cattle rearing.

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26. Of the twenty-six omodias in Dar Hamar, four with a population of 13, 264, belong exclusively to nomadic animal-owning populations. See Sudan Government, Khartoum, 1958, op. cit., p. 52.

27. The Humr, which is a section of the Messeriya tribe, comprises two main groups. These are the Humr Agaira and the Humr Falaita, numbering 37, 341 and 26, 154 persons respectively. See Ibid., pp. 52 - 53.

28. Henderson, K.D.D., 1939, A Note on the Migration of the Messeriya into the South-Western Kordofan, Sudan Notes and Records, Vol. 22 pp. 48 - 77.

Prospects for Utilization of the Region's Resources:

It is evident from the fore-going descriptions that South-Western Kordofan possesses great possibilities for the development of agriculture and livestock. Rain-fed cultivations are possible. Rainfall and soil conditions are suitable for grains and groundnut production. In fact, "The sandy regions of Kordofan and Darfur Provinces lying within the 18 inches (450 mm.) to 24 inches (600 mm.) rainfall belt," according to Low, "constitute the principal rainland groundnut area of the Sudan."[29] The annual and perennial grasses together with the herbs and shrubs of the region form excellent pastures and browses for livestock, and the numerous stands of Acacia senegal and Acacia seyal offer good job opportunities for the people.

Yet, these resources are far from being fully exploited; at best, their utilization is seasonal, because certain human and physical factors limit their utilization. The human factors include personal preferences for particular modes of life, existing levels of technology and economic and social expectation. The determination of the degree of limitations they place on utilization of resources is rather subjective and cannot be fully appreciated until they have been isolated from the physical factors.

The latter are bound up with the environment and are, in the study area, seasonal shortage of water and/or grazing, prevalence of biting flies and water-logging conditions. But the single most important limiting

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29. Low, E.W., 1967, The Marketing of Groundnut in the Sudan, Development Studies, No. 12, University of Reading, Department of Agricultural Economics, pp. 8 and 11.

factor to optimum utilization of resources of land and grazing is shortage of water. Grazing has been found to be adequate at least in quantity, cattle can, if immunised thrive in fly-infested environment, and they can tolerate clays, though they may develop hoof trouble. Now that this "weak link" of resource development and utilization in South-Western Kordofan is being eliminated by sinking deep bores, it would be interesting to examine in the context of Bowden's principles of "possibility", "acceptability", "profitability" and "permissibility", what changes have been taking place.

About 60 per cent of the area of Dar Hamar and more than 80 per cent of that of Dar Humr are underlain by the sub-surface water - rich Nubian and Umm Ruwaba series. Except in very few cases, water obtained from wells tapping the aquifers of these rocks has been proved to be chemically suitable for human and animal consumption. Chemical analysis of water from Nubian aquifers show the total dissolved-solids content to be low, ranging from 100 parts per million (ppm) to 340 ppm. On the other hand, the total dissolved-solids content of water from Umm Ruwaba aquifers is of the medium order, ranging from 420 ppm to more than 3,000 ppm.[30] Newport and Hadder have classified water into 'good quality' if it has less than 1,500 ppm. dissolved-solids content, 'fair quality' if its dissolved-solids content lies between 1,500 and 3,000 ppm. and 'poor quality' if it has more than 3,000 ppm dissolved-solids

30. Rodis, H.G., Hassan, A. and Wahadan, L., 1964, op. cit., pp.52-55.

content.[31] On the basis of this classification, water from Nubian and Umm Ruwaba aquifers of South-Western Kordofan is of good quality and good to fair quality respectively. The sinking of deep bores is thus a physical possibility, and the numerous boreholes that have been successfully sunk, and that are now in use clearly attest to this. In fact, more than 90 per cent of the existing and proposed water-yards in Kordofan Province are sited in Dar Hamar and Dar Humr.

Socially, the use of underground water is acceptable to the people; at least, there is no known traditional taboo against the use of sub-surface water for consumption by man and animal. However, since watering livestock from water-yard is done at a cost, and since the number of animals that can be watered at a water-yard is limited by the daily yield of the well, it would be a worthwhile exercise to examine what the attitudes of the livestock owners are on this topic. Any resource use which produces a livelihood or a profit for the population is economically gainful, and boreholes are used here to aid the production of livelihood. Determination of the impact of the utilization of sub-surface water on the livelihood of this area will be carried out at two levels. First, an assessment of returns to the public via the volume of taxes paid to the government (who provides the capital for the sinking of boreholes

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31. Newport, T.G., and Hadder, Y., 1963, Ground Water Exploration in Al Marj Area, Cyrenaica, United Kingdom of Libya. U.S. Geological Survey, Water Supply Paper 1757 - A., Vide Rodis, H.G., Hassan, A. and Wahadan, L., 1964. op. cit., p. 52.

and the construction of water yards), will be made. Secondly, returns to the individuals will be assessed by carefully analysing their sources and levels of income.

Legally, the sinking of deep bores is permissible. The Sudan Government like the government of any other independent country, has an absolute right to exploit its minerals including underground water. Therefore, in sinking boreholes, she does not have to consult, nor obtain the consent of any foreign government, as she must needs do if and when she wants to make use of the waters of the Nile, an international river; for her rights to utilize the Nile waters for irrigation has been sharply restricted by the Nile Waters Agreement of 1929, and to a lesser extent by that of 1959.[32]

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32. The 1929 Nile Waters Agreement allocated 48 and 4 milliard cubic metres of water to Egypt and Sudan respectively. The 1959 Agreement raised Sudan's share to 18.5 milliard cubic metres and that of Egypt to 55.5 milliard cubic metres, an increase of 14.5 and 7.5 milliard cubic metres respectively. For more information on this, see - (i) Barbour, K.M., 1957. A New Approach to the Nile Waters Problem. International Affairs, Vol. 33, pp. 319 - 330. (ii) Mageed, Y.A. 1965. Nile Control for Agricultural Development in the Sudan, in Ed. Shaw, D.J., Agricultural Development in the Sudan. Proceedings of the Thirteenth Annual Conference of the PSS, Vol. 2, pp. 319 - 320.

CHAPTER THREE

DISTRIBUTION OF DEEP BORES IN SOUTH-WESTERN KORDOFAN

History of Government's Rural Waters Supplies' Programmes.

Introduction:

The problem of providing rural water supplies in the Sudan has been such an important one that it has scarcely escaped comments from people, with whatever discipline, who have worked in, or visited the water deficient area of the country since the nineteenth century. In the report of his travels in Kordofan Province published in 1884, Pallme, I. had called attention to the serious water situation in that province.[1] As far back as 1906, a governor of Kassala Province had in his annual report called for the opening up of many more wells in his provincce as "the whole development of the country depends on water supplies".[2] W. Lloyd, while describing the water situation in the Central Kordofan in 1910 had noted that the Arabs devoted their major activity to a continual quest for dependable supplies of water, and that water was the most absorbing topic of conversation.[3] A similar remark was made by W.J. Berry in 1928.[4]

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1. Pallme, I., 1884, Travels in Kordofan Province.
2. Sudan Government, Khartoum, 1906, Annual Reports on Kassala Province.
3. Lloyd, W., 1910, Notes on Kordofan Province, Geographical Journal Vol. 35, pp. 249 - 267.
4. Berry, W.J., 1928, The Arabs of Kordofan - A Study of Adaptation, Scottish Geographical Magazine, Vol. 44, pp. 278 - 292.

Pre-Rural Water Supplies Programmes Government Water Points:

These comments had served to invite the attention of government to, and to stimulate its interest in this very important problem of water supplies. This claim is borne out by the fact that there had existed a few council-owned shallow walls and boreholes drilled by the central government before the programmes for rural water supplies officially began. As early as 1919, the government had set up a drilling unit in the Geological Surveys Department.[5] The drilling unit had responsibility for sinking deep bores and constructing dawanky[6] (rural water yards) to supply water to towns and several government departments. Between 1919 and 1945, sixteen water yards were completed, thirty-one other boreholes successfully drilled and seventy-two unsuccessful ones abandoned. In 1953, the drilling unit was transferred from the Geological Surveys Department to the Ministry of Works.

The Soil Conservation Committee:

It was the Soil Conservation Committee's Report of 1944[7], however, that originally triggered off direct government participation in providing water to the rural population. The initial inspiration for the setting

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5. F.A.O., Rome, 1959, Organization of the Drilling Division, Report to the Government of the Sudan, No. 1075, pp. 1 - 8.

6. "Dawanky" is the plural form of "donkey", the Sudanese name for a yard in which are located the tank into which water from borehole(s) is pumped, public water taps, animal drinking troughs and the kiosk of the clerk to the water yard.

7. Sudan Government, Khartoum, 1944, Soil Conservation Committee's Report.

up of the Soil Conservation Committee came from B. Kennedy - Cooke,[8] a keen botanist. In 1939 when he was Governor of Kassala Province, he wrote a letter to the government in which he expressed worries about the damage which over-grazing by goats and camels could do to the Flora and scanty soil of the Red Sea Hills and suggested that propaganda (on the need for conservation in the Sudan) should be supplemented by remedial measures based upon taxation and the replacement of the goat as a milk supply by the sheep. The government communicated Kennedy - Cooke's ideas to the other Provincial Governors and the Directors of Agriculture and Forests, Veterinary and Medical Services and asked for their comments.

Following the generally favourable comments which these officers made, the government decided to set up in 1942 a Soil Conservation Committee. The Committee which consisted of four technical and two political civil servants was to study and report on the deteriorating conditions of the soils of some areas of the Sudan, and to recommend measures, including estimates of their capital and maintenance costs, for arresting the situation.[9]

The members of the Soil Conservation Committee undertook, as a body, in groups and individually, extensive study tours of many areas of the Sudan, and produced twenty-six separate reports (including two reports by

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8. Jefferson, J.H.K., 1954, Soil Conservation in the Sudan - Development and Projects, Ministry of Agriculture, Khartoum, p. 12.

9. For detailed information about the composition and terms of reference of the Soil Conservation Committee, See Sudan Government, Khartoum, 1944, op. cit., pp. 1 - 2.

two non-members of the Committee) about special areas and subjects.[10] The Committee submitted its reports in May, 1944 after one-and-a-half years' of work. In its report, the Committee devised fifty-one schemes to be executed in a five-year plan over a wide area of the country. The schemes which were divided into priorities A and B covered a wide range of topics such as land reclamation, erosion prevention, soil deterioration surveys, fire control, town perimeter control, village planning and resettlement, rural water supplies and improvements, agriculture and forestry developments, irrigation and rainland cultivation experiments, and stock improvement.[11]

From the report and recommendations of the Soil Conservation Committee it became evident that soil deterioration was not a universal problem in the Sudan. Rather, it was a phenomenon associated mainly with some areas of Central and Northern Sudan, and in particular with towns whose immediate surroundings had been over-grazed and/or over-cultivated; with rural centres in water-deficient environment which had permanent sources of water supplies and which subsequently carried large human and animal populations; and with tracks traversed frequently by

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10. For detailed information on reports on the special areas and subjects, See Sudan Government Khartoum, 1944, op. cit., appendixes I - XXVI.

11. For further details on the schemes devised by the Soil Conservation Committee, See (i) Sudan Government, Khartoum, 1944, op. cit., pp. 24 - 31; (ii) Jefferson, J.H.K., 1954, op. cit., pp. 11 - 12.

large numbers of animals being driven to and from water and grazing or to the market, for these animals ate up the bush and grass on their way to produce soil deterioration. Some of the Committee's findings thus supported the views expressed in most of the pre-Committee writings which blamed the deteriorating soil conditions on over-stocking and over-cultivation arising from the uneven distribution of the then very few existing water points. It was generally believed then that the causes of soil impoverishment could be eliminated by creating more water points.

Rural Water Supplies and Soil Conservation Board:

In August, 1944, the government accepted the Soil Conservation Committee's Report "as a basis for future policy on soil conservation and approved the five-year programme of work outlined in the report subject to further review of the estimated expenditure totalling £E.300,000."[12] The government also approved the formation of a Rural Water and Soil Conservation Board to advise on all matters relating to conservation and rural water supplies and to execute the programme recommended in the Soil Conservation Committee's Report. The eight-member Board[13] which, like the Soil Conservation Committee, consisted entirely of technical and political civil servants except two government-nominated Sudanese members held its inaugural meeting in October, 1944.

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12. Sudan Government, Khartoum, 1945, Annual Report of the Rural Water Supplies and Soil Conservation Board, p. 1.

13. Ibid., p. 1.

It was not until 1946, however, that it started to implement the first five-year plan, the year 1945 having been spent on organizational work and on recruitment of staff for the Board. The first five-year plan thus covered the period 1946-50, and this is why in this thesis 1946 is regarded as the year when the government's rural water supplies policy started officially.

The fact that soil deterioration, the result of population pressure on land and grazing resources, in thinly populated Sudan[14] was restricted to centres with permanent water-base showed that soil deterioration was due mainly to maldistribution of the existing inadequate water points. In view of this, the Board seemed to have concluded that no soil conservation programmes could succeed without adequate sources of water supplies. One should therefore, not find it difficult to understand why between 1946 and 1956 when the Rural Water and Soil Conservation Board assumed a new name, its programmes of action according to J.H.K. Jefferson, were confined almost exclusively to providing rural water supplies, and to be more precise, to hafir excavation.[15]

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14. In 1948, Sudan with an area of about one million square miles had an estimated population of 7,547,000 only. see: Barbour, K.M., 1966, Population Shifts and Changes in Sudan since 1898, Middle Eastern Studies, Vol. 2, No. 2, p. 108.

15. Jefferson had in 1954 reported that almost all work (undertaken by the Soil Conservation Committee) had been applied to Water Conservation from surface sources and but little to "Soil Conservation" .... and remarked that in view of the stated aims of the Soil Conservation Section of the Ministry of Agriculture, it was an anomalous situation indeed. For further comments on this, see: Jefferson, J.H.K., 1954, Soil Conservation in the Sudan, Development and Projects, pp. 148 - 150.

Land Use and Rural Water Development Board:

In 1956, the Soil Conservation Committee was reconstituted and its name changed to Land Use and Rural Water Development Board. The Board which consisted of eleven members, like the Soil Conservation Committee before it, was operated as a department of the Ministry of Agriculture. It was set up to plan for, and secure more effective and economic development of water, plant and land resources.[16] The economic prosperity of the rural population, it is generally recognized, is a function of the intensity of resource exploitation. Among people at a low level of technological development, this depends upon the amount of effort they could invest in exploiting their resources. The inhabitants of water deficient regions expend considerable time ane energy on fetching water. They have to travel to places as far away as ten to twenty miles, at least, every other day to fetch water. Consequently, the people are poor, because they have little time and effort left to invest in cultivation or gum picking or both.

Two problems commonly associated with water deficient environments are those of over cultivation and over grazing. Remoteness from water has been found to result in reluctance by farmers to crop new land. Cultivators therefore continue to work plots which are very close to water points but from which fertility has departed through overcropping and from which poor yield is inevitable. For the same reason, stock

16. F.A.O., Rome, 1959. op. cit., p.8.

is concentrated at the few existing centres with the attendant overgrazing. Yet vast potential grazing areas which lack adequate water supplies are left to waste. And where water is available locally from hand-dug shallow wells, considerable time and energy are expended on sinking, lining and repairing wells, and in drawing water from them. The following comments on hand-dug wells by Kleinsorge and Kreysing give a vivid description of the situation. "The sinking and the keeping of wells takes a great amount of time of the population. In Tebun es Sewani, the local people reported that the construction of a well of 12 metres (about 40 feet) in depth takes about 25 days. Digging the shafts requires always 2, often more workers. From the well-field of Abu Qalb, it has been reported that normally on each day of the dry period, about 25 - 35 workers are fully occupied with the deepening of the wells. The total working expenditure for the upkeep of the water supply of the well-fields is quite considerable."[17]

Before 1957, two separate bodies existed for providing rural water supplies in the Sudan. The drilling unit, first of the Geological Survey Department, and then of the Ministry of Works, had responsibility for sinking boreholes and construction of <u>dawanky</u>. Similarly, the Soil Conservation Committee was responsible for shallow well digging and <u>hafir</u> excavation. In 1957, however, the drilling unit was transferred from the Ministry of Works and merged with the Department of Land Use and Rural Water Development.[18] Since then, the responsibility for the

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17. Kleinsorge, H., and Kreysing, K., 1959, <u>Geological and Hydrologic Researches in the Western Sudan</u>, p. 12.

18. F.A.O., Rome 1959. <u>op. cit.</u>, p. 8.

provision of rural water supplies has been vested in one body only. Nevertheless, separate sections still exist for drilling wells, whether shallow or deep, on the one hand, and for the excavation of hafirs on the other.

Rural Water and Development Corporation:

In 1966, the Land Use and Rural Water Development Board, like its predecessor, the Soil Conservation Committee, was reconstituted and its name changed to the Rural Water and Development Corporation. In addition, statutory control was withdrawn from the Ministry of Agriculture and given to the Ministry of Animal Resources. Since its inception in 1947, the body for planning and executing the rural water supplies' programmes had had its name changed thrice. The change of name on each occasion was a reflection of shifts in emphasis of government's aims and objectives. During the time of the Soil Conservation Committee, emphasis was placed exclusively on conservation measures to reclaim the already impoverished soils and to prevent those that were still good from deteriorating. This objective, the Committee set out to achieve by creating many more water points. Similarly, the Board of the Land Use and Rural Water Development believed in a policy of using the provision of rural water supplies to influence the direction and intensity of resource utilization. The Board therefore, committed itself fully to providing water supplies to all places, except those found to be physically unsuitable, with high agricultural and grazing potentials. Both the Soil Conservation Committee and the Land

Use and Rural Water Development Board seemed, however, to have paid little or no attention in their programmes of action to the social implications of the rapid rise in the number of water points.

On its part, the Rural Water and Development Corporation recognizes the decisive role which availability of adequate water supplies can play in the socio-economic transformation of the water deficient areas. It has thus planned to use the provision of rural water supplies to bring about the development of the rural areas of the Sudan. The Corporation is however, aware of its predecessors' short-comings. It has therefore included in its programmes, measures for dealing with them. When the Soil Conservation Committee and the Land Use and Rural Water Development Board were the government's planning and executing agents for the provision of rural water supplies, the only investigations ever conducted before siting water points were geological. But since the agency passed on to the Corporation, the siting of water points is preceded by several other surveys. The Corporation has a separate division named the Department of Rural Development which plans for and organize these surveys. This department has four sections, one for each of agriculture and forestry, pasture, soil, and social development surveys.[19]

Drilling of Deep Bores in South-Western Kordofan:

Now that a brief history of the government's rural water supplies programmes has been presented, it is time to attempt an analysis of the

19. Rural Water and Development Corporation, Khartoum, 1967, Proposed Organization of Rural Water and Development Corporation, unpublished Internal Memo.

spatial distribution of the existing deep bores in South-Western Kordofan. It should be remembered that it has been indicated in chapter one that this thesis is concerned with the deep bore aspect of the rural water supplies' programmes only.

It has been stated earlier on in this chapter that although the well drilling programmes in the Sudan had begun in 1919, it was in 1946 that the government's rural water supplies development policy officially started. Between 1919 and 1946, forty-seven wells were sunk. Thirteen of these were sited in South-Western Kordofan. From 1946 to 1969, ninety-two additional wells were drilled in the study area alone. However, the annual rate of well sinking varies from period to period. This rate varies from one well every other year (Pre - 1946) to15.25 per annum (1966 - 1969). (See Table 1 below).

TABLE 1

RATE OF WELL DRILLING IN SOUTH-WESTERN KORDOFAN: 1919 - 1969

Period	Number of Wells	Annual Rate of Construction
1919 - 1946	13	0.50
1946 - 1955	15	1.50
1956 - 1965	16	1.60
1966 - 1969	61	15.25
1946 - 1969	92	4.00
1919 - 1969	105	2.10

Source: Chart showing Deep Bores in Kordofan Province, 1919 - 1969, Rural Water and Development Corporation Office, El Obeid.

For ease of reference and for the purpose of analytical comparison, the history of deep bores has been divided into four periods. These are (a) Pre - 1946; (b) 1946 - 1955; (c) 1956 - 1965 and (d) 1966 - 1969. For the same reason, South-Western Kordofan is divided into four regions, namely: Northern Hamar, Eastern Hamar, Southern Hamar and Dar Humr, (Fig.VI). Division is made to follow administrative boundaries to facilitate collection of data, especially data on human and animal populations and crop production.

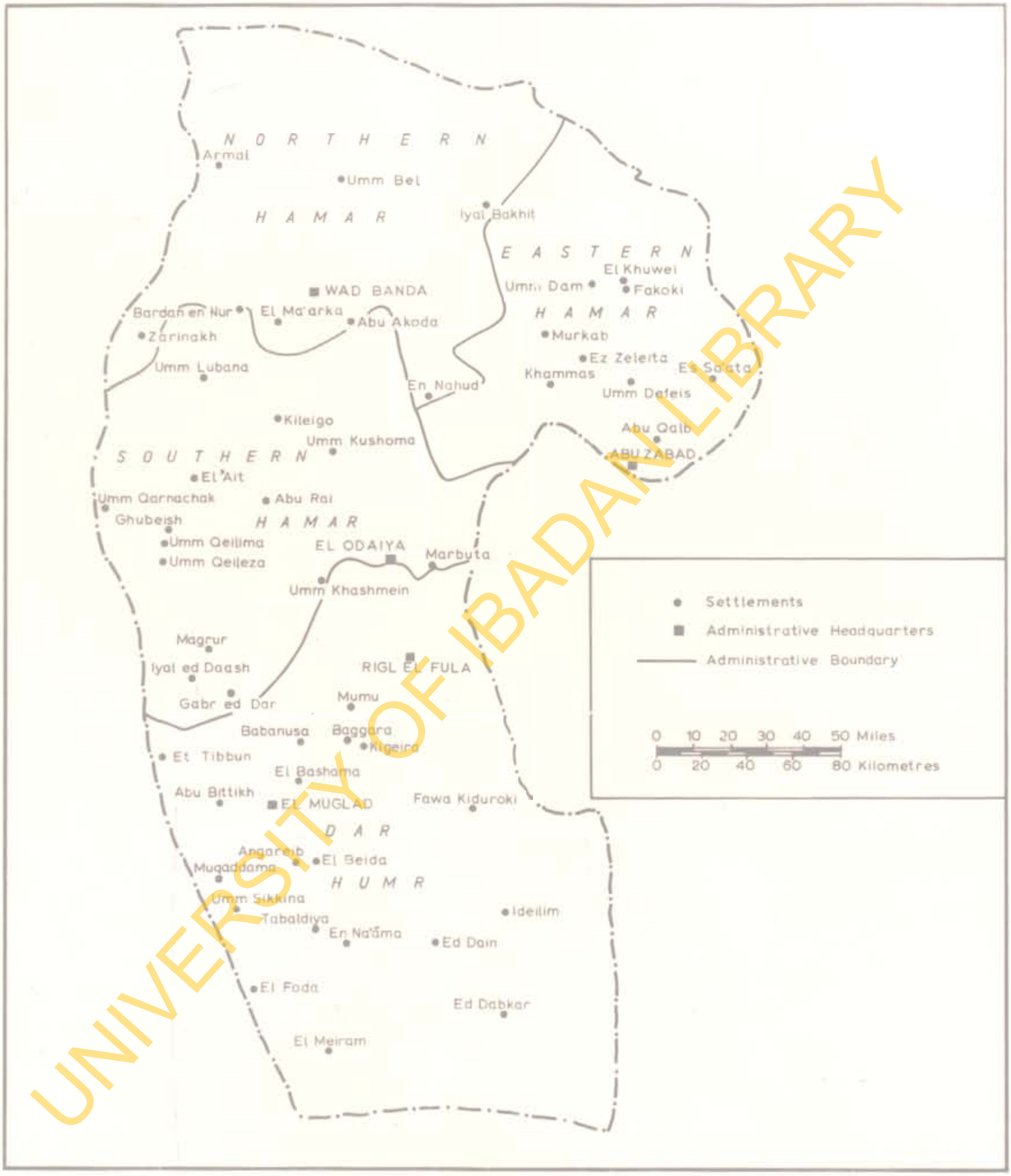
In this chapter, attempts are made to determine the distribution pattern of deep bores. This determination is made on a period to period basis. This is done to enable the author assess the effects of government's intervention on the distribution pattern. In determining the pattern, the Nearest Neighbour technique is employed.

After this, explanations are sought for the pattern that emerges. To do this, reference is made to the various principles which the water authorities claim guide them in the allocation of wells. Later in the chapter, the author makes attempts to ascertain the effects of deep bores on resource utilization.

Deep bores have significant impact on settlement pattern and on the rural economies of South-Western Kordofan. This is because, economic development is a function of land use. The Hamar and Humr, the two tribes who inhabit this area, depend for their livelihood mainly on crop farming and animal husbandry. Land use, in turn, is a function of

Fig.VI.

SOUTH-WESTERN KORDOFAN — ADMINISTRATIVE DIVISIONS



the availability of water on a permanent basis. The author has therefore hypothetically suggested what he considers to be appropriate distances between wells for utilisation by each of the two main types of rural economies of South-West Kordofan.

The inhabitants of South-Western Kordofan need water. If this could be provided everywhere that it is needed, there would be no problem. There would be no pressure on resources provided human and animal populations could be kept down to the level of available resources. This is because the area being studied is sparsely populated. The region has an area of 83,675 sq. kilometres and its population according to the 1955/56 census figure is 330,359. This gives an overall population density of 3.9 persons per square kilometre. This density, however, varies from one region to another, (See Table 2 below). It varies from as low as 2 persons per square kilometre in Dar Humr to 5.7 persons per square kilometre in Eastern Hamar.

TABLE 2

POPULATION DISTRIBUTION IN SOUTH-WESTERN KORDOFAN

Region	Area (km^2) 1	Population 2	Density per km^2
Northern Hamar	18,000	88,125	4.9
Eastern Hamar	14,269	81,325	5.7
Southern Hamar	18,906	97,416	5.2
Dar Humr	32,500	63,495	2.0
Total	83,675	330,359	3.9

Source: (1) Ministry of Social Affairs, Population Census Office, Khartoum, 1959 - Maps of Omodias. Areas were calculated from Maps N.C. 35 and N.D. 35 with the aid of planimeter.
(2) Ministry of Social Affairs, Population Census Office, Khartoum, 1958 - First Population Census of Sudan, 1955/56: Notes on Omodia Map, pp. 52 - 53.

The livestock populations are also low. The livestock tax registers for both Dar Hamar and Dar Humr for the 1968/69 financial year show that there are 26,947 camels, 230,910 cattle, 170,362 sheep and 130,812 goats in South-Western Kordofan.[20] Since these figures were declared for the purpose of taxation, they suffer severely from gross under-estimation. The charge of gross under-estimation is obvious from a comparison of these figures with those obtained from Animal Density Maps of the Sudan.[21] The author has accepted the figures from the Animal Density Maps as representing a much better picture of the true animal population of the area being studied than those from tax registers for the following reasons. First, the data for making the maps were collected by the Ministry of Animal Resources for the purpose of veterinary services. The animal owners were quite aware of this fact and therefore would have had no cause to under-state their livestock numbers, for veterinary services are given free, in most cases. Secondly, veterinary services are innovations for improving the health and standard of livestock.[22] These innovations, however, would not change the basic way of life, but would rather improve it. It is thus reasonable to hold that the animal

20. (i) Hamar Rural Council, En Nahud, Livestock Tax Register, 1968/69;
(ii) Messeriya Rural Council, Rigl el Fula, Livestock Tax Register, 1968/69.

21. For detailed information, see: Surveys Department, Khartoum, 1969, Animal Density Maps of the Sudan, Topo No. S. 987 - 69 (camels), Topo No. S.988 - 69 (cattle); Topo No. S.989 - 69 (sheep); and Topo No. S.990 - 69 (goats).

22. Cunnison, I., Asad, T., and Hill, L.G., 1965, op. cit., p.114.

populations would accept veterinary services. Consequently, the animal owners would cooperate much more readily with officials from the Ministry of Animal Resources than with those from the District Councils, in their surveys into the livestock populations.

The animal Density Maps show that the numbers of camels, cattle, sheep and goats in South-Western Kordofan are 62,000, 366,000, 438,000 and 278,000 respectively. These figures show wide departures of 57, 37, 61 and 53 per cent respectively from those obtained from tax registers. When converted to animal units,[23] the figures stand at 578,000 as against 321,524 from tax registers. This yields an under-estimation of about 44 per cent.

Animal populations like human populations are unevenly distributed. The overall density is 3.9 units per square kilometre. The density also shows spatial variations. It is as low as 1.8 units per square kilometre in Northern and Eastern Hamar, and rises to 6.2 units per km^2 in Dar Humr. Unlike human populations which show a higher density in Dar Hamar, animal populations are however, more heavily concentrated in Dar Humr. For instance, Dar Hamar's share of the land area is 61 per cent, its shares of human and animal populations are 81 and 37 per cent respectively. Dar Humr

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23. For ease of reference, the animal populations have been reduced to animal units. The conversion rate used has been adapted from Harrison's work, and this rate is stated here:

One cattle equals one animal unit;
One camel equals one-and-a-half cattle;
Six sheep/goats equal one cattle.

For further discussion on this, see: Harrison, M.N.R., 1955, op. cit., pp. 3 - 4.

comprises 39 per cent of the land area of South-Western Kordofan while it accounts for only 19 per cent of the human population, its share of the animal population is 63 per cent.

TABLE 3

DISTRIBUTION OF LIVESTOCK IN SOUTH-WESTERN KORDOFAN

Region	Camel	Cattle	Sheep	Goats	Animal Units	Animal Unit per km^2
Northern Hamar	4,039	17,105	10,971	40,173	31,684	1.8
Eastern Hamar	2,393	15,221	12,836	25,077	25,130	1.8
Southern Hamar	20,515	12,597	66,722	48,773	62,619	3.3
Dar Humr	-	185,987	79,833	16,789	202,091	6.2
Total	26,947	230,910	170,362	130,812	321,524	3.9

Sources: 1. Hamar Rural Council, En Nahud - Livestock Tax Register, 1968/69.

2. Messeriya Rural Council, Rigl el Fula - Livestock Tax Register, 1968/69.

The uneven distribution of populations has important but not grave implications for planning for water supplies. When the human and livestock populations are considered separately the differences in densities between the north and the south of this area are immense. On the other hand, when the two populations are considered jointly, the between region differences in densities are sharply reduced. To enable the two populations to be jointly treated, they are converted to the same units - animal units - the basis of conversion being water needs. According to calculations by World Health Organization Authorities, the daily minimum per capita water requirement by man and cattle (the equivalent of one animal unit) are 4 and 6 gallons respectively.[24]

The conversion exercise evens out the wide variations in the densities of the two populations. But distribution is still far from being even. The over-all density is now 6.5 units per km^2. The density is lowest in Northern Hamar (5.0 units), and highest in Dar Humr (7.5 units). Eastern and Southern Hamar occupy mid-way positions with 5.6 and 6.7 units respectively. In absolute terms, Dar Humr's (39 per cent of the land) share of human and animal populations is 45 per cent, while that of Dar Hamar (61 per cent of the land) stands at 55 per cent.

TABLE 4

DISTRIBUTION OF HUMAN AND ANIMAL POPULATIONS IN SOUTH-WESTERN KORDOFAN

Region	Human Populations	Animal Population	Total Population in Animal Units	Density
Northern Hamar	88,125	31,684	90,434	5.0
Eastern Hamar	81,323	25,130	79,345	5.6
Southern Hamar	97,416	62,619	127,563	6.7
Dar Humr	63,495	202,091	244,421	7.5
Total	330,359	321,524	541,763	6.5

Source: Same as for Tables 2 and 3.

24. Vide Hamid Abu Zeid, A Note on Water Provision, Capacity and Consumption, Pricing and Revenue in the Sudan, Unpublished Internal Memo. to Rural Water and Development Corporation, Republic of the Sudan, p. 3.

It is not possible to provide water for all places that need it. In addition to physical limitations, government does not possess enough resources for this. To judiciously spend the resources allocated for developing rural water supplies, government had devised some principles for siting wells.

Principles of allocating wells:

In allocating new wells, priority is given to needs. Needs are determined in the first instance, by the size of the human and animal populations. Account is also taken of the distances to nearest existing water points. Another guiding ~~principles~~ principle is that wells should be allocated on the basis of maintaining a balance between water supplies, populations and resources. The objective here is that the water provided should enhance a rational utilization of resources. That is, land and grazing resources should be exploited in such a manner that they would continue to support their populations indefinitely.[25]

Water is needed where there are people and livestock. At the same time, populations which suffer from severe water shortage migrate seasonally or permanently to places where water is available. This action results in the resources of the sources of migration being under-used and creates pressures for the resources of the receiving regions. Thus, achievement

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25. For further information on the principles of allocating water points, See: Rural Water and Development Corporation, Khartoum, Anti - Thirst Campaign, Second 1967/68 Programme, Booklet No. 4 pp. 4 - 5.

of the above stated objective is going to be a well-nigh impossibility unless adjoining inhabited, but water deficient territories are simultaneously provided with water supplies.

Hypothetically, the case can be put in this way. A village without any sources of permanent water supplies has a few inhabitants. If it is provided with water, its population increases rapidly. This increase is due to in-migration from neighbouring territories that lack water supplies. The population continues to grow and soon, the water - population ratio becomes very low. Demands for more water are made and if they are met, more people keep on coming, and water becomes grossly inadequate.

Meanwhile, land is fixed. More land could be worked only at the expense of walking great distances. The alternative is to over-work the land within easy reach of the water point, and this leads to land and grazing deterioration. This vicious circle could be broken only by providing water in the sources of migration. This will, perhaps, serve two purposes. First, it will halt out-migrations. Secondly, it will preserve the already hard-pressed resources from further pressure, and may even relieve pressure on the resources by inducing some of the migrants to go back to their places of origin to take advantage of the newly provided water supplies.

Principles of allocation of deep bores and their distribution pattern:

If allocation of wells were determined exclusively by the principle of needs, one would expect a high degree of positive correlation to exist between population size and the number of wells existing at any period if all wells are equally productive. The distribution pattern would thus be close to "clustering". If on the other hand, allocation of wells were influenced more by the desire to maintain a balance between water supplies, populations and resources, a uniform distance between wells would be expected. A pattern that approximates "maximum dispersal" would thus emerge.

However, these expected patterns are likely to be distorted by two factors; first, by the availability of natural sources of water, and secondly by political considerations. Such distortions are not likely to be very significant. In the first instance, there are four major natural sources of water (well-fields)[26] in South-Western Kordofan. By a very remarkable chance, each of the four administrative divisions in the study area has one well-field located in it. These are Foga (Northern Hamar), Abu Zabad (Eastern Hamar), El Odaiya (Southern Hamar) and Rigl el Fula (Dar Humr). The second distorting factor - political considerations - is more likely to further reinforce the tendency for population size and number of wells to be positively correlated. This is because, in the view of the author, political pressures are likely to be stronger in centres of large population concentrations. This view agrees with that of Graham. In her discussion of the factors which influence the siting of hafirs in Gedaref District, she makes the following observations. "The siting of

26. Well-fields are natural morphological depressions of large areal extent, which collect run off in the rainy season and allow it to stagnate for long enough time to enable it percolate and form shallow underground aquifer. When they are still carrying water, they are referred to as "fulas" or turdas". When the surface water disappears, in the dry season, the underground aquifer is tapped by hand-dug shallow wells.

water points is now influenced by local politics. Outlying pioneer villages may suffer in comparison with large villages in the traditional settlement areas, which can exert powerful pressures on the Councils. Thus a high proportion of the new water points may go to old villages in areas which are already over-populated and "over-cultivated."[27]

There is no other place where the influence of politics on allocating and siting new wells is more clearly demonstrated than in South-Western Kordofan. New deep bores continue to be sunk at El Muglad, Ghubeish, and in the immediate environs of En Nahud, El Khuwei and Abu Zabad. These are areas which already have more than their fair share of existing water yards. Yet there are distant areas that suffer from acute water shortage, and do not have wells allocated to them. How else can one explain this anomalous situation other than by reference to political influence, unless it can be proved that these areas lack underground water supplies?

To determine the pattern of well distribution, the Nearest Neighbour Technique was employed. All the wells were plotted on a map. The distance of every well to its nearest neighbour was measured. The "r" value was then calculated (see Apendix 1 for the processes of calculation). The "r" values for each of the four periods are 0.90 (Pre - 1946); 0.70 (1946 - 1955); 0.89 (1956 - 1965) and 0.90 (1966 - 1969). These results show a high degree of tendency towards randomness. They also show that allocation of wells with the objective of enhancing a rational utilization of resources

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27. Graham, A.McS., 1963, op. cit., p. 396.

is insignificant. If this principle were followed, the "r" values would lie between 1.0 (absolute randomness) and definitely very close to 2.1491 (maximum dispersal), that is, the distance between wells would be uniform.

In discussing allocation of wells on the basis of needs, human and animal populations were correlated with the number of wells at each of the four periods. Human populations were converted to animal units, and the converted figure was added to the actual animal units. Conversion was made on the basis of the daily minimum per capita water needs by man and animal. As stated earlier on in this chapter, these are 4 and 6 gallons respectively. On this basis a man becomes the equivalent of two-thirds of a unit of animal.

The correlation coefficient (r) values for the four periods are -0.63, -0.46, 0.01 and 0.60. The r values -0.63 and -0.46 for the periods Pre - 1946 and 1946 - 1955 respectively show a medium degree of negative correlation. This, in effect means that the areas with the largest populations have had alloted to them the fewest number of wells, while the greatest number of wells have gone to those areas with the smallest populations. Thus correlation is however superfluous, because when the "r" values are tested by using the Student "t" test, they are not significant even at the 5 per cent level. In the third period, the "r" value of 0.01 shows no correlation of any kind between populations and the number of wells. However, in the last period, the "r" value is 0.60. This shows a medium degree of superfluous positive correlation, but when tested, it is found also to be statistically insignificant. Nevertheless, it is clear from the foregoing analysis, and from Table 5 below that government's attempt at allocating deep bores on the basis of needs have started to achieve some measure of success.

Deep Bores and Land Use:

The Hamar and Humr tribes who inhabit South-Western Kordofan are engaged in two main types of rural economy. These are crop farming and animal rearing. Crop farming is labour-intensive relative to animal husbandry. It is therefore less demanding in its use of land.

TABLE 5

DISTRIBUTION OF POPULATIONS AND ALLOCATION OF DEEP BORES

Region	Converted Population (Human and Animal)	No. of Wells Period I (Pre - 1946)	Period II (1946 - 1955)	Period III (1956 - 1965)	Period IV (1966 - 1969)
Northern Hamar	90,434	3	5	6	18
Eastern Hamar	79,345	5	8	10	17
Southern Hamar	127,563	4	11	18	37
Dar Humr	244,421	1	4	10	33
Total	541,763	13	28	44	105
Correlation Coefficient (r):		-0.63	-0.46	0.01	0.60

Sources: Same as for Tables 1 - 3.

Pastoralism, on the other hand, demands less labour per unit of land, but requires a larger area for its operations. Therefore, water requirements per unit of land by each of the two rural economies differ markedly. The author has therefore suggested what he considers to be "appropriate maximum distances between wells" which would enable agricultural and grazing resources attached to each well to be adequately and rationally utilized.

If deep bores are more than 16 kilometres (10 miles) apart, cultivators would not be able to utilize all the agricultural land attached to each deep bore. Agricultural land would thus go to waste. The choice of 16 kilometres was made after carefully observing the distances from water points of crop fields belonging to settled farmers. In South-Western Kordofan, it was found that permanently settled cultivators rarely have fields at places more than 8 kilometres (5 miles) away from permanent sources of water. Those who do so live on the farms in the rainy season only and drink from <u>fulas</u>(depressions where water collects). In the dry season, they all leave to settle in or near places with permanent sources of water supplies. The only exceptions are those villages that are situated on tolerably motorable roads. These have water brought to them every other day by motor vehicles in tanks or barrels or both, at very high prices.

Several authorities have made observations about the distances which farmers could travel to and from the fields daily; and about distances people could go daily in search of water. Barbour[28] in his discussion of Nuba agriculture, observed that the far farms of the Nubas are perhaps as much as 5 miles (8 km.) into the clay plains. In an earlier reference

28. Barbour, K.M., 1961, <u>op. cit.</u>, p. 175.

to agriculture in the Qoz of Northern Kordofan, he pointed out that "the actual location of the cultivators throughout the region is mainly determined by the presence of water supplies" although it is not necessary that each village should be sited beside a well, it is imperative that when other sources fail, they should be able to go with their donkeys to a nearby well to bring back full water skins. If such a supply is not available within half a day's journey, say 15 miles (25 km), the whole village may have to migrate after the harvest and settle where water can be easily procured."

The experts who executed the United Nations Development Programme for Land and Water Use Survey in Kordofan Province have recommended that water points should be at intervals of 6 kilometres. This recommendation was made on the basis that "virtually all the cultivated land is situated within 3 kilometres of a fixed village, and this suggests that a distance of 3 kilometres from the village to the field (out in the morning and back in the evening) is about as far as the farmer can manage.[29]

A distance that would cost a cultivator half his working day is definitely not suitable for crop farming. For, to expect that a man who spends half his working day fetching his drinking and cooking water would do serious farm work, is to expect the impossible. The problem is aggravated by the fact that children under the age of fifteen who could fetch water for the older members of the family while they work on the farm are either at school, or are tending animals on the field, or when

29. F.A.O., Rome 1967, Land and Water Use Survey in Kordofan Provinces the Sudan. Final Report. p. 94.

they are free, conditions at hand-dug wells and water yards which are discussed in greater details in chapters four and seven respectively do not encourage the use of children in fetching water. This is because fetching water at hand-dug wells is a laborious and time - consuming task, and at the often congested water yards, children cannot compete effectively with older and stronger people in the struggle to gain entry into and fetch water at water yards. The fact that men who live far away from sources of water supplies cannot do serious farm work since fetching water will absorb a large proportion of his daily working time, was recognized by Barbour[30] when he observed that people whose villages are not located within half a day's journey from permanent sources of water supplies would need to migrate seasonally and settle near water points. A distance which absorbs one-third of a farmer's working day might, however, be tolerated. Sixteen kilometres (total distance to and from water point) could be conveniently covered on donkey in about four hours. This would still leave the farmer with some time to attend to his farm work.

While the 6 kilometre interval recommended by experts from the F.A.O. is ideal for enhancing arable farming, it is unrealistic for all practical purposes. In the first place, it would require too many water points - well over 2,000 - to provide water supplies to the whole of South-Western Kordofan. In the second place, government lacks the resources to undertake, at least for the present time, water development

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30. Barbour, K.M., 1961, op. cit., p. 158.

programmes of such a magnitude when it is realised that the problem of water shortage is not unique to South-Western Kordofan alone, but a feature common to the whole central and northern Sudan, except those areas which lie close to the River Nile and its tributaries. But if the 16 kilometre interval was adopted, many fewer water points - just slightly over 400 - would be needed. This number is, as will be seen later in this chapter, more than enough to meet the minimum water requirements of South-Western Kordofan's present day human and animal populations. Already, this area can boast of 105 dawanky. Providing the balance is therefore, not likely to constitute a very serious strain on government's resources, if spread over a number of years.

Furthermore, the claim that all cultivated land is situated within 3 km. of a settled village is not borne out by the author's field observations. El Odaiya and Mumu are 48 km apart; yet crop fields could be seen at any point on the route joining these two water centres. Other areas with cultivated land beyond 3 km of settled villagers are to be seen between El Muglad and Abu Bittikh (27 km); Abu Bittikh and Et Tibbun (46 km); Babanusa and El Bashama (18 km); and Abu Rufai and Et Tibbun (18 km), to mention only a few. At the same time, many crop fields around El Khuwei, En Nahud, Ghubeish, Wad Banda, etc., are more than 3 km. distant from settled villages. Perhaps what the experts failed to recognize is the fact that there are many cultivators who settle temporarily on their fields for the whole duration of the cultivation season. Such cultivators do not need to go from and back to the village daily. They therefore need not have their crop fields within 3 km of settled villages.

For pastoralism, twice the distance suggested for arable farming might be tolerable. Thus it could be hypothesized that if water points are more than 32 km (20 miles) apart, pastoralists would not be able to utilize all the grazing land attached to them. Grazing would therefore go to waste.

Every type of beast has a limit beyond which further travelling becomes injurious to its health. There is dearth of information about such a limit. Nevertheless, inferences, but not of a physiological nature, could be drawn from the works of Jefferson [31] and Harrison.[32]

Jefferson, relying on information he received from veterinary authorities, recommended that the interval between hafirs for beasts should be about 15 miles (24 km). He however recognized that where water is scarce, animals may be driven up to 20 miles (32 km) every other day. Harrison had investigated and reported on grazing in the Sudan. He has found that in the low Rainfall Woodland Savannah zone, cattle, watering daily or every two days, could graze within a radius of 8 miles (13 km) and 15 miles (24 km) of water point in a normal and a bad year respectively. For sheep and goats which water once every two or three days, the radii are 12 miles (19 km) and 20 miles (32 km). Camels which have longer watering intervals could graze within twice the radius for sheep and goats.

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31. Jefferson, J.H.K., 1954, op. cit., pp. 45 - 46.
32. Harrison, M.N.R., 1955, Report on Grazing Survey of the Sudan, Part III, pp. 17 - 19.

The 32 km interval between wells for livestock suggested by the author would seem reasonable. In the first instance, almost all the nomads whom he interviewed claimed that cattle could easily travel 16 km daily to and from grazing. In the second place, it does not mean that everybody would have to walk this distance daily. With careful planning, this distance could be considerably reduced. During the rainy season, animals could graze far away from deep bores, while the grazing near the wells is conserved for use in the dry season.

<u>Hypothetical Distances and Resource Utilization:</u>

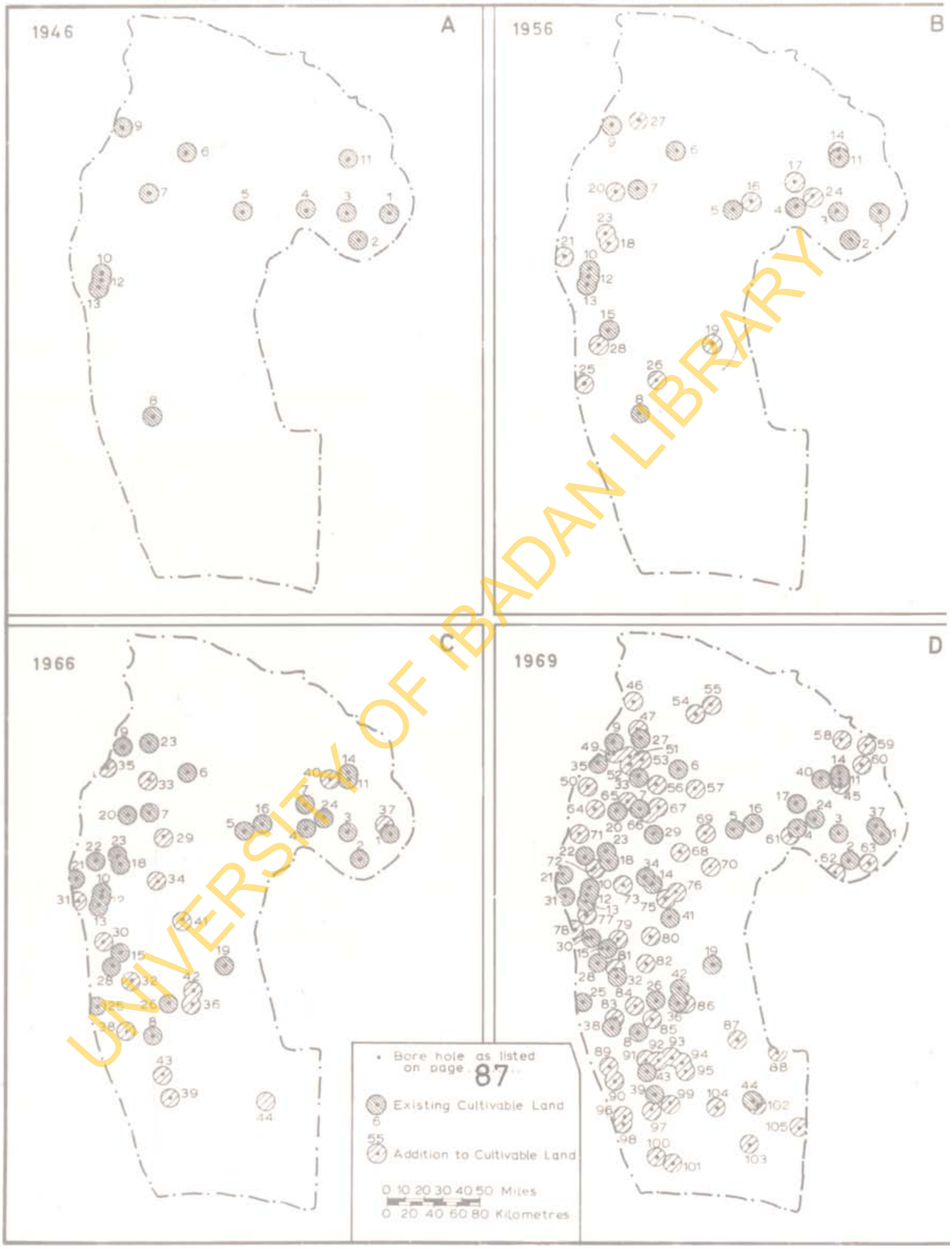
In practical terms, what are the effects of these hypothetically suggested distances on the utilization of agricultural land and grazing? Up to the end of 1969, there were 105 functioning <u>dawanky</u> in South-Western Kordofan. If the standard distance of 16 km. between wells were maintained, the expected usable agricultural land would be 21,105 square kilometres, or just less than 26 per cent of the total area (83,675 km^2).

Observed usable land is, however, rather less. It is 17,286 km^2 or just less than 21 per cent of the land area. To put it in another way, 82 per cent of the expected usable agricultural land is observed to lie within a radius of 8 km. (for a periodic and regional break-down of these figures (See Table 6 above).

From the table, it is obvious that the provision of deep bores has rendered usable for crop farming 21 per cent of the area's potential agricultural land. This proportion, however, varies widely between regions within the area, (Fig.VII). Southern Hamar tops the list with

Fig. VII.

DISTRIBUTION OF DEEP BORES AND "CULTIVABLE" LAND



1. Es Sa'ata
2. Abu Qalb
3. Umm Defeis
4. Khammas
5. En Nahud
6. Wad Banda
7. Suq el Gamal
8. El Muglad
9. Dam Gamad
10. Ghubeish
11. El Khuwei
12. Umm Qeilima
13. Umm Qeileiza
14. Ed Daliya
15. Magrur
16. Bir Muneim
17. Murkab
18. El 'Ait
19. Rigl el Fula
20. Umm Lubana
21. Umm Qarnachak
22. Umm Debeiba
23. Humeir Dirra
24. Ez Zeleita
25. Et Tibbun
26. Babanusa
27. Surfan
28. Iyal ed Daash
29. Kilsigo
30. El Hamra
31. Sharafa
32. Gabi ed Dar
33. Bardan en Nur
34. Abu Rai
35. Abu Kabisa
36. Baqqara
37. Es Sa'ata Zarqai
38. Abu Bitikh
39. Tabaldiya
40. Umm Dam
41. Umm Khashmein
42. Mumu
43. Ga'abatein
44. Ideilim
45. Fakoki
46. Armal
47. Heilat Wad el Faki
48. Umm Rasas
49. El Metirbeira
50. Zarinakh
51. El Hanana
52. Kabish Wad Awuda
53. Sideirat
54. Umm Bel
55. Umm Sayala
56. El Ma'arka
57. Abu Akoda
58. El Faki Hamid
59. Umm Zarqa el Qafil
60. Kol Yousif
61. Hamir Sahal
62. Abu Zabad
63. Ayak
64. Humeir er Ril
65. Es Safi
66. Ed Duma
67. Duma es Salam
68. Umm Kushoma
69. Abu Saq
70. Rahad ed Dayaa
71. Aradeiba
72. Dabanqa
73. Umm Ghabeisha
74. Abu Qeid
75. Himeir
76. Sabi
77. Umm Leilaya
78. Zarqa
79. Shagg el Humei
80. Aradeiba
81. Hemeidam
82. Rahad es Sidei
83. Es Sumua
84. El Andadeib
85. El Bashama
86. Kigeira
87. Fawa Kiduroki
88. Abu Likri
89. Miqaddama
90. Umm Sikkina
91. El Anqareib
92. El Beida
93. Shurab
94. Iradaya
95. Ras el Fil
96. Guweighina
97. Es Siteib
98. El Foda
99. En Na'ama
100. El Meiram
101. Ed Dawas
102. Umm Shaqq
103. Ed Dabkar
104. Ed Dain
105. Ed Dabirka.

32 per cent. It is followed by Eastern Hamar, Northern Hamar and Dar Humr in that order with 20, 17 and 16 per cent respectively. To render the whole territory usable for arable farming, the present number of water points has to be increased four-fold.

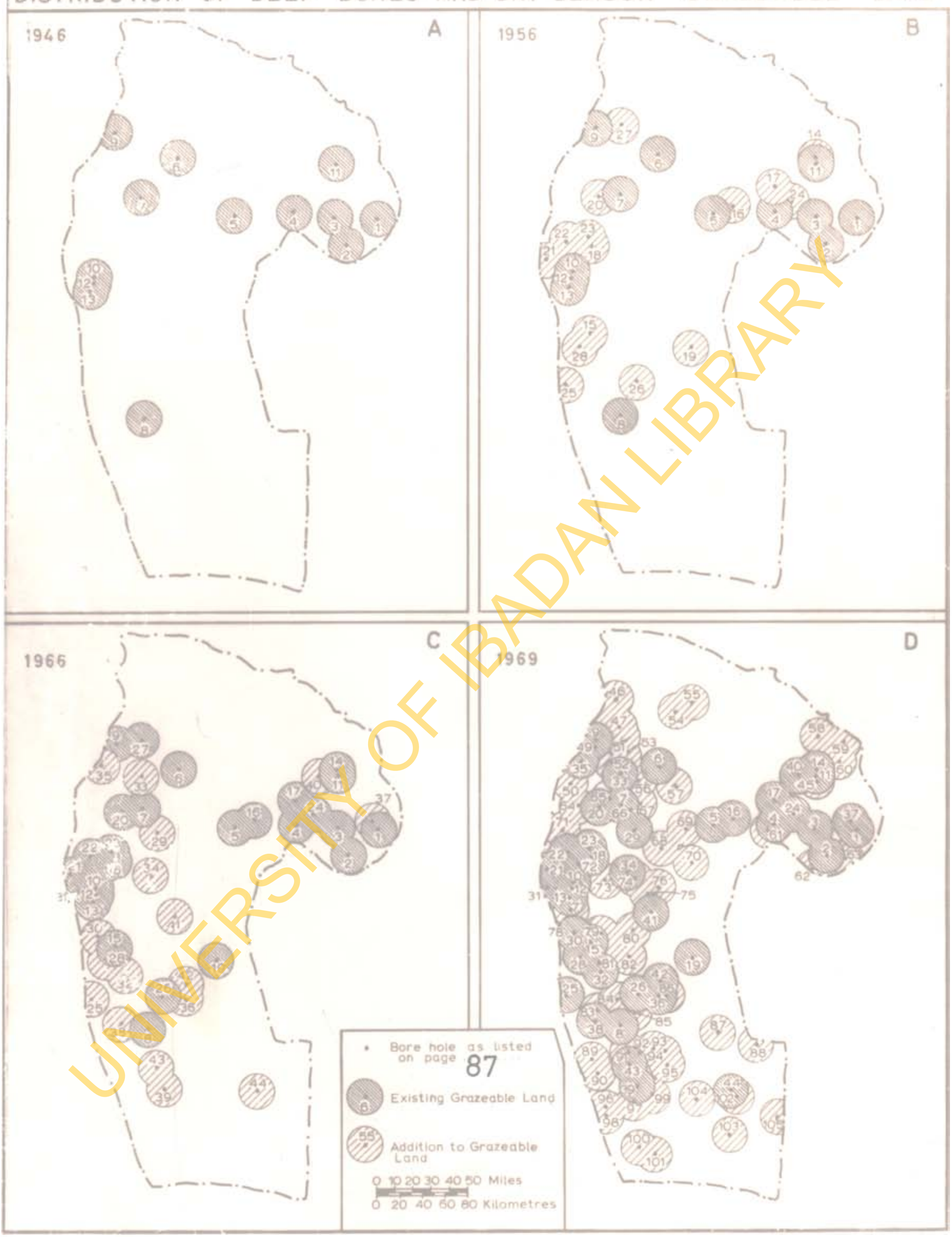
In 1947, the area added to usable land by deep bores was 2,425 $km.^2$ or 3 per cent of the land area. By 1969, the proportion had risen from 3 to 21 per cent. This represents an over-all percentage increase of 613 over the 1947 figure. This increase also varies spatially. The most spectacular increase of 2,543 per cent has been observed in Dar Humr. This rapid increase post-dated 1965, and can be attributed to the Milk Processing Factory at Babanusa. The factory, which has a capacity for 50 metric tons of milk daily, went into production in 1968. For the factory to operate successfully, milk must be available within a distance that can be conveniently covered by lorry tankers in under five hours. In South-Western Kordofan where road transportation is difficult and slow because there are no roads in the modern sense but motorable tracks, this distance has been set at under 80 kilometres (50 miles) by the management of the Milk Processing Factory. Meeting the factory's milk supply requirements within such a small distance is not possible without adequate sources of permanent water supplies. The rapid increase in the rate of well drilling in Dar Humr since 1966 should not be seen as part of a conscious effort by the rural water supplies authorities to correct the glaring but not generally recognized regional imbalance in allocation of wells. It should rather be regarded as the result of the pressure exerted by the management of the Milk Processing Factory on the well allocating authorities, to ensure an adequate and regular supply of milk to their factory. In the remaining regions, the increase is much less spectacular, being 879 per cent in Southern Hamar, 418 per cent in Northern Hamar and only 181 per cent in Eastern Hamar.

For pastoralism, the story is markedly different. With 105 water yards, the expected usable grazing land at a radius of 16 km is 84,479 square kilometres, an area larger than that of South-Western Kordofan. This anomalous situation is due to the fact that wells situated very close to the imposed boundaries command land in other territories adjacent to them, (Fig. VIII). If all the 105 water yards had been located at the postulated uniform interval of 32 kilometres, the present number of wells would have been adequate to render all the grazing in this area usable; nevertheless if human and animal populations were not kept down to the level of available water supplies the area's grazing resources would deteriorate.

In practical terms, however, the observed additions to usable grazing land by deep bores ~~is~~ are only 46,134 km^2 or 55 per cent of the area of South-Western Kordofan (See Table 7 below for periodic and regional breakdown of this figure). As for agriculture, this proportion shows wide regional variations. The regional contributions to the over-all increase in usable grazing land are 17 per cent (for each of Northern and Eastern

Fig. VIII.

DISTRIBUTION OF DEEP BORES AND DRY SEASON "GRAZEABLE" LAND



Hamar), 32 per cent (Southern Hamar), and 34 per cent (Dar Humr). These proportions respectively represent 44, 55, 78 and 48 per cent of the total regional land.

From the above analysis, it is quite obvious that in terms of availability of water for resource utilization, Southern Hamar fares much better than any other region. Northern Hamar is at the bottom of the ladder, while Eastern Hamar and Dar Humr occupy mid-way positions. But when the whole of Dar Hamar is compared with Dar Humr, the table is definitely in favour of the former.

What precisely is the trend of the contributions made by new wells to usable land over the years? To determine the trend, the proportion added to usable land, both for agriculture and grazing, by every additional well over the four periods, is correlated with the total number of new wells. The "r" values are - 0.55 and - 0.56 for crop farming and grazing respectively (See Table 8 below, for more information). When tested by using the student "t" test, the "r" values are significant at 2 per cent level. Thus, they show a medium but statistically significant negative correlation. In other words, contributions made to usable land by every additional well has been on the decline. Thus, there is enough evidence to conclude that the fewer the number of water points, the longer are the inter-water point distances, and the smaller is the degree of overlapping. Conversely, the greater the number of water points, the shorter are the between water point distances, and the larger is the

(km^2)

degree of overlapping.

Populations and Water Needs:

The next logical enquiry that should be made is to find out the extent to which existing water supplies can meet the needs of the populations. This is a difficult exercise indeed. Besides deep bores, there are other sources of water supplies. During the rainy season, a large proportion of the populations obtains their drinking, washing and cooking water from fulas. In the dry season, a smaller proportion procures their water from shallow wells sunk in the bottom of the Fulas. A smaller proportion still depends on water stored in baobab (tebeldis). These sources are not only difficult to quantify, but they are also unreliable. They depend directly on rainfall for their annual replenishments. This unreliability has been further spotlighted by the fact that all but two (Foga and El Odaiya), of the major well fields have had deep bores sited in them. One could therefore safely predict that over time, deep bores would become the only reliable permanent sources of water supplies for the populations of South-Western Kordofan.

In this exercise, only the dry season water needs of the populations are considered. For it is during this period that water needs are greatest. It is also during the dry season that the smallest proportion of the populations depend on other sources of water supplies.

There are 330,359 people and 321,524 animal units in South-Western Kordofan. With the average family size estimated at 5, there would be

66,072 families. Each family would have, on the average, 5 animal units. Using the recommended daily minimum water need of 4 and 6 gallons per man and animal unit respectively, a family require 50 gallons of water a day.

The average rate of pumping water from deep bores has been estimated at 1,000 gallons per hour, and the wells are pumped for an average of ten hours per day. At this rate of pumping, a twin-well donkey would support 400 families. Each family would have at its disposal 125 acres of usable land. The F.A.O. experts who executed the United Nations Organization's programme for land and water use survey in Kordofan province set up experiments in eight stations to determine the carrying capacity of pastures. Two of the stations were in the environs of En Nahud and El Khuwei. The results of the experiments showed that 11 and 20 acres respectively, of properly managed pasture would support one animal unit.[33]

The pastures in the environs of En Nahud and El Khuwei are already degraded due to over-grazing. However, pastures in most parts of South-Western Kordofan have not suffered the same fate. It could therefore, be reasonably expected that they would have a higher carrying capacity. This optimistic view nothwithstanding, it is the opinion of the author that a generous allowance of at least 15 acres should be granted a beast. This would still leave the family with an average of about 50 acres of usable land. This is more than enough to meet its land demands for agriculture and forestry, and where possible, for the establishment of gum gardens.

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33. F.A.O., Rome, 1967, op. cit., p. 179.

To meet the recommended minimum water needs of the present officially declared populations of South-Western Kordofan within the 8 km radius, at least 165 twin-well water-yards would be needed. But the livestock population is much larger than the officially declared one. It is common knowledge that livestock owners are reluctant to give information about their stock. They know too well that they will be assessed for taxation on the size of their herds. They therefore, contrive all sorts of methods to conceal the numbers. Therefore, any plan for water supplies based on the present livestock size is going to be ineffective.

To make up for under-estimation in livestock numbers, the officially declared animal populations for each region have been adjusted. The factor used in adjusting is the percentage difference between the estimated livestock numbers by the Ministry of Animal Resources, and the figures obtained from livestock tax registers for Hamar and Messeriya Rural Councils. As stated earlier on in this chapter, the Ministry's estimates show that there are 578,000 animal units in South-Western Kordofan. This is about 44 per cent larger than the figure obtained from tax registers. In the correction exercise, a uniform rate of understating livestock numbers has been assumed throughout the area. Thus, the livestock population of each region has been increased by 44 per cent.

Using this adjusted figure, there would be 9 animal units to a family. The family's daily minimum water need would rise to 74 gallons.

At this rate a twin-well water yard would support only 270 families, and each family would have 185 acres of usable land. On this basis, 244 twin-well water yards would be needed to supply the populations of South-Western Kordofan with their minimum water requirements.

Whatever figures are employed, it is quite obvious that water shortage is still severe in this area. However, the degree of shortage has wide regional variations; (for a clearer picture of the water situation, see Table 9). The greatest shortage occurs in Dar Humr. At present it can obtain only 27 per cent of its daily minimum water needs from permanent sources. Although the three Hamar regions suffer from water shortage, they are much ~~well~~ better off than Dar Humr. The least shortage occurs in Southern Hamar where 68 per cent of the populations can procure their minimum water needs from government wells. In Northern and Eastern Hamar where the degree of water shortage is fairly equal, this proportion is slightly over half.

Until now, it has not been generally recognised that the area of greatest water needs on the basis of population size is the South (Dar Humr). Attention has always been focus ed on the north (Dar Hamar). From the fore-going analysis, it is now quite clear that the north fares much better than the south. About 60 per cent of its populations can obtain their minimum water requirements from deep bores. This is in sharp contrast to the south's 28 per cent. To satisfy the minimum water needs of the present populations of South-Western Kordofan, 139 additional twin-wells will have to be sunk. Ninety-one of these must be in Dar Humr.

In the context of land use, the south fares much worse still. On the whole, land is not in scarce supply, but usable land is. Employing the calculated minimum water need per family, the number of families a twin-well water yard could support has been determined. This number is then employed to calculate each family's share of land within the ekistic envelope of radius 8 km. It is the land within this envelope that is described as "usable land" in this text.

These calculations show that just less than 36 per cent of the land requirements of the populations lies within the postulated 8 km radius of permanent sources of water supplies. As usual, this proportion varies from one region to the other. In the South, it is as little as 22 per cent, while in the North, it is as much as 50 per cent.

From Table 10 below, it is quite obvious that not all the families supported by a donkey, (on the basis of recommended minimum water needs), could have their postulated share of usable land within the 8 km radius. Definitely, water availability is in excess of usable land within this radius. If all the families were to depend only on the land within this zone they would do so at the expense of reduction in the postulated acreage per family.

Observed usable land is only 82 per cent of postulated usable land. Overlapping accounts for the balance. In this respect also, the table is tilted against Dar Humr where the degree overlapping is 20 per cent. This is 2 per cent higher than the average for the whole area (See Table 6, 1966 - 1969, Column V).

Nevertheless, if adequate water were available, it would be possible for the entire populations of South-Western Kordofan to obtain their postulated share of usable land within the 16 km radius. However, when availability of usable land within this zone is considered regionally, an entirely different story is told. While the three Hamar regions have usable land in excess of their populations postulated shares to the value of 29 per cent Dar Humr has land deficit to the value of 37 per cent.

In terms of capacity for utilizing resources, the advantage lies with the South. Capacity is defined in terms of population density per unit of land, and on the assumption that no regional differences exist in the quality of the populations. If this were so, one would expect capacity for resource utilization among purely agrarian populations to be a function of population density. Population is higher in the South than in the North (See Table 4). In this context, capacity for resource utilization is determined by the proportion of the land area, formed by the postulated land demands by the populations. For the whole area, this proportion is 58 per cent. As usual, this proportion is not uniform throughout the area. It is 73 per cent in the South but only 46 per cent in the North.

Thus, it is the opinion of the author that whether allocation of wells is considered on this basis of needs, or on the basis of resource potentials, or even on the basis of capacity for resource utilization, Dar Humr is entitled to a greater degree of attention than it had hitherto received.

SUMMARY

It has been shown that government rural water development programmes have gone a long way to alleviate the acute water shortage in South-Western Kordofan. However, there is still much to be done. Existing deep bores could satisfy at most, only 43 per cent of the recommended water needs of the populations. Yet, no populations have been going without water. This could only mean that a very large proportion of the population ~~have~~ has been subsisting on water supplies at very much below their average requirements.

It has also been demonstrated that contrary to general belief, the area of greatest water shortage, on the basis of population needs, is the south. This is the result of a serious imbalance in the allocation of wells. Prior to the 1960's, the North was favoured. The principle of needs in terms of size of populations, was not seriously adhered to in allocating wells, at least on a regional basis; for the results obtained when wells and populations were correlated showed that if any principle was applied at all, it was the exact opposite of that based on need.

Similarly, in this chapter, it has been shown that the pattern of well distribution is almost wholly random. There is therefore, no evidence of any deliberate attempt to use deep bores to encourage a balanced use of resources. This situation tells adversely on the availability of usable land. Observed usable land falls short of expected usable land by 18 and 45 per cent within the 8 km and 16 km radius respectively. This fall results directly from overlapping, the amount of which is a function of the degree at which wells are "clustered" in centres of localized population concentrations.

Finally, it has been shown that there is need to allocate wells equitably both between and within regions. This is about the best weapon which government could use to enhance and ensure a balanced use of resources.

CHAPTER FOUR

DEEP BORES AND THE PASTORAL ECONOMY

Introduction.

In the last chapter, the principles for allocating deep bores and the resulting distribution pattern were discussed. In the next three chapters, the effects of deep bores on the rural economies of South-Western Kordofan are examined. This chapter begins with a consideration of livestock husbandry vis-a-vis availability of water supplies.

The Humr people have remained predominantly animal rearers since they arived in the Sudan about the 12th century A.D. Like the Humr, the Hamar people were dependent almost entirely on animal breeding until the beginning of the Mahdiya.[1] As pointed out in chapter two, the Hamar who refused to support Khalifa Abdullahi, the Mahdi's successor lost their animals to the Kababish supporters of Abdullahi. The Hamar were therefore compelled to become cultivators to earn a living. They have, however, been trying with some measure of success to regain their lost glory in the livestock industry. This is because they, like the Humr, place high premium on animal wealth; hence every Humr and Hamar strives hard to own animals. Consequently, today, livestock husbandry

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1. Mahdiya refers to the period 1881 - 1898 when the Mahdists (members of a politico - religious movement) ruled the Sudan first under the leadership of Muhammad Ahmad, (1881 - 5) and later Khalifa Abdullahi (1885 - 98). For detailed information on Mahdism in the Sudan, see Holt, P.M., 1958, The Mahdist State in the Sudan.

is the most and second most important economic activity among the Humr and Hamar tribes respectively. This explains why there is a very large animal population in the study region.

According to the 1969 estimate by the Ministry of Animal Resources, there are 62,000 camels, 366,000 cattle, 438,000 sheep and 278,000 goats in South-Western Kordofan.[2] Most of these animals are owned and herded by nomadic and semi-nomadic Arabs under a nearly self-sufficient pastoral economic system. This system of operating the livestock industry of the Sudan has been condemned by men of education for various reasons. Academicians from various disciplines and planning authorities have consequently suggested schemes which are designed to upgrade the environment of the nomadic population and eventually raise their present low standard of living.[3]

In terms of scope and of capital requirements, the two most important among these schemes are the government's Rural Water and Development Programmes, and the planned settlement of the nomadic population. Since the success of the proposed planned settlement depends upon the availability of adequate and all - season sources of water supplies, this

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2. Sudan Surveys Department, Khartoum, 1969, op. cit.

3. For detailed information on proposals for improving the modes and standard of living of the nomads, see The Proceedings of the Tenth Annual Conference of the Philosophical Society of the Sudan on "The Effect of Nomadism on the Economic and Social Development of the Sudan", Khartoum, 1962.

chapter briefly summarises the policies which have been pursued for about a quarter of a century. Later, the expected and observed changes in the mode and standard of living of the people are examined. These changes are considered as they affect the relationship between the nomadic population and their land as reflected in the management of their animals, their grazing practices and seasonal movements, their attitude to cultivation and the extent to which they now engage in crop production.

Existing Literature on Livestock Husbandry in South-Western Kordofan:

Literature abounds on the pastoral economy of the Sudan. Bennett, John and Hewison have given a general account of this industry in Tothill's Agriculture in the Sudan.[4] Their account includes sections on the description of type of animals reared, their role in Sudan's rural life, and the products derived from them. Snow, D.W. has also discussed Sudan's animal foodstuffs in the same book.[5] Harrison, M.N. had surveyed and reported on grazing in the Sudan.[6] Barbour[7] and Lebon[8]

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4. Bennett, S.C., John, E.R., and Hewison, J.W., 1948, Animal Husbandry in (Ed.) Tothill, J.D., op. cit., chapter XXII.
5. Snow, O.W., 1948, Animal Foodstuffs, in (Ed.) Tothill, J.D., op. cit., Chapter XXIII.
6. Harrison, M.N., 1955, op. cit.
7. Barbour, K.M., 1961, op. cit., pp. 93, 148, 151, 159-60, 165-7, 169-72, 176, 182, 238-40, 260-2, 270-1 and 276.
8. Lebon, J.H.G., 1965, op. cit., pp. 78-149, and 158-172.

give prominent space to discussing the pastoral industry of the Sudan in several sections of their works. Perhaps, the most comprehensive study of any nomadic tribe in the Sudan has been undertaken by Cunnison.[9] In his anthropological study of the Baggara Humr, cattle husbandry receives satisfactory treatment. Others who have contributed to the study of the Sudanese nomads and their livestock include El Hadi El Nagar and Baasher, T.,[10] Randell, J.R.,[11] Hassan, H.I.,[12] and Berry, L.[13] All these men are unanimous in their views that the whole life of the animal owners is bound up with the well-being of their animals, since it is upon these animals that they depend for their subsistence.

It is also universally accepted (by the afore-mentioned scholars) that the choice of a nomadic way of life either wholly or partly by the livestock owners, is a logical reaction to an environment characterized by seasonal shortage of water or pasture or both. While this may be so in the northern part of South-Western Kordofan, it is largely the

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9. Cunnison, I., 1966, op. cit.
10. El Hadi El Nagar and T. Baasher, 1962, Psycho-Medical Aspects of Nomadism in the Sudan, op. cit., pp. 29 - 39.
11. Randel, J.R., 1962, The Potential Development of Lands Devoted to Nomadic Pastoralism, op. cit., pp. 70 - 79.
12. Hassan, H.I., 1962, The Environments of the Nomads, op. cit., pp. 22 - 27.
13. Berry, L., 1962, The Nomadic Environment in the North Eastern Sudan, op. cit., pp. 80 - 85.

necessity to escape from the swarms of biting flies (Tabanids and stomxys spp.) that imposes seasonal movements on the pastoralists in the Southern part of South-Western Kordofan.[14]

The Case Against Pastoral Nomadism:

Nomadism, as a way of life, has been decried on educational, economic, psychological, social, political and medical grounds. The children of the nomads, it is generally claimed, are very difficult and expensive to educate. The nomads, according to El Hadi El Nagar and Baasher, T.,[15] will not willingly bring their children to school due to their aversion to education. They contend that this aversion arises from the socio - economic state of the nomads, because the children are part of the economic system which is organised around the family. Consequently, nomadic people cannot afford to leave their children behind in schools that are hundreds of miles away from their abode.[16] In his own contribution

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14. Joshi, N.R., McLaughlin, E.A. and Phillips, R.W., 1957, Types and Breeds of African Cattle, F.A.O. Agricultural Studies. No. 37, p. 63.

15. El Hadi El Nagar and T. Baasher, 1962, op. cit., p. 31.

16. The difficulty in educating nomads' children arises mainly from the fact that large scale education is incompatible with continual movement. To overcome this difficulty, and thus encourage and promote the education of the children of nomads, two methods are employed by the government. First, mobile elementary schools are set up to accompany the pastoral nomads on their annual migrations. Secondly, most elementary schools in the dar of the nomads have free boarding and lodging facilities for the children of nomads.

to the debate on the attitude of nomadic populations to education, Ian Cunnison asserts that the nomadic Baggara Arabs have rejected formal education for "the schooling of children would interfere with their training in nomadic techniques."[17]

Economically, it is said that nomadic populations contribute little to the commercial sector of the national economy. Their attitude to their animals differs significantly from that of 'rational economic man'; hence pastoral peoples are very reluctant to part with their animals whatever economic stimuli they may be offered. This is because they possess more than purely mercenary attitude to their livestock, and are therefore, not interested in them for maximisation of profit.[18] This attitude is particularly characteristic of the cattle - owning populations not only of the Sudan, but also in many parts of Africa among whom "the social aspects of cattle keeping outweigh commercial considerations".[19] Also, by their communal and extravagant use of resources (pasture), the nomads constitute a great obstacle to economic development. Furthermore, their supervision and control to ensure that they do not destroy the crops of the sedentary cultivators, is often a time consuming undertaking.

On the political plane, the nomads are said to present the administrators with several problems. The personal loyalty of the nomadic peoples

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17. Cunnison, I. Asad, T., and Hill, L.G., 1966, Settlement of Nomads in the Sudan: A Critique of Present Plans, in (Ed.) Shaw, D.J., op. cit., Vol. 1, p. 114.

18. For further information on the nomads' attitude to their animals, see Ibid., p. 105.

19. Mahadevan, P., 1966, Breeding for Milk Production in Tropical Cattle, Technical Communication No. 17 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh, p.1.

in the Sudan as elsewhere in the World, is mostly tribal. And as the group cohesion within the clan or tribe is very strong, there is always the tendency to collective fighting.[20] This attitude has often been a serious handicap to the development of a national spirit and outlook, and to the maintenance of national solidarity. As the nomads are on the move for most part of the year, collection of taxes from them is a hazardous and expensive task. For in Awad's words, "the normal duties of all citizens, like the payment of taxes, and conscription, are especially hated".[21] And for the same reason, government's efforts at providing essential social services for them are always frustrated.

In addition, nomadic populations pose serious problems to the health and veterinary authorities. For one thing, their movements make it difficult to prevent and control the spread of diseases among them and their animals. For another thing, "in their wanderings, nomadic populations

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20. Two such collective fightings took place in South-Western Kordofan in 1968 alone. The first was between 'Awlad Heban and Gazaya over who should innoculate their cattle first. During this feud, a total of 74 people were killed. The second feud which arose over right to tap gum involved Ben 'Umran from Darfur and 'Awlad Kamil of the Humr tribe. In the feud, 'Awlad Kamil suffered two dead, while the Ben 'Umran were forced to return to their dar in Darfur - Source: Personal interview with Babo Nimr 'Ali Jula, the Nazir General of the Messeriya Tribe, El Muglad, March, 1969.

21. Awad, M., 1959 "Settlement of Nomadic and Semi-Nomadic Tribal Groups in the Middle East, International Labour Review, Vol. LXXIX, p. 33.

contract and disseminate a number of infectious diseases".[22] Furthermore, the unsettled nature of their mode of living makes the treatment of those suffering from diseases not easily attainable. Finally, they are easily susceptible to diseases, for they are liable to suffer from malnutrition. This is because they subsist mainly on a diet of milk and porridge which is far from constituting a balanced diet.

For the reasons listed above, based largely on emotional assumptions rather than on purely scientific investigations, these scholars have in their studies called for, and put forward plans for developing the environment of the nomads. They differ, however, in their approach. There are two schools of thought on how best to solve the problems associated with nomadism. At one end of the scale is the group that strongly hold the view that the best and only way to improve the living conditions of the nomadic peoples is to settle them. Belonging to this group are geographers, veterinary and agricultural officers, and administrators.

Why the Pastoral Nomads should be settled:

Various arguments have been adduced for advocating a programme for settling the Sudanese nomadic populations.[23] According to Hassan, H.I.,

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22. (i) El Hadi El Nagar and T. Baasher, 1962, op. cit., p. 34.
(ii) Prothero, R.M., 1961, Population Movements and the Problems of Malaria Eradication in Africa, World Health Organisation Bulletin, No. 24, pp. 405 - 425.
(iii) Prothero, R.M., 1967, Public Health, Pastoralism, and Politics in the Horn of Africa, The Sixth Melville J. Herskovits Memorial Lecture under the Auspices of the Northwestern University, U.S.A.
23. El Hadi El Nagar and Baasher, T., 1962, op. cit., pp. 29 - 39.

El Hadi El Nagar and Baasher, T., and Mihaymid, nomadism is not a natural way of life, and therefore, it could be safely assumed that in the ultimate, settlement would be accepted as a better alternative. This view has been supported by Ahmed Ali Zaki and Ahmed Magdoub, when they assert that "nomadism is a way of life which has been forced on people by the decree of natural conditions.". In his own contribution, Mustafa Baasher contended that "nomadism is a primitive adaptation, which at one time in past history could have ranked as being one of the most easy, most profitable and safest of man's numerous adaptations to secure his living". He added that "it is illogical to assume that Sudan nomads, through choice, have preferred to live as they do now, and made up their minds to the rejection of other means of earning their daily living".[24] Writing in the same vein, El Hadi El Nagar and T. Baasher added that, "so far, we do not know of any scientific research which attributes nomadism to purely innate or biological factor". They went further to assert that a change in the nomads' physical environment would be followed by a corresponding change in their reactions and rhythm of life."[25]

Awad has found that the size of a community varies according to environment and mode of living; and since nomadic communities are small, he has concluded that absolute nomadism has a restrictive influence on

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24. Baasher, M., 1962, Range and Livestock Problems Facing the Settlement of Nomads, op. cit., p. 51.

25. El Hadi El Nagar and T. Baasher, 1962, op. cit., p. 31.

size. Under nomadism, when a tribe grows beyond a certain level, it begins almost immediately like the Anza of Arabia and the Fertile Crescent, to split up into several sub-tribes, in order, perhaps to prevent sufferings arising from psychological stress often associated with "over-population." Under sedentary conditions, however, the size of communities tends to be large. Accordingly, the size of nomadic tribe which becomes partly or wholly sedentary, often grows to considerable proportions in accordance with the growth of the means of subsistence. The Hadendowa of the Sudan, a Beja tribe of over 100,000, and the Awlad 'Ali of Egypt which have increased steadily in the past fifty years are good examples.[26]

The smallness of size acts as a constraint upon economic and social development. Since all settled communities are larger than nomadic ones, the proponents of nomad sedentarisation strongly hold the view that in any community, a change from a migratory to a sedentary mode of living would remove this constraint. This would make it possible for the nomads not only to be provided with, but also to make economic and effective use of organized social services.

The success elsewhere of programmes to sedentarise the nomads has been thought to betoken their success in the Sudan. In several parts of the Middle East, Southeast Asia and the Soviet Russia, settlement of nomadic populations has been successfully accomplished by a combination of several measures. These include the growth of strong and stable

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26. Awad, M., 1959, op. cit., p. 27.

government, religious, social and land reforms, and the development of agriculture. Thus the proponents of nomad sedentarisation optimistically believe that what has been achieved in one place is capable of accomplishment in another, especially if the physical and cultural environments are similar. Of course, they could not have though otherwise, for they are disciples of the doctrine that nomadic or semi-nomadic mode of existence is but a stage in the evolutionary process towards sedentary mode of living. For this evolution to take place, the natural environment has to be modified, since, "nomadism", according to J. Berque, "is an extreme case of a human society's adaptation to an unfriendly environment".[27] Since the rate at which the evolution takes place is a function of the rate of change in the natural environment, it can be controlled or accelerated or both.

In Saudi Arabia, the Wahabis, motivated by the zeal of religious reforms started the Hijira movement. Settlements called Hijiras[28] were

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27. Berque, J., 1959, Nomads and Nomadism in the Arid Zone, International Social Science Journal, Vol. XI, No. 4, p. 484.

28. Hijira is the name of the immigration of Mohammed to Medina in 622 A.D. It is given to Wahabi settlements to highlight the significance of religion in the life of the inhabitants of these settlements. Hijiras which now number over 200, and some of which have grown to respectable little towns with about 20,000 inhabitants consist of a kind of oasis, where permanent settlements have been built, and an agricultural life is pursued. For further details on Hijira settlements, see Awad, M. 1959, op. cit., pp. 51 - 54.

founded with royalties received from petroleum. In these settlements, nomads were encouraged to settle to enable them live a truly religious life. The founding of the Hijira movement has resulted in many tribes like the Tameem becoming completely sedentary and the Nejd ceasing to be a land of nomads.

In oil-rich Iraq, the settlement of the nomadic populations was triggered off by the establishment of peace and order, and the development of water supplies (both surface and underground) which enabled tribal lands to be brought under cultivation. In Syria, the sedentarisation of nomads was made part of the constitution of the land, for Article 158, Section (i) of the 1950 Independent Syrian Constitution stipulates that "The Government shall endeavour to sedentarise all nomads".[29] This objective was achieved through a rapid and systematic expansion of the cultivated area, which deprived the Bedouin of the most fertile and suitable grazing land.[30]

On the other hand, nomad settlement was indirectly triggered off in some parts of Egypt. It was the cutting of the Suez Canal which has helped to create permanent settlements in the middle of the desert, and limited the inter-tribal raids between Sinai and Eastern Egyptian Desert.[31]

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29. Ibid. pp. 45 - 51.

30. Mahouk, A., 1956, Recent Agricultural Development and Bedouin Settlement in Syria, The Middle East Journal, Vol. 10, No. 2, pp. 167 - 176.

31. Award, M., 1959, op. cit., p. 35.

Among the Ait Atta of Morocco, the movement towards sedentary life was voluntary. When the country was pacified and strong government established, the Ait Atta nomads lost many of their traditional sources of income - protection of settled farmers, escorting caravans, tribal wars, guarding cattle against theft, and trading. This movement was further reinforced by the greater economic security provided by irrigated agriculture in comparison with the heavy, and often fatal risks of nomadic herding.[32]

In Soviet Russia, it was the contact of the nomadic populations with the working peasants who had been moved over from the central region, that initially stimulated the nomads to become settled. This contact, which was encouraged by the government, resulted in the nomadic population, for example, the Kazakhs, settling down on the land and taking to cultivation. The consequent settlement later proved a significant factor in the development of the economy and the improvement of the cultural and living conditions of the nomads.[33]

In Anatolia, every expedient means was used to settle the nomads. While land was often distributed to them, the most recalcitrant were called up for work on the mines or on the fortifications and others were deported to Cyprus.[34] Yet in Israel, spontaneous sedentarisation

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32. Jongmans, D.G., and Gerlings, J.H.J., 1958, The Settlement of the Ait Atta Nomads of Morocco, Geographical Review, Vol. 48, pp. 110 - 112.

33. Tursunbayev, A, and Potapov, A., 1959, Some Aspects of the Socio-Economic and Cultural Development of Nomads in the U.S.S.R., International Social Science Journal, Vol. XI, No. 4, pp. 511 - 524.

34. Xavier de Planhol, 1959, Geography, Politics and Nomadism in Anatolia, International Social Science Journal, Vol. XI, No.4, p. 525 - 531.

seems to be a frequent correlate of political stabilization and economic development.[35]

The Case Against Settlement of the Pastoral Nomads:

Cunnison, Asad, and Hill on the other hand, are, however, sceptical about the wisdom of a policy of planned settlement of the nomads. They have criticised those who object to nomadic existence on economic grounds, drawing attention to the fact that with few exceptions[36] nomads occupy poor and marginal lands which are generally not suitable for exploitation by other than nomadic means. To settle nomads of those districts, they have to be evicted. By evicting them from one place and settling them elsewhere, the resources of those marginal and poor lands, now being successfully exploited by the pastoral nomads, would be lost.

To improve the nomads' social and mental well-being, argued Cunnison and those in his school of thought, it is not absolutely necessary to settle them. Those who plan to settle the nomads, they contend, have their priorities wrong. What they should worry about is not how to settle the nomads, but rather, how best to integrate them more closely into the life of the whole community. This integration could be accomplished by relying on the effect of the normal development of their economic resources and social services. Nevertheless, this development can be hastened by

35. Muhsam, H.V., 1959, Sedentarisation of the Bedouin in Israel, International Social Science Journal, Vol. XI, No. 4, pp. 539 - 549.

36. The land occupied by the Baggara Arabs of South-Western Kordofan is among the few lands with high development potentials in the Sudan.

embarking on plans of community projects. They should proceed from the existing social frame-work which, among the pastoralists, implies a nomadic life. The social, no less than the economic aspirations of the nomadic populations should be catered for. Planned settlement goes with stock reduction and regulated culling. Yet, a nomad's social aspirations largely centre on the size of his livestock, and a limitation on the number of animals he can own is tantamount to an interference in his social life and a restriction on his liberty to exploit opportunities for attaining his social prestige which is often reckoned in terms of numbers of animals owned.[37]

Holding the same view as Cunnison and his associates is Mohi El Din Mahdi. He wonders why the nomads should be interfered with at all. To settle the nomads, he maintains, will only introduce to them such stress-symptons as high blood pressure and nervous diseases.[38]

As has been pointed out earlier in this chapter, many of the views expressed by both the proponents and opponents of nomad settlement have been based not on valid scientific investigations, but on intuitive judgments very largely influenced by emotions. The remaining ~~rest~~ part of this chapter tries, by using information derived from actual field surveys, to evaluate the deep bore programmes as they affect the mode of life and the economy of the inhabitants of South-Western Kordofan. An attempt is also made to reconcile the two opposing views on the desirability for

37. Cunnison, I., Asad, T., and Hill, L.G., 1966, op. cit., p. 104.
38. El Hadi El Nagar and T. Baasher, 1962, op. cit., p. 37.

planned settlement of nomadic populations, and to define what role deep bores have played and can play in the economic and social development of South-Western Kordofan.

Factors and Patterns of Movements:

In his study of pastoral migrations in South-Western Asia and Northern Africa, Johnson, D.L. has found that it is the combination of seasonal and areal variability in the location of pasture and water that makes the movement of pastoral nomads necessary. Because water and grass are in short supply in one area during one season of the year at the same time that they are abundant elsewhere in the tribal territory, survival of both herds and herders makes movement from deficit to surplus areas both logical and necessary."[39] Thus to Johnson, seasonal migrations by pastoralists are a funtion of the temporal and spatial shortage of grazing and water, features which are of particular relevance to the goz area of South-Western Kordofan. His reasons for pastoral migrations do not include the regional prevalence of biting insects and waterlogging which are important factors in out-migrations from the bahr area of South-Western Kordofan, where comparatively speaking, availability of pasture could be said to be perennial and adequate. Therefore, any attempts at explaining the reasons for and pattern of seasonal pastoral movements must make reference not only to the factors of temporal and

39. Johnson, D.L., 1969, The Nature of Nomadism, Department of Geography Research Papers, No. 118, University of Chicago, p. 4.

spatial variations in pastoral resource, but also to those of the prevalence of flies and muddy environments.

The Hamar and the Humr pastoralists of South-Western Kordofan practise annual and seasonal movements. To some extent these movements may be described as repeating; for they confirm to a basic pattern which is repeated each year. In this way, the pastoralists of South-Western Kordofan resemble the Somali pastoralists of the Horn of Africa whose movements have been described in details by Lewis.[40] In the kharif (rainy season), the two most essential needs of livestock - water and grazing - are plentiful both in the bahr to the South and in the goz to the north. It is only in the goz, however, that these resources can be, and are used. This is because the bahr is not only waterlogged, but also heavily infested by biting flies (Tabanids and stomxys spp.), which are irritating and deadly to animals. So each year at the beginning of the rainy season, the pastoralists who are in the bahr migrate to the fly - free goz. On the other hand, during the seif (dry season), water is scarce in the goz; and in consequence, the available pasture in form of 'standing hay' cannot be used except around centres with permanent water - base. The pastoralists are therefore compelled by the need to obtain water for themselves and their stock to migrate from the goz to places which have permanent sources of water supplies. Three factors,

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40. Lewis, I.M., 1961, A Pastoral Democracy, Chapter II.

the type of pastoral economy, the nature of the physical environment and geopgraphic distance from centres with permanent water -base determine the destination of the migrating pastoralists in the dry season. While most of the Humr with large numbers of cattle go to the bahr, now rid of much of its mud and flies, and where the availability of water in the khors and later only a few feet below their beds allows the hitherto abandoned grazing to be used, the others go to the 'well-fields' at Riglel Fula, Abu Zabad and El Odaiya. On the other hand, most of the Hamar, whose sheep and camels need a relatively drier environment than do cattle, migrate to the 'well-fields' at Riglel Fula, Abu Zabad, El Odaiya and Foga (all within South-Western Kordofan), and also Umm Badr in Dar Kababish further north. And since the deep-well drilling programmes began, a few of the Hamar and Humr pastoralists have started to migrate to centres which have boreholes.

To these fairly but distinct movement patterns must be added several more complex seasonal movements of people and stock mostly at the beginning and towards the end of the wet season in response to the detailed and immediate availability of water and pasture which are conditioned by the sporadic occurrence of rain in storms of limited duration and affecting only limited areas. Such complex movements may also occur in the bahr during the dry season and in the goz at any season in the event of the outbreak of animal diseases.

It is the view of the author of this thesis that the situation briefly described above is largely responsible for the pastoralists' distinct seasonal movements between the two geographically contrasting regions of the <u>bahr</u> and the <u>goz</u>, and the complex movements within the two regions. In short, scarcity of water, poor drainage coupled with prevalence of Tabanids and stomxys spp. constitute serious limiting factors to perennial pasture utilization in the <u>goz</u> and the <u>bahr</u> respectively. It has therefore been hypothesized that if these limiting factors to the exploitation of resources are eliminated, the <u>raison d'être for</u> seasonal pastoral migrations would cease to be tenable.

One might wonder why in spite of the possibilities which South-Western Kordofan possesses for crop production, its inhabitants still prefer animal rearing to farming. The reasons for this are not only historical, social and economic, but also, and more importantly physical. Before the Hamar and Humr tribes arrived in South-Western Kordofan, they were pastoral nomads. This was because pastoral nomadism was the only means of existence which their low level of technology enabled them to practise in the arid environment in which they lived. Their present environment is only slightly wetter; rainfall is very low and variable and the probability of crop failure is very high. The keeping of animals by the Hamar and Humr is, therefore, "a reflection of their value in protecting the human race from the vagaries of climate in regions where the cultivation of cereals and vegetables for human consumption is precarious, but where the ruminant can more effectively convert pasturage into milk".[41] In addition, animals are very valuable assets in an environment plagued by seasonal shortage of water and pasture, prevalence of biting flies and muddy conditions. This is because they can be marched with considerable ease from place to place in accordance with changing environmental conditions. Furthermore, it is easy to convert these animals into real cash and at no extra cost since they can be walked to markets. These two qualities - mobility and ease of conversion - which livestock possess have given the pastoralists an immense advantage over the cultivators who can only convert their surplus agricultural produce into real cash with much difficulty because in South-Western Kordofan, 'crop markets' are few and far between, and road transportation is inadequate, difficult and expensive. Finally, from what they know about the cultivators' living and working conditions the pastoralists do not feel that by becoming cultivators they will enjoy a much higher degree of comfort and attain a significantly higher standard of living. In the first place, the _ghutiyat_ (huts) of the cultivators, except that they are permanent, are scarcely more comfortable than the pastoral nomads' mobile _tukuls_ (tents.) The _goz_ villages are almost completely barren of vegetation; therefore, in the _seif_ both day and night, their _ghutiyat_ are exposed to the full effects of the _habub_ (violent convectional dust storm) causing much hardship to their occupants. The pastoral nomads do not experience such hardship because they pitch their _tukuls_ in well protected sites. In the second place, farm-work which involves bush clearing, tilling, weeding and harvesting is more laborious and much

41. Mahadevan, P., 1966, _op. cit._, p. 2.

dirtier than livestock husbandry. In the third place, livestock are recognized in South-Western Kordofan as the most valuable sources not only of wealth but also of honour and power; hence it is the ambition of every Hamar and Humr to own a large number of animals.

In the *bahr* the elimination of the limiting factors mentioned earlier on in this chapter would require two separate operations. While the stomxys can, perhaps, be kept at bay by spraying them with insecticides, major engineering works involving the investment of a large sum of money would be needed to solve the problem of excessive water. This, though feasible, is quite unattainable, at least for the present. A single act - the multiplication of water points by sinking deep wells could, however, remove the *goz's* most formidable factor limiting the effective exploitation of its pasture resources.

Another factor of significance in discussing seasonal movements by pastoralists of South-Western Kordofan relates to the quality of grazing. The *bahr* grazing has been found to be more nutritious than *goz* grazing. This is because the *bahr* grazing is rich in certain mineral salts which are lacking in *goz* grazing. The absence of these minerals in any grazing can be tolerated by animals, particularly cattle, only temporarily. The lack of these salts in the *goz* grazing is one of the reasons for the southward movement of livestock owners of South-Western Kordofan soon after the cessation of rains. The animals themselves are aware of the difference betwen the nutritive value of *bahr* and *goz* grazing, and are always anxious to leave the *goz*. Infact, the author was told of numerous cases of herds forcing a premature movement of their owners towards the _bahr_. A satisfactory solution has, however, been found to this problem of poor quality grazing. The solution consists giving the animals some quantity of natrun to take before they are watered.

At this point, it is necessary to point out that solutions to the _goz's_ water and grazing problems notwithstanding, the pastoralists of South-Western Kordofan may continue to be transhumant within the _goz_ unless measures that can satisfactorily eliminate the factors of all-season migrations are found. These factors relate mainly to certain behaviours of herds/flocks. Herds/flocks foul their kraals with their droppings and urine which produce bad odour and invite numerous insects particularly flies. The intensity of the odour and the size of the insect populations increase with the length of the herds'/flocks' stay in a place. So, to minimise the discomfort resulting from this inevitable situation the pastoralists engage in frequent changes of grazing and watering sites.

Nevertheless, since it is possible to find some solution to the problem of poor quality grazing, the sinking of deep wells should hold high hope for solving the problems associated with seasonal pastoral migrations in South-Western Kordofan. The determination of the extent to which this hope has materialised is the subject of the remaining part of this chapter. In doing this, the following indices have been examined both in the pre-deep bore era and since the well sinking programmes began: (i) the size of the nomadic population; (ii) the pastoralists' watering practices; (iii) their seasonal movements; (iv) their attitude to milk sales; and (v) their attitude to and involvement in crop production.

Before the deep well sinking programmes began, 188 (52 per cent) of the 360 respondents led one form of nomadic life or another. This proportion showed, however, very wide variations between villages (see Table 11 below). It was highest in Abu Bittikh (87 per cent) and surprisingly lowest (17 per cent) in Marbuta. The very low proportion for Marbuta could be attributed to 'reporting error' on the part of the respondents. The proportion also showed wide variations between the groups of villages, being highest in villages forming group two, and as expected, lowest in those forming group one.

Since the deep bore programme began, there has been a considerable reduction in the size of the nomadic and semi-nomadic population of the sampled villages, and hence of South-Western Kordofan. Only 69 (19 per cent) of the informants reported that they still moved about personally with their animals. This number represented only about 37 per cent of those that led this mode of living in the pre-deep bore era.

In the post-deep bore period, the proportion also varied both between individual and group of villages. It was still highest in Abu Bittikh (50 per cent) and nil at El Odaiya. For the group of villages, group three had the highest percentage (30) and group one the lowest

TABLE 11

THE NOMADIC POPULATION BEFORE AND SINCE THE BEGINNING OF THE DEEP BORE PROGRAMMES

VILLAGES	INDIVIDUAL VILLAGES					GROUP OF VILLAGES				
	PRE - DEEP BORE		SINCE DEEP BORE		% Reduction	PRE - DEEP BORE		SINCE DEEP BORE		% Reduction
	No.	%	No.	%		No.	%	No.	%	
1. Abu Zabad	10	33.3	5	16.7	50.0	18	30.0	5	8.3	72.2
2. El Odaiya	8	26.7	-	-	100.0					
3. El Muglad	24	80.0	12	40.0	50.0	71	47.3	21	14.0	70.4
4. Et Tibbun	12	40.0	5	16.7	58.3					
5. Ghubeish	8	26.7	1	3.3	87.5					
6. Wad Banda	12	40.0	1	3.3	91.7					
7. El Khuwei	15	50.0	2	6.7	86.7					
8. Abu Bittikh	26	86.7	15	50.0	42.3	69	76.7	29	32.0	58.0
9. El Bashama	24	80.0	12	40.0	50.0					
10. Mumu	19	63.3	2	6.7	89.5					
11. Marbuta	5	16.7	3	10.0	40.0	30	50.0	14	23.3	53.3
12. Iyal Bakhit	25	83.3	11	36.7	56.0					
T o t a l	188	52.2	69	19.3	63.3	188	52.2	69	19.3	63.3

Source: Field Survey, 1969.

(18 per cent). One strange phenomenon should be taken note of here. Following on the trend of discussion in this chapter, one would expect group four villages to record the highest proportion of nomadic population. But this proportion was only second highest. The reason for this rather strange phenomenon may be ascribed to the fact that the size of the nomadic population in the two periods has been very much lower than the group mean in Marbuta. This as would be seen later on in this chapter, may be rightly attributed to the degree of her involvement in crop production.

To evaluate how provision of deep bores has influenced the rate of change from nomadic to sedentary life, the size of the nomadic population of the sampled villages in the two periods has been compared. The statistical technique employed is the analysis of variance, the null hypothesis being that deep bores have no effect on the size of the nomadic population in the two periods.

From the table of analysis of variance below, it is obvious that the observed 'between period' differences are highly significant, for the calculated F - value of 13.60 falls within the one per cent level of probability. The "null" hypothesis is therefore rejected.

Another way in which to view how the sinking of deep bores has affected the size of the nomadic population is through time. From a visual observation, it is obvious from Table 11 Column 6, that the rate of change from nomadic to sedentary mode of living varies widely between

TABLE 12

COMPARISON OF THE SIZE OF THE NOMADIC POPULATION BEFORE AND SINCE THE BEGINNING OF THE DEEP BORE PROGRAMMES: THE USE OF THE ANALYSIS OF VARIANCE.

Source of Variation	Sums of Squares	Degree of Freedom	Variance Estimate
Between Periods	590	1	590
Within Periods	961	22	43.38

F - value (calculated) = 13.60
" (observed) : 1.0 per cent = 7.95**
" " : 0.1 " = 14.38

** Significant at 1.0 per cent.

villages. The rate of change has been crudely determined due to non-availability of data about the number of the nomads that become settled annually. Thus, the rate used is the over-all percentage reduction in the size of the pre-deep bore nomadic population.

To the nomad, a change to sedentary life is an innovation. And for widespread adoption of any innovation, a considerable time-lag is required. Thus, the over-all reduction per cent should vary directly with the length of time a village has been provided with water. This pattern has been observed in our region if only in a modest form, for when the reduction per cent of each of the sampled villages is correlated with the age of their deep bores, an 'r-value' of 0.29 was obtained, thus showing a low degree of positive correlation.

From the fore-going analysis, while it is possible to categorically state that deep bores do encourage the nomads to settle down, and that the size of the nomadic population of any deep bore centre varies inversely with the age of its deep bore, (Fig. IXb), it is not possible to draw conclusive inference about how long it would take the nomads of a particular deep bore centre to become completely sedentarised. A careful study of Fig. IXa reveals, however, that the rate of percentage reduction in the size of the nomadic population of the sampled villages, over the years, shows varying patterns. Abu Bittikh, El Bashama, and Mumu whose boreholes are less than a decade old, have very rapid rate of change; Et Tibbun, Ghubeish, Wad Banda and El Khuwei, have fairly rapid rate of change, while El Muglad, which has the longest history of deep bore behind it has a very slow rate of change.

From a careful examination of the above graph, it could be predicted at least, with some measure of accuracy, that if a water deficient area, whose inhabitants are wholly or partly nomadic, is provided with water, the nomads would settle down over time. The rate at which they settled would tend to be rather fairly rapid initially, but would taper off with time.

Watering Practices.

The watering practices of the pastoralists have been changing with

Fig.IX.(a)

PERCENTAGE REDUCTION IN THE SIZE OF THE NOMADIC POPULATION OF SAMPLED SETTLEMENTS WITH DEEP BORES SINCE THE DRILLING OF THEIR DEEP BORES

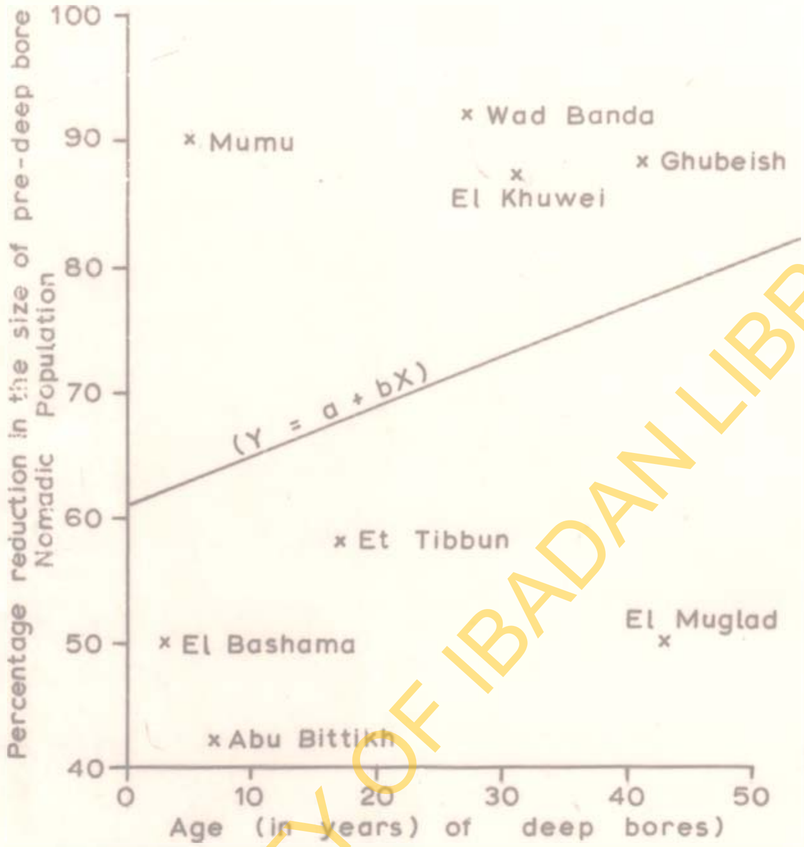
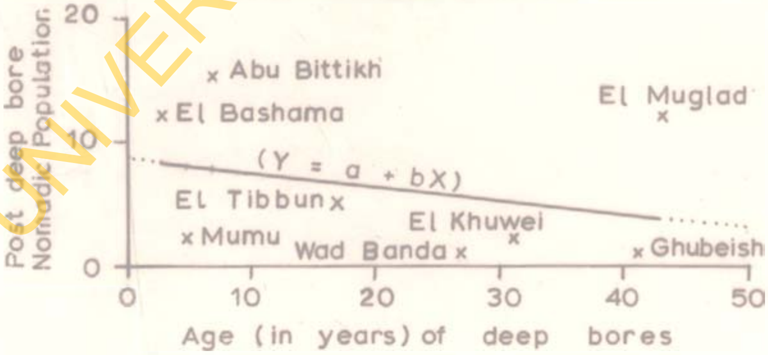


Fig.IX.(b) POST DEEP BORE NOMADIC POPULATION OF SAMPLED SETTLEMENTS WITH DEEP BORES



the provision of deep bores. Fewer pastoralists now go to the bahr in the dry season. This is a logical corollary from the change in the mode of living. Not only are there fewer nomads now, but the fewer nomads migrate over considerably shorter distances. For example, while the actual position of old wells have not altered, the drilling of new bores has in many instances appreciably reduced the actual distance between water points. Indeed, if all the wells in South-Western Kordofan were evenly spaced, the mean distance between wells would have declined from 41.7 km in 1946 to 15.6 km in 1969.[42]

It is not to be assumed, however, that once a pastoral nomad becomes settled, he automatically elects to water his animals at the deep bore centres. This is not always the case. If it were so, the number of those who still go to water their animals at the bahr/well-field should correspond to the number of pastoralists who do not make use of deep bores in watering their stock. In fact what happens is that watering practices vary immensely within a single structure of water supply. During the period of water scarcity, people go to settle in areas where they are sure of obtaining water for themselves and families, but whether they water their animals in those areas or away from them depends on several other variable factors which are described later on in this chapter.

Before the deep bore programmes began, those who owned animals in the ten sampled villages without permanent water-base numbered 159 (see

42. See Appendix I for full details of calculation.

Table 13 below). Those who practised one form of seasonal migration or another were 170. It could therefore be safely assumed that all those who owned livestock watered and grazed them away from their rainy season homes in the dry season.

TABLE 13

COMPARISON OF NOMADIC POPULATION AND LIVESTOCK OWNERS AND THEIR WATERING PRACTICES.

1	2	3	4	5	6	7	8
1. Abu Zabad*	10	13	5	24	21	2	1
2. El Odaiya*	8	12	-	26	26	-	-
3. El Muglad+	24	23	12	28	9	1	18
4. El Tibnun+	12	14	5	24	6	3	15
5. Ghubeish+	8	10	1	26	-	-	26
6. Wad Banda+	12	10	1	26	-	-	26
7. El Khuwei+	15	19	2	28	-	-	28
8. Abu Bittikh+	26	28	15	29	20	-	9
9. El Bashama+	24	24	12	27	12	1	14
10. Mumu+	19	19	2	24	2	-	22
11. Marbuta	5	2	3	27	17	-	10
12. Iyal Bakhit	25	10	11	28	21	-	7
Total	188	184	69	317	134	7	176

1. Name of village
2. Nomadic population (Pre-Deep Bore)
3. Livestock Owners (" ")
4. Nomadic Population (Since Deep Bore)
5. Livestock Owners (Since Deep Bore)
6. Livestock Owners not watering their stock at Water Yards.
7. Livestock Owners watering both at Water Yard and Surface wells.
8. Livestock Owners watering at Water Yards only

* Centres with permanent natural sources of water

\+ Centres with Deep Bores.

Source: Field Survey, 1969.

At present, the pastoralists water their animals in a variety of ways. What factors determine the choice of watering type by a pastoralist? Several factors could be cited. These range from the size of stock, the size of labour force (determined by the size of the house-hold), desire and opportunity for selling milk, and the availability of adequate pasture within a reasonable distance of sources of water, distance from the Bahr el Arab, and time.

In discussing the factors which govern the watering practices of nomads since the beginning of the well-sinking programmes, only those centres which possess boreholes have been chosen. These are eight in number. Of the 212 who owned animals, only 54 (26 per cent) were still watering their stock at the bahr/surface wells at the time this survey took place. Of these 54, five have already started to make partial use of deep bores. Virtually all the 54 were from the Humr sampled villages (See Table 13).

Great differences exist between the size of the stock of pastoralists who water at deep bores and the size of the stock of those who still go to water their animals at the bahr/surface wells. These differences are statistically significant at the 0.1 per cent level by the Chi-Square test (See Table 14 below). Thus the size of herd is an important factor influencing a pastoralist in his decision on where to water and graze his animals.

TABLE 14

THE SIZE OF THE HERD (IN CATTLE EQUIVALENTS) OF PASTORALISTS WHO STILL WATER THEIR ANIMALS AT THE BAHR/SURFACE WELLS IN THE EIGHT DEEP BORE CENTRES

Size of Herd	Less than 10	10 - 24	25 - 49	50 - 99	Over 100	Total
Observed (O)	6	5	14	12	17	54
	21	10	11	5	7	54

Chi - Square (Calculated) = 38.12
" (Observed) at 0.1 per cent level = 18.47**
** Significant at 0.1 per cent level.

Source: Field Survey, 1969.

Several reasons could be adduced for the preponderant influence which size of herd exercises on the pastoralists' choice of watering type. Watering of animals at deep bores costs money, while watering at the bahr or surface wells is free. Watering rate at deep bores is as follows: 8, 4 and 1 milliems per head of camel; cattle and goat/sheep respectively.[43] Camels water about four times in a month, while cattle, sheep and goats water every other day in seif.

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43. The rate of watering per head of cattle and camel was cut by 50 per cent soon after the present military rulers seized power in 1969.

The cost of watering a unit of animal (equivalent of a head of cattle) per year varies with the duration of the dry season, and this varies from year to year. In South-Western Kordofan, the duration of the dry season ranges from about six months in the south to about eight in the north. Therefore, the total cost of watering a head of cattle, which has been chosen as the unit of reference varies from £S 0.360 in the south to about £S 0.480 in the north. To the Arab pastoralists, this is a substantial sum of money. Thus, any change in watering practice from watering at hand-dug wells to watering at deep bores can be regarded as a major break-through in the attempt to sedentarise the nomads.

However, watering at hand-dug wells, although free, is an exhausting labour-and time-consuming task. Digging, lining and maintenance of the wells is an expensive undertaking. The wells lie mostly in those parts of the valleys which are flooded from superficial runoff during the rainy season. They are filled with water, depositing mud and detritus. After the rains, all hand-dug wells have to be dug anew every year. Kleinsorge and Kreysing have put the number of man days required to complete one well at 25.[44]

Sinking the well is one thing, getting out the water from the well is another. The water is usually brought to the surface manually by means of a rope and a leather bag. To ease the task of getting out the

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44. Kleinsorge, H. and Kreysing, K., 1959, op. cit., p. 12.

water, at least two persons are needed. If the well is fairly deep, and the number of animals to be watered is very large, a riding camel or bull may be required. This animal is used with a rope and pulley to raise the leather bag to the surface.

Unlike watering at deep bores, watering at the bahr/surface wells does not involve any monetary expenditure. Therefore, the choice of where to water by a pastoralist may be explained in term of Griliches's concept of economic profitability and cultural congruence on adoption of innovation. In his study of the diffusion of hybrid corn in Kansas, Griliches found that congruence could be an important variable within the more general rational decision making under uncertainty model, supplementing rather than supplanting the other probability variables.[45] In applying Griliches's concept of profitability and congruence to explain the choice of watering practices by the livestock owners of South-Western Kordofan, account must be taken of the ease of obtaining grazing. Since there is always a heavy concentration of human and animal populations around centres with permanent water-base, pastoralists with large herds will find it difficult to obtain grazing for them. This fact helps to explain in part why a very large majority of those who still water their animals at the bahr are owners of very large herds.

Before the dawn of the era of deep bores, the bahr/hand-dug wells provided watering centres for the pastoralists in the dry season. This

45. Zvi Griliches, 1960, Congruence Versus Profitability - A False Dichotomy, Rural Sociology, Vol. 25, pp. 354 - 356.

pattern of watering fitted admirably with the cultural practices of the pastoralists of South-Western Kordofan. This region suffered, and still suffers, though in a lesser degree, from serious seasonal un-employment, for no crop production is possible in the dry season in the absence of any irrigation works.

Water from boreholes is to supplement rather than supplant the existing natural sources of water supplies. At present, supplies both from surface wells and deep bores are inadequate to meet the domestic and watering needs of the human and animal populations, let alone to have surplus for irrigation. Therefore, for the livestock owners, the urge to continue with the traditional watering pattern he has found so admirably suited to his way of life is very strong. As a rational economic man, he will decide to substitute watering at deep bores for watering at the bahr/surface wells, only after he is certain of means from which he can earn adequate cash to meet his watering bills. Milk and gum production offers two such means, for South-Western Kordofan possesses high potentials for these two resources, which in the recent past had been little, if at all exploited.

<u>Milk Sales:</u>

As was pointed out in the introductory chapter of this study, it has been postulated that the provision of water supplies would enable the population to benefit more fully from the hitherto little exploited gum and milk resources of South-Western Kordofan. The rationale behind this postulate runs thus - all deep bore centres have high population growth potential. Also their potentials for attracting services are equally large. In fact, centres with deep bores have been growing rapidly into major service centres.[46] It will be shown later that there is a positive correlation between the number of services in a village with bore hole and the age of its borehole. A substantial proportion of the population of large deep bore settlements with several services is likely to be service and non-livestock owning. Since milk is an important item in the diet of the Sudanese, these will provide the much needed market for the pastoralists' milk produce.

The probability that pastoralists, especially the nomads would react favourably to this situation is high. As pointed out in chapter one, the Baggara Arabs are known to be favourably disposed to accepting innovations that do not conflict with their traditional social values or lead to a fundamental change in their way of life. Deyoe, Ross and Peters[47] have shown that although nomads are very reluctant to part with their animals, they are not entirely self-sufficient and must have cash with which to buy the comforts and minor luxuries of life and to pay their taxes. Before now, to meet their cash needs, they had to sell some of their animals; this they did reluctantly, because sales of animals conflict with their traditional attitude to their animals which to them represent wealth, capital, prestige and power.

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46. For further information on deep bores and growth of services, see chapter seven of this thesis.

47. Deyoe, G.R., Ross, W.A., and Peters, W.H., 1954, Raising Livestock.

The Babanusa Milk Processing Factory:

The needed cash can now be earned from sales of milk for which there are several markets. The market potential for milk has been further increased by the establishment of a milk processing factory at Babanusa, the rainy season abode of the Baggara Arabs. The factory which has a daily milk capacity of 50 metric tons, went into production in July, 1968. It owns ten four-ton lorry tankers for collecting milk from depot to depot over a planned maximum radius of 48 miles (77 km) from the factory.

No detailed observations have been carried out on the milk yielding capacity of cows under pastoral conditions in South-Western Kordofan. Joshi, Mclaughlin and Phillips have, however, estimated the average daily yield per milch cow to be 10 lb. with a lactation period of between 200 and 300 days. For the herd of the Faculty of Agriculture, Khartoum University, the average yields were 15.7 and 14.2lb. for the periods 1952 and 1953 respectively.[48] At the Gezira Research Farm, the average lactation period of the Kenana cattle over a period of seven years has been observed to be 15.7 lb. Also, Snow writing on 'Animal Foodstuffs in the Sudan', reported that "cows produce appreciable milk of up to 20 lb. per diem during the rains in the Baggara area.[49] Total milk production on the Kuku Farm is probably well over one gallon (10 lb.) per day, while cattle of traditional producers yield 7 rotls (lb.) only.[50]

48. Joshi, N.R., Mclaughlin, E.A., and Phillips, R.W., 1957, op. cit., pp. 69 - 70.

49. Snow, O.W., 1948, op. cit., p. 669.

50. For detailed information, See El Hadi, A.R. and Simpson, M.C., 1967 The Production and Marketing of Milk in Khartoum Province, Department of Rural Economy, Faculty of Agriculture, University of Khartoum.

In the light of the above, it has been inferred that in South-Western Kordofan, a cow could conveniently produce 10 lb. of milk per day, at least in the rains. At this rate, 11,000 milch cows would supply the factory's daily milk requirements. And since the ratio of dry cows, bulls and calves to milch cows is not likely to be larger than 2:1, a total cattle population of about 30,000 should be adequate to feed the factory with milk.

The factory is located in Dar Humr where, as stated in chapter three, the cattle size per family has been estimated at 29. Thus, if the cattle and human populations were evenly distributed, 30,000 heads of cattle would be owned by 1,055 families. With a daily minimum water requirements of 194 gallons of water per family, a total of eleven twin-bore wells should be adequate to support 30,000 cattle and their herders. In fact, at the postulated daily minimum water requirement per man and beast, the number of families that could be supported by eleven twin-bore wells is 1,133, which is larger than 1,055. The postulated eleven twin-bore wells could be provided within the planned 48 mile radius of the factory from where it has hoped to obtain sufficient supplies of milk. If this were done, a family of 5 with 29 heads of cattle would have access to over 1,300 acres of usable land. In fact, the cattle's grazing needs could be satisfied within less than three-quarters that radius (See Table 15 below).

TABLE 15

HYPOTHETICAL DISTANCES BETWEEN DEEP BORES AND THE AMOUNT OF USABLE LAND AVAILABLE PER FAMILY OF 5 WITH 29 HEADS OF CATTLE

Distance Between Deep Bores (km)	Radius within which 11-Twin well Deep Bores could be provided (km)	Total Usable land (in acres) around 11-Twin well Deep Bores	Usable Land (in acres) Available Per Family	Usable Land (in acres) Per Beast, Allowing Each Family 50 acres for crop production.
16	27	552,750	488	15
20	33	863,500	762	24
24	39	1,245,750	1,100	36
28	46	1,694,000	1,495	50
32	52	2,213,750	1,954	65
36	60	2,799,500	2,471	83
40	66	3,456,750	3,051	103
44	73	4,182,750	3,692	125
48	80	4,977,500	4,393	150

Source: The figures in this table have been computed on the basis of minimum water requirement per man and animal per day. (See Chapter Three for detailed information).

According to the 1965-69 Tax Register, there are 185,987 cattle in Dar Humr. Yet the milk processing factory operated at very much below capacity in the 1968/69 season. The average daily milk supply to the factory over a period of 153 days was 0.994 metric ton,[51] or slightly less than 2 per cent of its capacity.

It could be said that the system under which the factory operates fits well into the culturo-economic practices and the social values of the pastoralists. In the first place, the factory is planned to be in production seasonally, at least in its first few years of existence. This is in the rainy season when the pastoral nomads are in the Babanusa with their animals. In the second place, the system of supplying milk to the factory by the livestock owners is fairly easy. For they are to deliver their milk to milk collecting depots located very near their camps, from where it will be collected by mobile lorry tankers.

Yet, in its first year of operation the factory failed to hit its target and even up till the second week of August, 1969, the factory was yet to start production for the 1969/70 season. The next vital question one would wish to ask is why, in spite of the fact that the system of operating the milk processing factory is congruent with the culturo-economic practices and the traditional values of the pastoralists, they are reluctant to supply milk to the factory? Investigations conducted by the author revealed that the stock owners were quite willing and ready to sell milk to the factory. Their refusal to do so, however,

51. This figure was calculated from the data of daily milk supplies to the milk processing factory at Babanusa - supplied to the author by the Director of the factory, Seyyid Er Rashid Abdel Magid on 13th August, 1969.

should be taken as a protest against what they described as very intolerably low prices which the factory offered for the milk. At the factory, a rotl (lb.) of milk fetched 7.5 milliems (£S 16.54 per metric ton) as against 20 - 30 milliems (£S 44.10 - £S 66.15 per metric ton) at the local market.

By mid-August, 1969 negotiations to resolve the dispute over milk prices were still deadlocked. The pastoralists wanted a minimum of 20 milliems per rotl, while the authorities were insisting on paying only 7.5 milliems which was regarded as 'economic price'. They accepted the charge of low price, but argued that the factory would offer a very large and reliable market and that the loss resulting from low prices, would be made good from regular sales of larger quantities of milk.

The positions of the pastoralists and factory authorities vis-a-vis milk price thus reviewed, one finds it rather difficult to accept either on principles of sound economics, or on the basis of equity, the factory authority's argument as tenable. In the recent past, many writers had accused the pastoralists of being unresponsive to economic stimuli. Events in Dar Humr are now proving these people wrong. If the authorities do not want the milk processing factory at Babanusa to go out of production sooner or later, as the Kosti Meat Factory, the livestock owners have to be offered economic prices for their milk. These economic prices should have to be very much higher than 7.5

milliems, and not much below 20 milliems.

There is no quantitative information about sales of milk produce (fresh milk and semn - clarified butter) in the local markets. To obtain an idea, if only in a crude form, on this, the interviewees were asked during the course of the survey, the type and quantity of milk produce they offer(ed) for sale, and duration, before and since the deep bore programmes began. A summary of their answers is contained in Table 16 below.

In Dar Humr, all the 132 livestock owners expressed the desire to sell milk to the factory if good prices were offered. In the 1968/69 season, only 57 (43%) of these did supply milk to the factory. These 57 had a daily production capacity of 2,135 rotls (about 0.97 metric tons) worth about £S 16. These figures represented 82 and 63 per cent by volume and value of the total fresh milk sold by the respondents both at the factory and at the local markets in the 1968/69 season. Daily sales of milk at the local markets in Dar Humr amounted to only 474 rotls (0.215 metric tons) worth between £S 9.50 and £S 14.20.

Since the well sinking programmes began, the number of people who sold semn (clarified butter) and the quantity sold, have been declining. In the era, before deep bores 65 informants sold 137.5 bottles of semn every week. Since then, the corresponding figures were 24 and 57 respectively (See Table 16, Columns 1 - 2 & 9 - 10). On the other hand, the number who sold milk at the local markets, and the quantity sold

BORE											
S E M N											
Local Market				Local Market							
9	10	11	12	13	14	15	16	17	18	19	20
Number of Producers	Production Per Week (Bottles)	Average Duration (Weeks)	Average Value Per Bottle (Milliems)	Number of Producers	Production Per Day (Rotls)	Average Duration (Days)	Average Value Per Rotl (Milliems)	Number of Producers	Daily Production (Rotls)	Average Duration (Days)	Average Value Per Rotl (Milliems)

have witnessed a spectacular rise. In the former period, only one man reported sales of milk, the quantity sold every day being 10 rotls. In the latter period, as many as 43 informants sold 454 rotls of fresh milk every day (See Columns 5 - 6 & 13 - 14 of Table 16 above). Since it is only those who do not own any livestock that will purchase milk, and since most farmers possess at least a milch cow or a few goats to supply their families' milk needs, it can be reasonably inferred that the population of the sampled villages are occupationally becoming less homogeneous. This trend is a happy one for the future economic and social development of South-Western Kordofan.

Except El Muglad all the Humr villages, who, because they sold milk to the Babanusa Milk Processing Factory reported no sales of milk at the local markets; the two waterless settlements (Marbuta and Iyal Bakhit) had sales and sold milk for shorter duration than any other village (See Table 16, Columns 13 - 15). Even the respondents from the two villages reported they sold milk only at their dry season centres at El Odaiya and El Khuwei respectively. Thus, to the extent that availability of water helps to create potential markets for milk and to the extent that it makes perennial production of milk possible, to that extent should the governments deep bore programmes be seen as a potent weapon in effecting a social and economic transformation of South-Western Kordofan.

Livestock Sales:

What are the likely implications of the milk factory on livestock sales in South-Western Kordofan? The traditional values of the pastoralists are against the sales of animals. Hitherto, they had sold part of their animals because no other sources of earning cash existed. Now, the pastoralists can earn some money by selling milk to the factory. If this happens, two things, either of which may contribute to increase the livestock population, may happen. If a pastoralist could obtain all his cash needs from sales of milk, it would not longer be necessary for him to sell any of his animals. Thus, the size of his herd would increase annually by the net births. This might affect adversely the supply of animals to the urban meat markets. Already, the pastoralists' participation in crop production has been having the same effect. During and shortly after crop harvests, supply of livestock to the markets is almost nil. There is therefore a spectacular rise in the prices of the various types of animals between late October and February. For example, cattle, which sell for £S 10 - 12 about June - August, now fetch from £S 15 - £S 20. Similarly, sheep prices go up from £S 1.50 - 2.50 to £S 3.00 - 5.00 and goats from £S 0.75 - 1.20 to £S 1.50 - 2.00.[52] Secondly, surplus money could be further invested on purchasing more animals, thus increasing the size of herd. This might also have an adverse effect on the water and grazing situations of their areas.

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52. Personal interview with livestock merchants, livestock owners and market officials, March to September, 1969.

At present, there is very little reliable quantitative information about the trend and size of livestock sales in South-Western Kordofan. This is rather strange, for there are special livestock markets throughout our region. In these markets, records of animals sales are expected to be kept. Available records are, however, scanty and fragmentary. This situation results directly from the system of administering the markets which varies from one council to another. In Dar Humr, the markets are administered directly by the Messeriya Rural Council, but no records of sales for any two consecutive years are available. In Dar Humr, the markets are run by contractors on an annual payment of sums of money ranging from £S 300 to £S 500 depending on the size of the market, size being determined by the animal population of the territory served by the market. The contractors' fear of being supplanted by their rivals, has served to make them regard any information about the number and types of animals sold in the markets as a jealously guarded secret. This fear, coupled with the planned take-over of the administration of the markets by the Hamar Rural Council have stultified any attempts by the author to obtain information about livestock sales from the contractors.

The author therefore had recourse to two other sources - records of livestock sales at El Obeid Animal Market, and information from interviewees. El Obeid, whose records of livestock sales dated back to 1942, is the chief commercial centre for the Western Sudan. It has been chosen to represent South-Western Kordofan for it is believed that the trend of livestock sales there will reflect in that of El Obeid.

Table 17 below is a summary of the types, volume and average value of animals sold at El Obeid market between 1942 and 1967. The figures in this table represent the five-yearly averages of the annual sales of livestock since 1942. (See Apendix II). A mere visual inspection of the table reveals variable trends in respect of the number of each type of livestock sold, but a uniform trend in respect of the average price of all types of animals sold.

The number of camels offered for sale annually, has been showing a steady decline. Cattle sales in the first few post-war years were fewer than those in the war period. In the second half of the first decade of the post war period, cattle sales almost equalled those of the war period, and since then, annual sales have been showing slight, but steady increases. Sales figures for sheep have been showing a slight but consistent rise, while those for goats have fluctuated widely. Taking the sales figures for all types of animals together, a syncline-like trend is revealed. In the first decade of the post-war era, figures of sales fell below those of the war period, and since then, sales have been running at above the level of the war period.

For the average price per beast, the trend is simple. The average price has almost doubled for camels and slightly more than doubled for cattle, sheep and goats. One might wish to know why in spite of the fact that average prices of all types of beasts have gone up, fewer animals were offered for sale in the immediate post-war period.

Before 1942, in the absence of any data, it has not been possible to know whether the level of animal sales and the average prices offered were below or above those of 1942; but for our purpose, they have been assumed to be below. Except by enforced sales, for which there is no evidence, the level of sales in the war period could have been achieved only through inducements in form of higher prices. The level of sales might have so adversely affected the take off level that the size of the pastoralists' stock had fallen below that which their traditional values would allow. They would therefore need time to restore the take off to the acceptable level, this time should coincide with the period of decline.

The trends revealed by Table 17 are not instructive on the proportion of pastoralists selling animals and on the proportion of the livestock population offered for sale annually. To obtain information relating to these, the author had in the course of his field survey, asked questions about the composition and size of the pastoralists herd, and the types and number of animals offered for sale annually just before and since the deep bore programmes began. The figures which refer to the size of herd and animal units sold since the water supplies programmes started, represent the means of figures collected over a period of years ranging from a minimum of two to a maximum of five. A summary of the pastoralists' answers is tabulated below.

From this table, it is obvious that in the latter period, the number of people who owned livestock, the animal population, the number of livestock - sellers and animal units sold per annum have shown increases of 28, 67, 24 and 60 per cent respectively over the former period. But while the per capita[53] size of herd and the per capita animal units sold have gone up from 27 and 2.2 to 35 and 2.4 respectively, the mean[54] size of herd and the mean animal units sold per annum have declined from 66 and 4.3 to 41 and 2.8 respectively. It has thus been revealed to us that the increases in the overall animal population and in the animal units sold yearly, have not been reflected in the per capita animal units owned and sold every year. A different trend has, however been observed in respect of the proportion of the livestock population sold yearly. A smaller percentage of the animals owned is now being disposed of than in the former period.

In the light of the above varying observations, the following inferences have been made and these conclusions arrived at. It has been shown that since the deep bore programmes began, annual livestock sales per livestock owner have been declining. Since there is no evidence that the pastoralists now spend less money than they had hitherto done, it could only mean that they have been deriving an

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53. This refers to the over-all sampled population.

54. This refers to the livestock - owning population only.

increasing proportion of their cash needs from other sources, possibly from crop and gum production. Opportunity for selling milk either at the local markets or at the factory, or both, is going to increase these sources. Similarly, unless there are other avenues of expenditure to absorb the extra cash earned from this source, it is going to further accentuate an already unhappy trend. If this happened, fewer animals would get to the urban meat markets, and this would mean higher prices for the meat consumers. If a decreasing proportion of the net annual increase in the livestock population were disposed of, a rapid increase in the animal population would result. This might lead to water and grazing shortage.

SUMMARY

Many writers have written to advocate or discourage direct efforts by governments to settle the nomads. This chapter sets out to show by specific studies that whether a nomad would decide to settle or not would depend on the opportunities he has for satisfying his social and economic aspirations, and that in a water deficient environment, the provision of water would afford him these opportunities. In this chapter the central theme is the influence of deep bores on the pastoral economy of South-Western Kordofan. It has been shown that the provision of deep bores have encouraged many nomads to become sedentarised, but that pastoralists would not water their animals at the deep bore centres until assured of means to earn enough cash to foot the watering bill.

In this chapter the hypothesis that deep bore would expose the population to a greater participation in the monetary economy has been posited. It has, however been demonstrated that the pastoralists' involvement in other economic activities besides pastoralism would result in unpleasant consequences for the urban meat market and the water and grazing resources. Finally, it is suggested that means of introducing the population into a wider range of consumer goods that would absorb a larger part of their increased earnings from these other economic activities are found, otherwise, the sinking of more deep bores would create more problems than are solved.

CHAPTER FIVE

DEEP BORES AND CULTIVATION

Pre - Deep Bore Programmes' State of Cultivation:

A very large percentage of the Hamar and Humr tribes of South Western Kordofan depend wholly or partly on cultivation for subsistence. Before the rural water supplies' programmes began, crop production depended mainly on the traditional and simple hoe - cultivation under a system of rotational bush - fallow. Cultivation was dominated by grain production for subsistence. Next in rank to grain was bittikh (water mel~~l~~on) which provided both the human and animal populations with an important source of water supplies in the dry season. Other crops grown mainly for subsistence included bamia (okra or Hibiscus esculentus) and lubia (Dolichos lablab). Ful sudani (Arachis hypogeae - groundnut), simsim (Sesamum indicum) and Kerkadeh (Hibscus sabdariffa), three rapidly expanding export crops at present, were little grown. Individual farm plots were very small and the use of fertilizers, except perhaps animal manure, was virtually unknown.

Thus, in spite of the heavy concentration of efforts on grain production, enough grains could not be produced to satisfy home requirements. In fact, until about the end of the Condominium, Sudan was a grain deficit country. The grains shortage was made manifest by several governmental measures. These included restrictions on grain export, maintenance of buffer stock of grains (famine relief), war-time price control, imposition of inter-provincial movement control, and direct grain production through the government sponsored mechanized crop production scheme.

Prospects for Expansion of Crop Production in South-Western Kordofan:

There are vast areas of land possessing high potentials for grain production. According to Jefferson[1], there are in the area known as the "central rainland", of which South-Western Kordofan is a part, at a conservative estimate, fifty million feddans (51.9 million acres) of good agricultural land. However, these huge areas have been little used for agricultural development. Of the several factors responsible for this situation, lack of water has been found to constitute a crucial problem.

Since the development of any tribal community requires a level of production per capita greater than subsistence[2], efforts should be made to raise the level of agricultural production in poverty - stricken South-Western Kordofan. This is necessary for as pointed out in Chapter one, economic development in the study region is a function of the

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1. Jefferson, J.H.K., 1956, op. cit., p. 136.

2. Salah El Din Noah, 1966, Agricultural Extension: Its Role and Importance in Agricultural Development in the Sudan; In Ed. Shaw, D.J., Agricultural Development in the Sudan, Volume 2 - Proceedings of the 13th Annual Conference of the Philosophical Society of the Sudan, p. 157.

intensity of resource utilization. It should be realized that South-Western Kordofan possesses neither minerals nor manufacturing industries, at least for the moment to provide its population with gainful employment.

A rise in the level of agricultural production can be achieved in any one or a combination of several ways. These include mechanization of production processes, the introduction of higher yielding seeds, the use of fertilizers, and the investment of more time and effort in cultivation. Among the technologically backward, financially poor and largely illiterate Hamar and Humr subsistent cultivators, there seems, at least for the present, to be only one easy way to rapidly raise the level of agricultural production. This is by increasing the amount of time and effort spent on cultivation. This can be achieved by liberating the substantial amount of time and effort expanded on fetching water by providing the population with adequate rural water supplies.

Already, it has been demonstrated in greater detail in the conceptual framework of this thesis how lack of water restricts cultivable land; reduces the strength of the potential agricultural labour fource; causes delay in sowing seeds; contributes to a haphazard harvesting of crops, and in certain cases causes crops to be left unharvested; and how all these help to bring down the level of agricultural production. In the rest of this chapter, attention is focused on assessing the extent to which the deep bore programmes have succeeded in eliminating the several limitations placed on cultivation by lack of water.

Previous studies on Crop Production in South-Western Kordofan:

The literature on crop production in the goz areas of the "Central Rainlands" of the Sudan, as elsewhere in the whole country except those areas specializing in cotton production and where grain production has been mechanized, has been scanty and descriptive. In Tothill's Agriculture in the Sudan[3], there are ten chapters on crop production in and crops of the Sudan. Crop production by Burnett, J.R.[4] is a description of farm implements, cultural operations, agricultural methods and labour. In this twenty-seven page account, reference to farm size is contained in only one sentence which is quoted below, "The actual area which can be cultivated under rain conditions by a normal family without the assistance of outside labour averages 6 feddans, but if cotton is included in the list of crops grown, it may be necessary to employ two outside helpers at picking time."[5]

In addition, there are seven chapters dealing with agriculture in the provinces[6]. The contents of these chapters were based on official reports from agricultural field officers supplemented by the authors' personal observations. The pattern of writing of each of the seven

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3. Tothill, J.D., (Ed.) 1948, Agriculture in the Sudan.
4. Burnett, J.R., 1948, Crop Production in the Sudan, In (Ed.) Tothill, J.D., op. cit., Chapter XV.
5. Ibid., p. 299.
6. Ibid., Chapters XXV - XXXI.

chapters, their structure and contents, are the same. Account is given of the historical, physical and cultural background to agriculture, crops grown and methods of cultivation in the various provinces.

The first researcher to undertake a comprehensive study of agriculture in the Sudan for a purely academic purpose, is Barbour. In 1953, he wrote a thesis, based on several years' intensive field study on "Peasant Agriculture in Anglo-Egyptian Sudan".[7] This study was undertaken at a time when the rural water supplies' programmes were just beginning. Therefore, although the thesis makes reference to the problems posed to cultivation by lack of adequate rural water supplies, it has no place for the impact of improved rural water supplies on crop production.

In later works by Barbour[8] and Lebon[9], there are also comments on crop production in the different regions of the Sudan and how the provision of adequate rural water supplies could affect its future development. In the Thirteenth Annual Conference of the Philosophical Society of the Sudan on 'Agricultural Development in

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7. Barbour, K.M., 1953, Peasant Agriculture in Anglo-Egyptian Sudan, Unpublished B. Litt. Thesis, University of Oxford, England.

8. Barbour, K.M., 1961, op. cit., pp. 25, 73 - 74, 131, 141-7, 151-7, 157-163, 174-6, ~~184-198~~, 200-214, 228-231, 240-2, 246, 254-261, 268-9.

9. Lebon, J.H.G., 1965, op. cit., pp. 70 - 101, 158 - 167.

the Sudan'[10], several papers on various aspects of Sudan's agriculture were presented. However, in these works, there has been very little said about farm size and the post-deep bore expansions in cultivated areas.

Since there is a dearth of accurate statistical information on crop production, a quantitative description of the pre - and post - deep bore production is going to be a very difficult exercise. Data

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10. Shaw, D.J. (Ed.), 1966, Agricultural Development in the Sudan, Proceedings of the 13th Annual Conference of the Philosophical Society of the Sudan, Vols. 1 and 2. In particular See papers by:

    (i) Thornton, D.S., The Role of Agriculture in Sudan's Economic Development, Vol. 1 pp. 12 - 21;

    (ii) Mutawakil, H., Diversification of Agricultural Production in the Sudan: Its Potential and Problems, Vol. 1 pp. 42 - 58;

    (iii) Pothecary, B.P., The Mechanisation of Agriculture in the Sudan, Vol. 1 pp. 85 - 101;

    (iv) Mirghani, A.R., Problems of Increasing Agricultural Productivity in the Traditional Sector, Vol. 2, pp. 98 - 103.

    (v) Salah El Din Noah, Agricultural Extension, Its Role and Importance in Agricultural Development in the Sudan, Vol. 2, pp. 153 - 173;

    (vi) Karrar, S., The Markets for Sudan's Agricultural Products with reference to Diversification of Agricultural Productivity, Vol. 2, pp. 255 - 269;

    (vii) Osman, M.S., The Possibilities and Problems of the Mechanization of Agricultural Production in the Sudan, Vol. 2, pp. 341 - 375.

on cropped area based on actual field survey are non-existent. The ideal apparatus for a satisfactory assessment of the role of deep bores on increased crop production would have been two sets of aerial photographs - one depicting the pre - water conditions and the other, the post - water conditions. Unfortunately, there are no such air photos for South-Western Kordofan.

Up to about the end of the Condominium, Sudan suffered from grain deficit. The deficit was rather strange, for the Central Rainlands have abundant cultivable lands, and an amount of rainfall that suits <u>dura</u> and <u>dukhn</u> production. However, since about the middle of the 1950's the situation has changed. Sudan has ceased to be hit by grain shortage. Instead, it has become a grain exporting country. This, no doubt, has been due to an expansion in cropped area. The observed increase in total annual production of various crop is mainly a reflection of an increase in the area under cropping by attracting more people to farming and duplicating the subsistence and peasant type production, more than through the realization of any other improvement. Cultivation on the <u>goz</u> until the present day is mainly dependent upon man power, with the matchet or axe and the hoe being the only tools in use in clearing the bush and in breaking up the soil and weeding respectively.[11]

11. Baasher, M.M., 1966, Livestock Development in the Central Rainland of the Sudan - Potential and Problems, In Shaw, D.J., (Ed.), <u>op. cit.</u>, Vol. 2, p. 377.

How much of this expansion can be attributed to the deep bore programmes? This depends on the post-deep bore expansion of cultivated areas in the sandy zone of Sudan's Central Rainlands. The determination of this, which is a difficult task, is the subject of this chapter.

<u>Evidence of Expansion in Cropped Areas</u>:

Since the late 1950's, the Sudan, once a grain deficit ~~deficit grain~~ country, has been exporting grains. By 1963, the annual export of <u>dura</u> has reached 73,843 metric tons, valued at £S 1,556,768.[12] It could be assumed that grain exporting became possible only after the home grains needs have been satisfied.

<u>TABLE 19</u>

<u>DURA EXPORT FROM THE SUDAN,</u>

<u>(i) 3 Years Average 1952/54 - 1955/57 - 1958/60 - 1961/63</u>
<u>(ii) 10 Years Average (1954/63), by Quantity and Value.</u>

	Year	Quantity (Metric tons)	Value (£S)
(i)	1952/54	50,627	893,192
	1955/57	27,237	546,240
	1958/60	85,447	1,585,778
	1961/63	80,797	1,632,974
(ii)	1954/63	65,324	1,242,952
	1963 (only)	73,843	1,556,768

<u>Source</u>: Department of Agriculture, Agricultural Statistics Bulletin, 1963, Vide Yassin, M.M., "The Influence of the Diversification of Agricultural Production on Marketing Structures in the Sudan", <u>Philosophical Society of the Sudan, 13th Annual Conference</u>, 1966, pp. 151 - 2.

12. Department of Agriculture, Khartoum, 1963, <u>Agricultural Statistics, Bulletin</u>.

It is not easy to determine the extent to which the deep bore programmes have contributed to this. The Gedaref and Gezira areas have never suffered from serious grains shortage. In fact, these two areas have been the granary of the Sudan. Furthermore, since 1960, further expansion in cropped area has taken place in Kassala Province. For example, the Kenana Scheme made possible by the construction of the Roseires Dam, has enabled large areas to be brought under cultivation. The construction of Khashm el Girba Dam on the Atbara has achieved the same objective.[13]

However, one might reasonably assume that a greater proportion of, if not all the grains exported, is from the Eastern Sudan, but that this has been made possible by the fact that the inhabitants of the rainland goz areas, formerly heavily dependent on Gedaref and Gezira grain, now produce virtually all their grain requirement with perhaps some surplus for sale occasionally.

Crop production is by peasants. This has led to serious consequences. There are no precise and reliable data about farm size and crop yields. The farmers do not keep any records, for they have no reasons for doing so.

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13. For further details on the Er Roseires and Khashm El Girba Dams, see: (i) Wynn, R.F., 1966, Water Resource Planning in the Sudan: An Economic Problem, In Shaw, D.J., (Ed.) op. cit., Vol. 2, pp. 104 - 132; (ii) Galal El Din Sid Ahmed, 1967, The First Year at Khashm Al Girba, Sudan Notes and Records, Vol. XLVIII, pp. 160 - 166. Peter von Blanckenburg, 1969, The Khashm El Girba Settlement Scheme in the Sudan - An Appraisal for the World Food Program, Rome, pp. 3 - 19, Institute Fur Auslandische Land wirtschaft der Technischen Universitat, Berlin.

The only information available on the size of farms is contained in the reports on the Sample Censuses of Agriculture in some Councils of the Sudan and the Kordofan Province.[14] The Censuses were conducted by the Department of Statistics in the 1963/64 and 1964/65 crop years respectively. The sample censuses were concerned with obtaining information about the number and size of holdings, land tenure, fragmentation, land utilization, crop area, type of cultivation, livestock number, farm population, and the use of fertilizers, power and machinery. This sample census of agriculture was the first of its kind in the Sudan. Information obtained from such a census is going to be of very limited value for the purpose of this thesis, for it deals with a static situation. The data yielded by the sample census give no indication of the past and future state of agriculture in the Sudan. Reports of two or more decennial sample censuses of agriculture would have served our purpose much better.

Another major source of information is the annual reports of estimates of cropped area published by the Ministry of Agriculture, Khartoum. Reports of such estimates suffer from two major defects. Over time, the estimates have been recorded in an inconsistent manner.

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14. (i) Department of Statistics, Khartoum, 1968, Some Results of Pilot Sample Census of Agriculture in Some Councils of the Sudan, 1963 - 1964;

(ii) Department of Statistics, Khartoum, 1968, A Brief Report on the Sample Census of Agriculture for the Year 1964-65 in Kordofan Province of the Sudan.

Until the 1964/65 agricultural season, the estimates for Kordofan Province were recorded on a soil-type basis; that is Qoz and Qardud. Since then, recordings have been made to conform with administrative boundaries. Consequently, it is only since the 1965/66 crop year that there have been separate estimates for the two rural councils in South-Western Kordofan. There is yet another complication. Only Dar Humr of the Messeriya Rural Council has been included in our study area, whereas the available information in respect of estimated cropped area refers to the whole of Messeriya.

Secondly, records of the estimated cropped area are available for short duration only. There are records in respect of the whole of Kordofan Province for ten years only (1958/59 - 1967/68), but separate figures for the study area for three years only, see Table 20 below.

Thirdly, the method and manner of collection of the data have rendered them of little value for dependable statistical analysis. Estimated data are based mainly on information supplied to inexperienced agricultural field officers by Sheikhs. This practice was known to the author while he was on field research in Ghubeish. There he came in contact with two field officers collecting data for the 1969/70 agricultural year. They interviewed the Sheikh of Debeibat only, and never made any attempt to interview any of the farmers, nor visit their farms.

Records of annual crop sales in the various markets of South-Western Kordofan provide another important source of information.

Such records are likely to throw light on the state of crop production, especially cash crop production over time. Officially, all agricultural produce are to be sold by weight in markets that have been officially designated as "Crop Markets". In each of the markets, there is a scale operated by a clerk who keeps records of all crop sales. It could therefore be expected that records of annual crop sales would serve as a useful guide to the position of crop production over time.

As usual, the records of produce sales suffer from several short-comings. First, records are available for short duration only. For Dar Hamar, there are records since the 1963/64 crop year, while for Dar Humr, the records exist since the 1965/66 crop season only. Secondly, the annual volume of produce sales in any one year depends on yields, and yields in turn depend on rainfall which varies from year to year. Thirdly, the volume of produce sales in any one market, may bear no direct relationship to production volume in the district served by that market. This situation results from the practice of selling produce in 'black markets'. This is done to avoid the payment of <u>ushur</u> (crop tax), and <u>gibana</u> (market and weighing fees). <u>Ushur</u> is a seven per cent tax 'ad valorem' to the value of the crop, while <u>gibana</u> is charged at the rate of three per cent of the crop value. Apart from the practice of evading payment of <u>ushur</u> and <u>gibana</u>, there is the desire on the part of cultivators to sell their produce where prices are higher. This desire is further reinforced by the fact that produce prices vary from market to market both within and between councils. (See Table 21 below).

TABLE 21

5 YEAR AVERAGE PRICES PER KANTAR (GROUND NUT): 1960/61 - 1964/65.

Market	Prices (in £S)
Kosti	1.27
Tendelti	1.29
El Jebelain	1.12
El Obeid	1.33
En Nahud	1.20
Er Rahad	1.22
Umm Ruwaba	1.20
El Ghabsha	1.22
Wad Ashana	1.20
Sherkeh	1.17
Others	1.10
Average	1.25

Source: Low, E.M., The Marketing of Groundnuts in the Sudan, Development Studies, No. 2, July, 1967, University of Reading, Department of Agricultural Economics, p. 12.

It is therefore not unusual to find farmers from one council going to sell their farm produce in markets within other councils. It is only at El Obeid that records of produce sales by people from other councils are kept, (See Table 22 below for produce sales at El Obeid by people from other councils from Kordofan and Darfur Provinces). Since prices are however, highest at El Obeid, being £S 0.08 higher than the average per Kantar in respect of groundnuts, it could be rightly inferred that sales elsewhere would be insignificant. Furthermore, the information on crop sales until 1963 is anything but complete for figures of sales in the Councils' markets are not available. Nevertheless, a fairly complete account of crop sales could be said to be available for Dar Hamar and Dar Humr since the 1963/64 and 1965/66 crop years respectively, (see Table 23 below).

Taking the above into consideration, the actual volume of produce sales in any council is the sum of the crop sales in the council's official crop markets, plus sales in the illegal markets within the council area and in the other markets outside the council, less sales in the councils' markets by people from other councils. Sales figures in the black markets as well as those in markets other than El Obeid, are not available. It is therefore impossible to accurately assess the actual annual volume of farm produce sales. And even if this were possible, such assessment would give but a rough indication only of the state of crop production in respect of groundnuts and sesame, and not in respect of <u>dura</u> and <u>dukhn</u>. This is because a greater proportion

of the grain produce is for home consumption. The market# sales figures represent the surplus. This surplus cannot even be regarded as the 'regional surplus' as there are many who do not produce grains. Therefore, even when the influence of the very variable rainfall on yields is disregarded, the annual produce sales figures are going to be of very limited value for this thesis.

Nevertheless, in spite of the short-comings from which records of produce sales suffer, they are useful, at least, as a rough guide to the trend of crop production. Though sales of groundnuts, sesame and grains from South-Western Kordofan have since 1956 fluctuated from year to year, they have shown an upward trend. To ascertain whether the upward trend in the mean annual crop sales figures is real or otherwise, the six-year averages (1956 - 61 and 1962 - 67) are subjected to test of significance by employing the 'student t' test technique. The result of the calculations shows that the 1962 - 67 mean of 182,097 Kantars is significantly larger than the 1956 - 61 mean which stands at 76,339 Kantars, for the calculated "t" is 4.16 while observed "t" at 1.0 and 0.2 per cent is 3.17 and 4.14 respectively.

A rise in volume of crop sales can be rightly attributed to an increase in crop production or a drop in consumption. Increase in crop production could result from larger yields from the same unit of cropped area, or from larger cropped area or from both. Larger yields could arise from physical and cultural factors. The most potent physical factor is rainfall, which in South-Western Kordofan is very variable. If rainfall becomes higher and more reliable larger crops yields might result. Rainfall aside, improvement in farm practices and the application of fertilizers would serve to raise crop yields. However, neither of these two factors is known to have altered significantly since the beginning of the deep bore programmes. From 1956 to date, rainfall has not been known to have become progressively higher and less chancy, nor has the duration of fall lengthened. Similarly, the Hamar and Humr cultivators are yet to change their methods of cultivation. Crop production is still carried out on a peasantry basis. Implements used are still of the simple and primitive type. The use of fertilizers other than animal droppings in growing grains, sesame and groundnuts is an innovation whose adoption is yet to be conceived by the cultivators. Therefore, the higher volumes of crop sales could not have been the result of larger crop yields per unit area.

We are then left with one other means - larger cropped area. Where only food crops are involved, increased sales could result without an increase in crop production if the proportion of the crop now consumed locally were smaller than before. This could happen if there is a discriminatory reduction by death or emigration, in the size of the non-farming population. It could also happen even if the population has remained unchanged, or even grown larger if the food crops the farmers grow were not their staple food, but that they depended on cheap food import from within or outside the country.

However, two of the three crops under consideration - groundnut and sesame - are not staple food crops. One of them, groundnut, is grown almost exclusively for export. Sesame is grown both for home consumption and for export. The third, grain, is the most important staple food of the Sudanese. When the two six - year means for the three crops are compared, it is found that whereas the latter mean is very significantly larger than the former in respect of groundnut, and probably significantly larger for sesame, no difference is found to exist even at the 25 per cent level between the two means for grain.

TABLE 24

CROP SALES IN SOUTH-WESTERN KORDOFAN: DIFFERENCE BETWEEN TWO-SIX-YEAR MEANS (1956-61 AND 1962-67) TEST FOR SIGNIFICANCE - THE USE OF THE STUDENT t TEST

Crops	t calculated Hamar	Humr
Groundnut	4.05**	6.74***
Sesame	2.11	2.88*
Grains	1.50	1.09

t - observed at 10 degrees of freedom

5 per cent	=	2.23
1 " "	=	3.17
0.2 " "	=	4.14
0.1 " "	=	4.59

Note: *** Highly significant (even at 0.1 per cent)
** Significant (at 1 per cent)
* Probably Significant (only at 5 per cent).

From a careful statistical analysis of the crop sales figures at El Obeid market, one could get the first rough hint that over time, and at least since 1956, crop production in South-Western Kordofan has been increasing annually, and that this is due to an expansion in the cropped area. But it should be remembered that since this analysis is not based on total annual crop production the validity of this conclusion would be liable to serious doubts. Therefore, to obtain an idea of the pre-and post-deep bore state of crop production, sample surveys were conducted. In all, the surveys were carried out in twelve randomly selected villages. The methods used for conducting the surveys have already been described in chapter one.

During the survey, attempts were made to collect information about the size of individual farms, the types and range of crops grown and the length of fallow. Efforts were also made to collect information that could be useful in ascertaining the changes that have been taking place since the deep bore programmes began. To do this, the size of individual farms and the types of crops grown in areas with deep bores are compared with those in waterless areas. Explanations are then sought for the differences or similarities noticed. The data yielded by the sample surveys were later statistically analysed to determine what variations there are in mean field sizes and distances from deep bores, length of fallow and distances from water, length of fallow and water availability, and differences in the pre-and post-deep bore farm sizes.

Crop Production.

In an earlier chapter, it has been hypothesized that the multiplication of deep bores in Sudan's Central Rainlands would lead to an increase in cropped area. This increase could be achieved in either, or both of two ways. The area under crop production will increase, first, if more people become cultivators, (assuming that the old cultivators do not reduce the size of their plots), and secondly, if the existing cultivators increase the size of their farms.

The first exercise to be carried out is to determine whether an increase in the annual cropped area has actually taken place. This has been done by comparing the pre-and post-deep bore programmes farm size means of the twelve sampled villages (See Table 25 below.) The pre - deep bore mean farm size is just under 6 acres while that for the post -

TABLE 25

PRE-AND POST-DEEP BORE MEAN FARM SIZE (IN ACRES)

Villages	Group	Pre-Deep bore	Post-Deep bore
1. Abu Zabad	I	5.6	15.0
2. El Odaiya	"	4.0	10.5
3. El Muglad	II	3.2	7.6
4. Et Tibbun	"	4.3	13.6
5. Ghubeish	"	6.0	18.2
6. Wad Banda	"	4.7	23.3
7. El Khuwei	"	14.1	27.0
8. Abu Bittikh	III	4.0	8.5
9. El Bashama	"	3.1	6.8
10. Mumu	"	9.9	15.3
11. Marbuta	IV	6.3	14.6
12. Iyal Bakhit	"	6.1	11.7
Average	I - IV	5.9	14.3

Source: Field Survey, 1969.

deep bore stands at just over 14 acres. This yields an overall mean difference of about 8 acres. A mere inspection of Table 25 above quickly reveals that the post - deep bore mean farm size is significantly larger than the pre - deep bore mean.

Now that it has been established that the post-deep bore farm size is larger than the pre - deep bore farm size by as much as 143 per cent, the next thing to do is to find out whether such a large increase is due to the deep bore programmes. This is done by comparing the sample farm size means in centres with deep bores with those centres without water both before and since the provision of water. The statistical technique employed is the Analysis of Variance. The twelve sample villages have been grouped into four; the basis for the grouping has already been stated in chapter one.

TABLE 26

ANALYSIS OF VARIANCE OF PRE-DEEP BORE MEAN FARM SIZE

Source of Variation	Sum of Squares	Degree of Freedom	Variance Estimates
Between group of Villages	8.43	3	2.81
Within Villages	226.14	8	28.27

F - Value (calculated) = 10.06*
F - Value (observed) at (i) 5 per cent = 8.85
F - Value (observed) at (ii) 1 per cent =17.50
* Probably significant at 5 per cent.

Source: Field Survey, 1969, Vide Table 25, Column 3.

The total range of pre-deep bore farm size recorded in Table 25 lies between 3.2 and 14.1 acres. The standard deviation of the individually recorded acreage measured from the over-all average is 3.1 acres. Much of this variation can be seen from a visual inspection to be due to over-all differences between groups of and between villages. The quantification of these between groups of and within villages differences is shown in the analysis of variance table above. From this table, it is clear that the variations within the sampled villages are greater than those between the group villages, but that the variations are only probably significant.

But the fact the within village variations are larger, though at a low level of probability, than the variations between the group of villages, has tended to negate the claim that availability of water affects farm size, and consequently, the level of crop production. This view is further accentuated by the result obtained from the comparison of the over-all mean with the group means. The group farm size means are 4.8, 6.4, 5.6 and 6.2 acres for groups one, two, three and four villages respectively, while the over-all mean is 5.9 acres.

Group one villages have the least mean. This is rather surprising, for if availability of water were crucial to cultivation, this group's mean farm size should have been considerably larger than those in other villages. Two factors might have been responsible for the very small farm size in the pre-deep bore era. First, the small size could be due to the manner in which the information about crop production in the pre-deep bore period was obtained. Respondents were simply asked what the sizes of their farms were in the period immediatebly preceding the sinking of deep bores in their villages, or before migrating into their present abode from waterless centres. The length of the period involved is very variable within the sampled villages. It varies from over twenty years among villages in group two to about five years in group three villages; in fact, it is only two years in El Bashama. On the other hand, respondents from groups one and four villages - centres that possess permanent natural sources of water, and no water respectively - were simply asked what their field sizes were fifteen years before. Thus, while the farm size means for groups one and four villages refer to conditions fifteen years ago, the means for groups three villages refer to conditions just five years ago.

Secondly, since the two villages in group one have permanent natural sources of water, they used to be centres of heavy concentrations of people and livestock in the dry season. Conscious of the damage which stock could do to crops, potential cultivators might have been scared away from the immediate environments of these centres. There is yet a third factor. The means for all the villages except Mumu in Dar Humr, noted for its cattle rearing industry, is smaller than the group one mean. On the contrary, the average farm size for all the Hamar villages, except Wad Banda, is larger than group one's. For instance, El Khuwei's 14.1 acres is about 191 per cent larger. The reason for this could be attributed to two factors. In the first instance, the Hamar people have since the beginning of this century been forced to become great cultivators. In the second instance, because of water shortage, large acreage used to be sown to water melon. More will be said on this later.

The pre-deep bore variations in the average farm size among the sample villages having been examined, attention is now to be focused on the post-deep bore variations in mean farm acreages. A visual inspection of table 25 column 4 shows that wide variations exist in the farm size means of the groups of villages. The total range of the post-deep bore farm acreage as shown in the table, lies between 6.9 and 27 acres. The over-all average is 14.3 acres with a standard deviation of 6 acres. Like the deep bore conditions, a visual inspection of the table reveals that much of the variation is due to over-all differences between groups of and between villages. From the accompanying Analysis of Variance table, it is obvious that variations in the mean farm size within the sampled villages are larger than those between the group of villages, but by a smaller proportion than the pre-deep bore variations. However, unlike the pre-deep bore era, the variations are not significant. Since the expected differences in farm sizes between groups of villages have not been found, should one then conclude that the expansion in cropped area already noticed has not been due to the deep bore programmes? The answer to this question will depend upon a careful examination of the variations within the villages in the same group and the factors responsible for those variations.

TABLE 27

ANALYSIS OF VARIANCE OF POST-DEEP BORE MEAN FARM SIZE

Source of Variation	Sum of Squares	Degree of Freedom	Variance Estimate
Between Group of Villages	259	3	86.3
Within Villages	889	8	111.1

F - Value (calculated = 1.29

F - Value (observed) - 5 per cent =8.85

The large variations in the mean farm acreage between villages have come mainly from the villages comprising group two with group three villages making probably a minor contribution. In group two, the mean farm acreage varies from just under 8 acres to 27 acres. It therefore has not only the largest mean farm size (18.4 acres), but also the largest standard deviation (7 acres), see Table 28 below. Group three villages with the next higher standard deviation (3.6 acres) have mean farm size ranging from 6.9 to about 15 acres. The standard deviation for groups one and four are 2.8 and 1.4 acres respectively. They have a smaller range as well; for group one, it is from about 10 to about 15 acres, and for group four, it is from 11.7 to 14.6 acres only.

TABLE 28

GROUP MEAN FARM SIZE AND THEIR STANDARD DEVIATIONS

Group	Mean Farm Size (Acres)	Standard Deviations (Acres)
I	12.5	2.8
II	18.4	7.0
III	10.2	3.6
IV	13.2	1.4
Over-all Average	14.3	6.0

Source: Field Survey, 1969.

Now, the factors responsible for the very wide variations in the farm acreage between group two villages are to be identified and explained. Of the five group two villages, two are from Dar Humr and the other from Dar Hamar. The Hamar and Humr tribes, have different attitudes to cultivation. As pointed out in chapter two and earlier on in this chapter, the Hamar had been forced by circumstances to turn to crop production since the end of the Mahdiya. On the contrary, the Humr are still apathetic to cultivation, which they regard as unpleasant, dirty and degrading work. It should therefore be understood why El Muglad, the Humr headquarters, and one of the first villages to be provided with deep bore (1926), has the least mean farm size (7.6 acres). As against this, El Khuwei's mean farm size is as large as 27 acres.

The very large variations that characterise the mean farm size of group two villages are not found in the villages of the three other groups. This is because the villages are homogeneous with respect to their tribal composition, and hence in their attitudes to cultivation. For instance, by sheer coincidence, the three group three villages - El Bashama, Abu Bittikh and Mumu - are Humr villages. By similar coincidence, group one villages - Abu Zabad, and El Odaiya - and also group four villages - Marbuta and Iyal Bakhit - are Hamar. From the fore-going discussions, it is pertinent that farm size cannot be explained off in terms of water availability only. Attitudes to cultivation among the people really plays a significant role.

A close examination of the physical environment of the Hamar and Humr territories (already discussed in details in chapter two) will help to further put this question of attitude to cultivation into its proper perspective. The southern part of South-Western Kordofan, in which Dar Humr is located, has a higher and more reliable rainfall than the northern, where Dar Hamar is located. For example, rainfall varies from about 200mm to 450mm, and from about 400mm to over 700mm in Dar Hamar and Dar Humr respectively. Dar Humr also has a longer wet season duration than Dar Hamar. The wet season duration is four and three months in Dar Humr and Dar Hamar respectively.[15] It is however, the north, with less and more chancy rainfall, and shorter rainy season that has a more intensive agricultural use of the land. This is due in part to the fact that the increase in the amount and reliability of rainfall from north to south is accompanied by increasing yield per acre. In response to this situation, the amount of cultivated land per family tends to decrease from north to south.

No difference has been observed to exist between cultivators in groups one and four villages. This is rather strange, for it is between these two groups of villages that the influence of water on crop production should be most apparent. To account for this apparent absence of difference, reference is made to two factors. First, the multiplication of water points has served to bring waterless areas nearer to water. Secondly, the government has not limited its water supplies activities to well sinking and hafir excavation only. Where none of these cources of water supplies is possible, the government, through the local authorities, arranges for supply of water by lorry tankers. For example, the Hamar Rural Council has three lorry tankers which supply water at two and a half <u>piastres</u> (£S 0.025) per 4-gallon tin to waterless areas such as Iyal Bakhit. Marbuta is supplied by commercial tankers at 4 piastres (£S 0.04) per 4-gallon tin. There is yet another factor - the

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15. El Tom, M.A., 1966, op. cit., p. 68

heavy concentrations of people and stock in the few water centres, compels a heavy and competing demand for land in the immediate environs of the wells by cultivators and pastoralists. This, in addition to risks of damage to crops (already mentioned), have served to discourage cultivation near the water centres.

In addition to the variations already observed in the farm sizes of cultivators of villages forming a group or the different groups, there are also large differences in the farm sizes of cultivators within each village (See Table 29 below). Such large 'within village' differences, unlike the 'between village' variations which have been explained in terms of water availability and attitude to cultivation, are due largely to the types of motive which are present for farming. In South-Western Kordofan, cultivation by most people is primarily for subsistence; and therefore farm sizes which are determined mainly by family sizes are small. There are, however, a few people, particularly the non-native merchants whose primary motive for farming is commercial. Such cultivators make use of paid labour in farming and in consequence, they have unusually larger farms than the subsistent farmers.

Another postulate that has been put forward is that the provision of water supplies would enable the population to be exposed in a greater manner to a monetary economy. This, it is expected, would be made manifest in any or combination of three ways. These are increased export crop production, increased awareness on the part of the inhabitants

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of the economic benefit from gum tapping, and increased livestock and milk sales. Only export crop production will be considered in this chapter livestock and milk sales having been considered in the last chapter and gum tapping reserved for the next chapter.

Increased contact with the outside world would result in high propensity to consume and increase in the level of wants. To meet this increased demand for wants, the level of income must rise. And in a purely agrarian community, the rise in level of income could be achieved only through increased crop production, preferably export crop production.

There are two ways by which an increase in export crop production can be ascertained. First, by showing that there is an occurrence of an increase in the volume of production, the volume of production being determined by the amount of produce sales. The other way is to show that the post-deep bore acreage of non-grain crops, other than water melon, is much larger than the pre-deep bores. Dearth of dependable data has preculded the effective use of the first method. However, it has been shown earlier on in this chapter that since 1956 the volume of groundnut and sesame offered for sale annually has been showing an upward trend, and that this has been ascribed to an expansion in cropped area. Similarly, it is to be demonstrated that the post-deep bore mean farm acreage sown to cash crops in each village is substantially larger than that of the pre-deep bore.

From Table 30 below, it is clear that the acreage devoted to cash crop cultivation has been increasing since the deep bore programmes began. The over-all pre-deep bore cash crop acreage is 1.1. This is just under 19 per cent of the total cropped area. In the post deep bore era, this acreage has risen to 6.8 or 48 per cent of the total cropped area. This represents an increase of 536 per cent over the pre-deep bore period.

There are, however, wide gaps between village group and within village group variations in the proportions of total cropped area given to growing cash crops in the two periods. In the pre-deep bore period, these proportions vary from 27 and 25 per cent (groups four and one respectively) to 14 and 13 per cent (groups two and three) respectively. In the post-deep bore era, the percentages stand at 55 and 48 (groups one and four respectively), and at 53 and only 28 respectively for groups two and three.

When these proportions are considered groupwise, the post-deep bore trend is similar to the pre-deep bore's. In both periods, groups one and four villages have larger mean cash crop acreage than groups two and three. Yet, group four villages are still without water. Should it then be concluded that the deep bore programmes have not served to expose the human population to increased monetary economic activities?

The answer to this question can come to light after a careful consideration and comparison of cash crop farm size between the Hamar and Humr villages. An inspection of Table 30 reveals that variations in

proportions of cropped area given to growing cash crops in the sampled villages are more pronounced between the Hamar and Humr villages. The pre-deep bore over-all mean is 19 per cent. All the Hamar villages except El Khuwei have larger proportions than the over-all mean. On the other hand, all the Humr centres except Abu Bittikh, have smaller proportions. In the post-deep bore era, the over-all mean is 49 per cent. As in the pre-deep bore era, all Hamar villages except El Odaiya and El Khuwei and all the Humr centres, have larger and smaller proportions respectively of total cropped area devoted to growing cash crops.

Two points of interest should be noted. First, during both periods, groups two and three villages - the deep bore centres - have smaller proportions of total cropped area sown to cash crops than groups one and four. And areally the Hamar villages, absence or presence of water not withstanding, have larger cash crop acreage than the over-all mean; the only exceptions are El Odaiya and Wad Banda (pre-deep bore). On the contary, all the Humr villages except Mumu (pre-deep bore only), have smaller cash crop acreage.

Two explanations could be offered for this unexpected phenomenon. That group four villages have larger proportions of their fields devoted to growing cash crop has been due mainly to the fact that the two villages in this group have been accidentally drawn from 'traditionally' agricultural areas. Secondly, the inhabitants of waterless villages sow a larger part of their fields to cash crops in order to obtain the money needed to pay for the water which is brought to them by lorry tankers.

Groups one and three villages are drawn from tribally and occupationally homogeneous territories. Only group two villages are drawn from heterogeneous cultural areas where there are very wide variations in the proportion of cropped area given to cash crops. These vary from 61 per cent (Ghubeish) to 40 per cent (El Muglad). Areally, larger variations also exist between group four villages. The acreage varies from about 14 (Wad Banda) to 3(El Muglad).

Another way of looking at this question of exposure to monetary economy, is to examine carefully the percentage increase in cash crop acreage since the beginning of the deep bore programmes. Group two have the largest percentage mean increase (989). This is followed in that order by groups one (493) three (300) and four (271). El Muglad and Abu Bittikh, two Humr and deep bore villages, have the largest, and smallest percentage increase of 1400 and 125 respectively. Group three villages have not only the least cash crop acreage, they also have the least proportions and the least percentage increase. This is because they have not had enough time to take full advantage of opportunities offered by the availability of water. For example, the water yard at El Bashama was just two years old at the time of the field survey, and the first batch of cultivators had just moved in. Therefore, the large increase in the acreage devoted to cash crop production in group two villages can be ascribed, at least, in part, to the deep bore programmes.

Distance From Water Point, Farm Size and Fallow Period.

Through distance, water exercises control over cultivation in several ways. This control is reflected in the manner in which farm size, length of continuous cultivation and fallow period vary with distance from settled villages, and hence from water points, since most of the permanently settled villages are water centres.

As pointed out in chapter one, farmers in settled villages have to travel to their fields every morning and back again every evening. According to Jefferson, this practice leads to a shortening of the working days as farmers cannot live in temporary camps in cultivation area.[16] To minimise the distance to be travelled, and thus the loss in working hours, there has grown the tendency on the part of cultivators to site their crop fields as near as possible to their settlements. Jefferson's claim has been supported by the findings of the F.A.O. experts who executed the Water and Land Use Survey Project in Kordofan Province. The experts had observed that virtually all the cultivated land in Kordofan Province is situated within 3 km. of fixed villages.[17] These are, however, not fixed villages with permanent sources of water.

To test the validity of these claims in South-Western Kordofan, two operations have been performed. First, the frequency distribution of

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16. Jefferson, J.H.K., 1956, op. cit., pp. 140 - 1.

17. F.A.O., Rome, 1967, op. cit., p. 85.

crop fields within specific distances of the twelve sampled villages has been determined. The frequency distribution of fields is shown in Table 31 below.

TABLE 31

FREQUENCY DISTRIBUTION OF CROP FIELDS WITHIN SPECIFIC DISTANCES OF THE SAMPLED VILLAGES.

Villages	0 - 3.0km	3.1 - 5.0 km.	5.1 - 8.0 km
Abu Zabad	20	8	2
El Odaiya	19	11	-
El Muglad	13	10	7
El Tubbun	16	11	2
Ghubeish	21	7	2
Wad Banda	20	9	1
El Khuwei	16	7	7
Abu Bittikh	23	7	-
El Bashama	18	12	-
Mumu	25	4	1
Marbuta	30	-	-
Iyal Bakhit	29	1	-
Total	250	87	22

Source: Field Survey, 1969.

An examination of this table reveals that 70 per cent of the respondents had their fields located within 3 km distance of fixed settlements, while 24 per cent had their fields between 3.1 and 5.0 and 8.0 km.

However, these proportions are not uniform in all the villages. For example, while all but one of the fields in group four villages were located within the F.A.O. experts' observed 3 km limit, only 60 per cent of the fields of groups one and two villages were situated within this distance, and 30 and 10 per cent of the fields were found between 3.1 and 5.0 km and between 5.1 and 8.0 km respectively. For group three villages, the corresponding percentages were 73, 26 and 1 respectively.

Also from the table, it appears as if the land within 3 km of a waterless villages is more intensively cultivated than land within the same limit of settlements with water. But the result obtained when the mean length of continuous cultivation and fallow period for each of the twelve sampled villages are correlated, has disproved this apparent trend. The correlation co-efficient value of -0.59 indicates that the two sets of data are probably[18] inversely correlated. Thus, the fields which suffer from the longest period of continuous cultivation enjoy the shortest fallow period.

The two waterless vilages have the longest fallow period, and they are among the four villages which suffer least from continuous cultivation (see Table 32, columns two and three). However, an abnormal situation

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18. The correlation co-efficient value of -0.59 is significant at 5 per cent only.

TABLE 32

MEAN FARM SIZES, MEAN FARM DISTANCE FROM FIXED SETTLEMENTS AND LENGTHS OF CONTINUOUS CULTIVATION AND FALLOW IN SOUTH-WESTERN KORDOFAN

1	2	3	4	5	6
1. Abu Zabad	3.06	15.0	0.04	4.4	3.3
2. El Odaiya	2.89	9.9	-0.05	5.9	3.8
3. El Muglad	3.81	7.6	-0.14	8.5	1.7
4. Et Tibbun	3.31	13.6	-0.20	5.5	2.5
5. Ghubeish	2.67	18.2	0.46	3.7	2.8
6. Wad Banda	2.57	23.3	0.30	5.8	2.7
7. El Khuwei	4.07	27.0	0.13	4.0	3.4
8. Abu Bittikh	2.07	8.5	0.08	6.3	1.9
9. El Bashama	2.96	6.9	-0.31	4.8	0.9
10. Mumu	2.24	15.3	-0.20	5.9	3.0
11. Marbuta	1.24	14.6	0.38	4.5	5.7
12. Iyal Bakhit	1.96	11.7	0.19	3.0	8.0

1. Name of village.
2. Mean Farm Distance (in km) from settlement.
3. Mean farm size (in acres).
4. Correlation co-efficient values (obtained from the correlation of individual farm sizes with distances of farm from settlement).
5. Length (in years) of continuous cultivation.
6. Length (in years) of fallow.

Source: Field Survey, 1969.

exists in respect of El Bashama and Abu Bittikh which are among the three settlements with the least fallow period. This abnormality is, no doubt, due to the fact that these villages are relatively newly settled villages, and most of the cultivators are new comers who have scarcely felt the need for fallowing their fields.

From the foregoing discussion, it can be inferred that the trend of frequency distribution of fields within specifically stated distances has revealed that the proportion of "usable" land being put to crop production is greater around settlements with water than around waterless ones. Another inference that can be drawn from Table 31 is in respect of population size and dynamism. Thus, the pattern of the frequency of occurrence of crop fields within given distances could be said to indicate that centres with water have larger and more rapidly growing population than those without water.

Implicit in Jefferson's assertion is the postulate that farm sizes vary inversely with increasing distance from fixed villages. To prove this hypothesis, farm sizes of all the respondents in each of the twelve villages have been correlated with distance of farms from their settlements. The correlation co-efficient values are shown in Table 32, column 4.

The r - values show that complex relationships exist between farm sizes and distance from settlements. The r - values for Ghubeish (0.46), Marbuta (0.38), and Wad Banda (0.30) show a medium degree of positive correlation - suggesting the occurrence of larger farms away from fixed settlements. In contrast, r - values of -0.31 for El Bashama and -0.20 for each of Mumu and Et Tibbun, indicate fairly low to medium degree of inverse correlation. For others, only very small correlations exist. Thus except for El Bashama, Et Tibbun and Mumu, and only probaly too, Jefferson's claim that farm sizes decrease with distance away from fixed settlements, has no universal validity for South-Western Kordofan.

It is necessary, however, to make one interesting observation. Farm sizes in all the Hamar villages except El Odaiya tend to vary positively, however small, with distance from settlements with permanent water-base. On the contrary, farm sizes in all the Humr villages vary inversely, if only in a small manner, with increasing distance from water points. On this account, Jefferson's claim might be said to hold no validity for villages whose inhabitants are by "tradition" cultivators, particularly in those centres with long history of water availability behind them.

Several reasons can be offered for this tendency for farm sizes to be larger away from water points. First, this tendency might be motivated by the desire by owners of large farms to avoid vying for the heavily and competively sought - after land near water points. Secondly, the tendency might be the result of the desire to avoid risk of damage to crops by livestock. There is always a heavy concentration of animals at water centres in the dry season.

Thirdly, virtually all the large farm owners are non-native merchants mostly from Northern Sudan. They had arrived in their respective villages, perhaps after the land in the immediate environs of water points had been taken up. Fourthly, being merchants, they employ paid labour on their farms. They can therefore afford to make farm labourers live in temporary camps in their farms and have water brought to them by lorry tankers or camels during the cultivation season. In Mumu, three of the merchant - farmer respondents, Mohamad Adam, Abdullahi Ahmad and Ahmad Murtalla adopted this practice. The farm size of each of the first two stood at over 50 acres while that of the third was about 40 acres. These farms were between 2.5 and 4 km away from Mumu. Through this practice much of the loss in working hours through daily journeys to and from farms, is eliminated. In consequence, the daily output per farm - worker has gone up.

SUMMARY.

In this chapter, it has been shown that a number of changes have taken place in South-Western Kordofan agriculture since the Sudan Government embarked upon its rural water supplies programmes. One of such changes relates to cropped area which has expanded considerably. This expansion has resulted from two factors operating singly or jointly. First, farmers now tend to have larger farms than they had in the pre-deep bore era. Secondly, crop production has gained a large number of new adherents (a fuller account of how this has happened has been given in the last chapter). Another change that has occurred is concerned with the pattern of crop production. The pre-deep bore farmer was almost wholly a food crop farmer. Today, he is as much a commercial crop producer as he is a food crop producer. For example, in the pre-deep bore era, only 19 per cent of the total cropped area was sown to export crop, but in the post-deep bore era, the proportion of the cropped area sown to export crop has gone up by more than two - and - a half times. As a result of these changes, South-Western Kordofan, once a grain - deficit region, has become a large commercial producer of grains, groundnut and sesame.

There is, however, no conclusive evidence about the relative contribution of the availability of water to the changes noted above. This is because both the absolute cropped area and the proportion sown to export crop have shown upward trends both in villages with and in those without permanent water-base. In fact, in the post-deep bore era, total cropped area and the percentage of it devoted to export crop production in each of the two waterless Hamar villages of Marbuta and Iyal Bakhit are larger than those of most of the villages which have permanent sources of water supplies. This clearly points to the fact that reference to water availability alone would not give complete explanation for the present trend and pattern of agriculture in South-Western Kordofan. Equally important in this explanation are the people's attitudes to cultivation, their daily felt needs, and their economic and social aspirations.

No significant changes have, however, been observed to have taken place in the structure and methods of cultivation in South-Western Kordofan. Cultivation is still peasant - dominated, depending largely on family labour and on traditional implements of the hand - hoe and the matchet under a system of rotational bush-fallow. The use of machinery and fertilizers is still virtually unknown. This situation is likely to persist for a very long time to come. Under this situation, any future progress in South-Western Kordofan agriculture in terms of larger cropped area and increased crop production would depend largely on increased input of labour. This in turn would depend on adequate, cheap and readily available sources of rural water supplies, the fetching of which would absorb very little of the cultivator's time.

CHAPTER SIX

DEEP BORES AND THE GUM INDUSTRY

In Central Sudan, a significant proportion of the income of the people is derived from the exploitation of forestry resources. These resources are exploited in several forms among which are the cutting of wooden poles and grasses for building purposes; the cutting of wood for making charcoal (for which there is a rapidly growing market in the urban centres), saddles and bowls; the tearing of the tree-barks for making ropes; and the tapping and collecting of gum. By far the most important of these, both in terms of the number of people it engages and in terms of the contribution it makes to the local and national economy, is the tapping and collecting of gum. It is also in respect of the gum industry alone that we have a tolerably adequate and reliable statistics, without which any analysis is impossible. The others are difficult to quantify, and the absence of any statistics relating to production, revenues, and the number of people engaged conceals their importance in the economy. Consequently, only the gum industry will be examined in this chapter.

Although gum has lost its prime of place in the export economy of the Sudan, it is still one of the leading foreign exchange earners for the country. Until the 1920s, gum was Sudan's principal export, accounting for between 30 and 40 per cent of the total value of exports.

By about 1925, gum was replaced by cotton as the leading currency earner, and since the early 1960s, gum has been further displaced by groundnuts. Gum has, however, in most years remained as the third most valuable export with a value at present of almost £S 5 million per annum.[1] In South-Western Kordofan, gum is of far greater importance to the local than to the national economy. Records of crop sales in Dar Hamar crop markets only between the 1963/64 and 1967/68 crop seasons have shown gum which, on the average, accounted for over 24 per cent of the total value of all crop sales to be the second most valuable export crop in Dar Hamar[2] (see Table 34). Reference to records of crop sales at El Obeid Crop Market on behalf of Dar Hamar and Dar Humr between the 1956/57 and 1966/67 crop years has brought out more clearly the importance of gum in the local economy of South-Western Kordofan (see Table 35). These records show that gum, accounting on the average for about 64 per cent of the total value of all crop sales, is easily the most important export crop of the study region.[3]

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1. Booth, G.A., 1966, Land and Water Use Survey in Kordofan Province of the Republic of the Sudan - Forestry Report, F.A.O. Document, DOK - SUD - A45, p. 18.

2. (i) Hamar Rural Council, En Nahud, Annual Reports on Crop Markets in Dar Hamar, 1963/64 - 1968/69;
   (ii) En Nahud Urban Council, En Nahud, Records of Crop Sales at En Nahud Market, 1963/64 - 1968/69.

3. El Obeid Crop Market, El Obeid, Charts showing Crop Sales at El Obeid Crop Market on behalf of other Districts in Kordofan Province, 1956 - 1968.

There have been several works and comments on the gum industry in the Sudan. Most of these works have discussed the distribution of hashab (Acacia senegal or gum arabic trees) and their exploitation, while a few have examined the place of gum in Sudan's economy. In 1881, J. Petherick[4] commented on the dominant position of gum in the economy of Kordofan Province. In 1918, W.R.G. Bond,[5] and later in 1950, J.K. Jackson and M.K. Shawki[6] described the working of the gum - cultivation cycle for different regions of the Sudan. In 1926, H. Blunt[7] made a general but comprehensive study of gum, its history, silviculture, tapping, collecting and marketing. A year later, Shaw[8] produced the first distribution and density map of Acacia senegal in Kordofan Province. In 1949, J. Smith[9] not only commented critically on Shaw's map, but reported on the Kordofan gum industry. The Soil Conservation Committee's Report of 1944[10] recommended a planned management for gum and T.R.G.

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4. Pethrick, J., 1881, Egypt, the Sudan and Central Africa, pp. 199 - 285.
5. Bond, W.R.G., 1918, Rotation of Crops in Gum-gardens of the White Nile, Sudan Notes and Records, Vol. 1, pp. 80 - 87.
6. Jackson, J.K. and Shawki, M.K., 1950, Shifting Cultivation in the Sudan, Sudan Notes and Records, Vol. 31, pp. 210 - 222.
7. Blunt, H., 1926, Gum Arabic with special Reference to Its Production in the Sudan.
8. Shaw, W.B.K., 1927 Distribution and Density Map of Acacia senegal in Kordofan Province, Vide Booth, G.A., 1966, op. cit., p. 35.
9. Smith, J., 1949, The Kordofan Gum Industry, Forests Department, Khartoum, (Unpublished).
10. Sudan Government, 1944, op. cit., pp. 78 - 90.

Moir's study of 1955[11] subscribed to this recommendation. In 1958, M.N. Harrison and J.K. Jackson[12] in addition to making a map showing the northern limit of _Acacia senegal_, commented extensively on the nature of occurrence of its species. Two years later, J.H. Elliot[13] made an estimate of the land under gum in Eastern Kordofan, and pointed out the existence of a clash between agriculture and gum in Dar Hamar and Dar Bederiya. In 1961, Vidal Hall[14] stressed the adverse effects of deep bores on gum, pointing out that the concentration of human population at water points has led to desertion of the remoter gum areas for over-cultivation round deep bores, leading in both instances to loss of gum. In their studies, K.M. Barbour[15] and J.H.G. Lebon[16] devote small space to general comments on the distribution of _hashab_, the system of ownership and exploitation of gum-gardens, and the relationship between gum-tapping and other agricultural activities. Finally, the most detailed survey of the gum industry was that undertaken by Hunting Technical Service Ltd. in 1963 in a very small but typical gum area in Kordofan Province. The report of this which was compiled

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11. Moir, T.R.G., 1955, Some Aspects of Agricultural Development in the Sudan, in _Food and Society in the Sudan,_ Proceedings of the 1953 Annual Conference of the Philosophical Society of the Sudan.

12. Harrison, M.N. and Jackson, J.K., 1958, Ecological Classification of the Vegetation of the Sudan, _Forests Bulletin_, No. 2, New Series, pp. 13-14, Forests Department, Khartoum.

13. Elliot, J.H., 1960, _Water Conservation and Land Development in Kordofan Province,_ Report No. 1258, F.A.O., Rome.

14. Vidal Hall, 1961, _Report on Gum Research, 1958 to 1961,_ Forests Department, Khartoum, (Unpublished).

15. Barbour, K.M., 1961, _op. cit.,_ pp. 160 - 163.

16. Lebon, J.H.G., 1965, _op. cit.,_ pp. 84 - 85.

by G.A. Booth and published in 1966 discusses the physical and cultural elements in the gum industry.[17] None of these works has, however, attempted a comparative and detailed examination of the gum industry and of its contribution relative to other export crops over time to the local economy vis-a-vis the rural water supplies programmes of the government of the Sudan. This is exactly what this chapter is out to achieve.

The gum industry is of significant importance in the economy of Central Sudan. This importance stems from several factors. At one time gum provided the Sudan government its greatest source of revenue. Writing in 1881, Petherick recorded that 'gum was the greatest source of wealth ever opened up to the entire population of Kordofan'.[18] What is strikingly important about gum is that it is a peasant industry. The revenue from it is thus widely distributed among the population. Hashab occurs in two states, it grows wild and in theory, right of tapping is communal; secondly, there exists geneina (gum-garden), that is, trees growing in fallow land. "Private ownership of such geneina is recognized in the sense that once a man has cleared and cultivated land, any gum trees on it are his to tap.[19] Continuing his writing, Petherick had remarked that "large amount of ready cash brought into the country for

17. Booth, G.A. 1966, op. cit.

18. Petherick, J., 1881, op. cit., p. 201.

19. Barbour, K.M., 1961, op. cit., p. 160.

the purchase of gum and finding its way into the gum collectors and carriers, had enabled the entire agricultural population to pay their taxes in hard cash."[20]

Interest in the gum industry has arisen from the following situations. The agricultural and pastoral populations of Central Sudan do not earn enough money from their activities to pay for their everyday needs. The average annual income per household in Kordofan Province has been estimated at about £S 66.[21] This has been found to be inadequate for the needs of all the members of the household. Revenue from gum tapping and collecting is therefore very important in the budget of the majority of the farmers and pastoralists of Central Sudan. In fact, the need for the revenue from gum is such that there is a minimum level of production which is always independent of price.[22] And quite out of tune with the principles of production economics, a low price level for gum may generate greater interest in the gum industry. For example, if in a certain year, the price of gum falls below that of the preceding year with the level of needs and the level of agricultural and pastoral productions and their prices remaining unchanged, more gum would have to be produced in order to prevent a fall in the already attained level of consumption. In this hypothetical case, a fall in the price of gum may serve to raise production level, all things remaining the same.

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20. Petherick, J., 1881, op. cit., p. 284.
21. For detailed information on this, See: Booth, G.A., 1966, op. cit., p. 44.
22. Ibid., p.44.

Hashab has a large concentration in Central Kordofan. As already pointed out earlier on in this chapter, hashab species occurs in two states - natural on uninhabited land, and induced, the result of the gum-cultivation cycle, in which the hashab fallow is referred to as geneina (gum-garden). The tenurial system encourages the participation of all willing peasants in the gum industry. In theory, all land is owned by the government, but only in trust for the people. Right of land ownership is exercised on behalf of government by the Sheikh of the village, or the Omda, or the Nazir. In practice, however, every inhabitant has prescriptive right to cultivation and gum collections. In the course of time, individuals have acquired proprietory rights over the land alloted to them by any of the government land agents, and they are considered to be owners of such land and are entitled to the income from it irrespective of whether they work it themselves or hire it out. If however, they are away from the village continuously for a period of more than two years, their rights to the ownership of land lapse. Even a new comer to a village, after satisfactorily fulfilling a probationary period of two years' stay, is entitled to as much cultivated land and as much 'gum-garden' as he and his family can work themselves. Meanwhile, during his two years' probation, he can hire land for cultivation, and tap in a 'gum-garden' on the half-share basis.[23]

23. For detailed information on patterns of gum-garden ownership and tapping, See (i) Booth, G.A., op. cit., pp. 68 - 70; (ii) Barbour, K.M., 1961, op. cit., p. 160; (iii) Lebon, J.H.G., 1965, op. cit., pp. 84 - 85.

Culturally, the gum industry is compatible with the farming activities of the inhabitants of Central Sudan. In fact, the gum culture fits admirably well into their agricultural practices. The gum tapping and collecting season begins in October during the harvesting of the grain crops, and ends in May/June shortly before the arrival of the first showers of rain which marks the beginning of a new cultivation season. Gum collecting does not, however, reach its peak until November/December after the harvesting of the bulk of the grain crops has been completed. Gum tapping and collecting thus corresponds with the dry season which is a period of agricultural inactivity. The gum industry therefore provides the agricultural population with employment at a time when they would have been idle, when other forms of employment are hard to secure and when a supplementary source of income is mostly needed.

The gum tapping and collecting season also coincides with the period of acute shortage of water when the need for extra ready cash to pay for domestic water is greatest. During this period, water costs from two to ten piastres (£S 0.02 - £S 0.10) per 4 - gallon tin in settlements without permanent water-base (depending on the distance over which the water is transported) as against two milliems (£S 0.002) at settlements with deep bores. As already pointed out, the majority of the people who have to pay high prices for water have virtually no sources of income, they therefore find collecting of gum a highly desirable help.

The fact that gum tapping takes place in the dry season has introduced a new element into the gum industry. During this time, villages without permanent water-base are deserted because of difficulty and expense of obtaining water; consequently, their gum resources are under-exploited. At the same time, however, there is a heavy concentration of population at centres with permanent sources of water supplies. Since crop production by most of the peasant cultivators is for subsistence only, supplementary income is needed to pay for water and other essential needs. And since gum tapping and collecting is the most important, the most reliable and the easiest means to earn extra cash, inhabitants of waterless settlements have to remain there and have water brought to them at great expense, to tap their 'gum-gardens'; otherwise, they have to go to centres with permanent water-base to tap and collect gum for wage or on half-share basis or both for wage and on half-share basis. Usually, they prefer share cropping to tapping for wage. This results in heavy demand for the gum-gardens which are close to water points, and leads to an increase in the intensity of gum-tapping in those areas.

Discussion in the remaining part of this chapter is devoted to the consideration of the effects of deep bores on the gum industry, with particular reference to the nature and pattern of ownership, the systems and intensity of tapping gum-gardens, and the place of gum in the local economy before and since the deep bore drilling programmes began. Examination of the industry has been attempted within the framework of the postulates stated below.

The first of these postulates states that interest in and intensity of gum tapping and collecting are functions of the availability and price of water. Interest and intensity could be measured either by the number of gum-tappers, irrespective of the mode of tapping, or by the volume of gum production. Although records of gum sales for South-Western Kordofan for at least twenty years are available at El Obeid Gum Market, there is no break down of these records for individual villages. Comparison based on volume of gum production between settlements with and those without permanent water-base has therefore been rendered impossible. Another information that could have been of much help as a basis for comparison is that pertaining to the number of gum-tappers; inevitably, no records of these exist. The author has therefore relied on quantitative information obtained from his field survey. A section of the questionnaire which he administered on the inhabitants has been designed to seek information about the number of gum-garden owners and tappers, the tapping systems and the quantity of gum produced annually before and since the beginning of the deep bore drilling programmes. The data obtained through this section of the questionnaire are set out in Table 33 below.

A careful examination of the table reveals that there were more gum-garden owners than tappers in the pre-deep bore era. Before the well sinking programmes began, only 54 of the 95 respondents who reported they had gum-gardens had them worked. This situation contrasts very

sharply with the period since the deep bore programmes began when gum-tappers (198) outnumbered gum-garden owners (189). It is appropriate, however, to point out the influence of the time factor on the wide disparity between the pre-and post-deep bore era 'gum-garden' owners and tappers. It should be noted that many of the respondents were too young to possess 'gum-gardens' in the pre-deep bore era of the villages with a fairly long history of deep bores behind them.

Implicit in the situation described above is the belief that gum-gardens near to settlements with permanent water-base would experience greater intensity of tapping than those in regions without perennial sources of water supplies. This is because water is much easier and cheaper to obtain, and this tends to attract a large population who are not only potential gum-tappers but also potential cultivators. The concentration of cultivators at settlements with permanent water-base has led to a depletion of the area of "exploitable" 'gum-gardens'. This is due to the felling of young gum trees for cultivation - a consequence of population pressure on 'usable' land - in preference to making farms in areas of mature or very old gum trees but which are situated far away from sources of water supplies. In addition, regeneration of Acacia senegal is delayed as there is an enforced lengthening of the period of continuous cultivation in response to the pressure of population on 'cultivable' land.[24]

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24. For further details on the impact of population concentration at centres with permanent water-base, See: Booth, G.A., 1961, op. cit., pp. 48-50.

Thus, since the demand for "exploitable" 'gum-gardens' is larger than their supply, intensity of tapping is expected to increase.

On situations in the period before the well sinking programmes began, Table 33 is not very instructive, for no distinct pattern is discernible either in the ownership or in the system of tapping hashab. In the post-deep bore era, however, two fairly distinct patterns - one each in respect of the number of people possessing and the number of people tapping gum-gardens - have emerged. In absolute terms, the two settlements without permanent water-base (Marbuta and Iyal Bakhit) had the highest number of tappers (twenty-five and twenty-four respectively), as well as the highest and third highest per capita annual gum production (20 and 16 kantars respectively). The reason for this situation could be attributed to a large part, to the high prices which the inhabitants of these settlements pay for drinking water and which force almost every body to tap gum. On the other hand, all the settlements with permanent water-base except three - Abu Zabad, El Muglad and Abu Bittikh - reported more gum tappers than 'gum-garden owners. The fact that the number of gum tappers was larger than that of 'gum-garden' owners is an indication that 'gum-gardens' in centres with permanent and adequate sources of water supplies experience greater intensity of exploitation.

As already pointed out, 'gum-gardens' in regions without adequate perennial sources of water supplies are accessible for tapping only to those who can afford to take water on camel-back and remain there for as long as the water lasts. Alternatively, water could be purchased from lorry tankers, as is now the practice in Marbuta and Iyal Bakhit at prices varying from 5 piastres (£S 0.05) to 10 piastres (£S 0.10) per 4 - gallon tin, but this would reduce the tappers' profit margin. Because of the difficulty and high cost of obtaining water, it might be assumed that 'gum-gardens' in centres without permanent water-base would be tapped by their owners. There is, however, nothing in Table 33, other than the fact that in the post-deep bore era there were fewer tappers than owners, to suggest that this assumption is valid.

It has also been postulated that interest in and intensity of gum tapping would vary with the price of water. The argument for this postulate is that making water available to the inhabitants of a water deficient settlement at a very high price would serve to activate their desire for gum tapping, if only to get money to pay for water particularly when other opportunities for earning cash are lacking. This would only happen if the people were averse to the idea of migrating seasonally to centres with permanent water base. If sufficient supplies of cheap water were, however, provided for the same people at a later date, their need for the supplementary income from gum would be reduced and this might affect adversely the volume of gum production unless there was a rise in the level, range and prices of their wants without a corresponding rise in the volume and/or price-level of their agricultural and pastoral produce. Thus, we are saying in effect, that new avenues for absorbing the 'surplus' revenue from gum should be created if the gum industry is not to decline.

It has been shown already that the sinking of deep bores has led to an expansion in the area under cultivation in South-Western Kordofan.[25] This implies an inevitable depletion in the gum-bearing areas. This has been found to affect adversely the level of gum production, at least in the short run. In the long run, this trend may, however, be beneficial to the gum industry. For one thing, a larger density of gum trees has been noticed in the inhabited areas than in the uninhabited ones. This trend has been clearly brought out in the report of the United Nations Special Investigation into Forestry in Kordofan Province when it states, "it is in the inhabited areas that the best Acacia senegal is found, in the 'gum-gardens' which result from shifting cultivation."[26] This is due to the facts that efforts are now being made to rehabilitate gum-gardens. The urge to rehabilitate gum-gardens has resulted directly from the people's increasing awareness of the economic benefits derivable from the gum industry. For another thing, the people have shown more interest in gum tapping and this has resulted in greater intensity of tapping. In the end, the loss of gum-bearing land to cultivation instead of leading to a fall in, is actually resulting in increase in the annual volume of gum production.

The expansion of the area under cultivation has a far-reaching implication for the relative contribution of gum to the economy. Growth

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25. Ibid., pp. 28 - 29.
26. Ibid., pp. 28 - 29.

in crop production means a rise in the contribution of agriculture to the economy. To maintain the relative position of gum in the economy, there has to be a corresponding growth in gum production. The need to achieve a higher level in gum production would continue to be desirable for as long as return on investment of effort or capital in the gum industry is equal to or larger than return on investment of similar effort or capital in other economic ventures. This is because gum tapping and collecting is not only hazardous, but also time consuming. Therefore, the eagerness of the inhabitants of South-Western Kordofan to invest effort in gum tapping and collecting is due mainly to the virtual unemployment of the dry season.

To show how gum has fared in the economy vis-a-vis other crops since the deep bore drilling programmes began, a comparison of the annual revenues from sales of gum and other crops has been attempted. This has been done at two levels and for varying length of time, (see Tables 34 and 35 below). The first level relates to Dar Hamar only and the indices employed are the revenues from local sales of gum and from other major crops (groundnuts, grains, water-melon seed, and sesame), at En Nahud and eleven other markets. These data date back to the 1963/64 crop year only. This could not be done for Dar Humr as no comparable records were available. Nevertheless, the result obtained from this comparison could, with some measure of confidence, be extended to Dar Humr, since the two districts have very similar physical and cultural characteristics. The second level, on the other hand, deals with the two districts in the region under study. The indices used are the same as for the first level but they are the revenues from sales made at El Obeid Crop Market by the Hamar and Humr tribes. Similarly, the comparison could be made for a short period only, for although there have been records of gum sales at El Obeid Crop Market since 1938, those for sales of gum and other crops for other districts date back to 1956 only.

TABLE 34

RELATIVE VALUE (IN £S) OF LOCAL CROP SALES IN DAR HAMAR: (TOTAL FOR EN NAHUD AND ELEVEN OTHER MARKETS, 1963/64-1968/69.

Year	Ground-Nut	Gum	Grains	Water Melon seed	Sesame	Total	% Gum
1963/64	919,347	194,449	80,096	17,198	1,241	1,212,331	16.0
1964/65	1,135,438	217,999	13,651	13,312	1,054	1,381,454	15.7
1965/66	897,959	203,313	5,526	49,738	1,165	1,157,701	17.6
1966/67	984,199	346,991	7,581	37,979	386	1,377,136	25.2
1967/68	639,374	418,766	8,732	47,854	1,226	1,115,952	37.5
1968/69	742,133	474,068	6,522	75,679	1,728	1,300,130	36.5
Average	886,408	309,264	20,351	40,293	1,133	1,257,451	24.6

Source: 1. Hamar Rural Council, En Nahud, Annual Reports on Crop Markets in Dar Hamar, 1963/64 - 1968/69.

2. En Nahud Urban Council, En Nahud, Records of Crop Sales at En Nahud Market, 1963/64 - 1968/69.

Records of sales are available in weight only. For ease of reference the annual average price per Kantar for each crop has been used to convert sales in weight to sales in value.

Throughout this short period, gum's contribution to the total revenue from local sales of major crops was always above 15 per cent, (See Table 34 above). In the last two seasons, there was a spectacular rise in the proportion of gum's contribution (over 36 per cent). This could be attributed to two factors. First, there were more sales of gum in Dar Hamar markets, and secondly, more sales of other crops especially groundnut, have been taking place outside Dar Hamar.

TABLE 35

VALUE (IN £S) OF MAJOR CROPS SOLD AT EL OBEID CROP MARKET ON BEHALF OF HAMAR AND HUMR DISTRICTS, 1956/57 - 1966/67.

Year	Ground-nuts	Gum	Grains	Water Melon seed	Sesame	Total	% Gum
1956/57	69,992	340,073	1,492	50,987	18,784	471,328	72.2
1957/58	68,354	300,665	2,142	18,117	30,320	419,598	71.4
1958/59	69,863	300,653	1,327	2,906	5,603	380,325	79.1
1959/60	67,499	254,019	1,736	2,430	15,502	341,186	74.4
1960/61	44,779	382,541	923	2,675	40,783	471,701	81.1
1961/62	48,563	311,793	4,051	5,122	34,823	404,352	77.1
1962/63	205,346	333,991	1,875	3,853	39,094	584,159	57.0
1963/64	114,763	234,713	8,882	6,240	42,359	406,957	57.4
1964/65	141,889	275,522	3,777	7,109	53,318	481,615	57.2
1965/66	218,133	314,243	7,436	8,817	39,565	588,194	53.4
1966/67	232,354	376,824	5,866	30,673	49,733	695,450	54.2
Average	116,501	306,822	3,592	12,629	34,535	476,806	64.3

Source: El Obeid Crop Market, El Obeid, Charts showing Crops Sales at El Obeid Crop Market on behalf of other Districts in Kordofan Province 1956 - 1968.

A careful examination of Table 35 above will help to put into clearer perspective the trend of the significant role which gum has been playing in the local economy of South-Western Kordofan. The table reveals two eras (1956/57 - 1961/62 and 1962/63 - 1966/67) when gum formed widely varying proportions of the total value of the major crops sold at El Obeid Crop Market by the Hamar and Humr tribes. In the first era, the mean annual contribution of gum stood at 77 per cent, but in the second era, the gum's annual contribution had dropped to 56 per cent. Thus, it is quite evident from the table that although revenue from gum has been flunctuating, its relative contribution to the economy has been declining. This trend could be explained in part by the fact that other crops, notably groundnuts and sesame, have been increasing their contribution to the economy at a faster rate than gum; and in part by the fact that a larger proportion of the gum produce is now being sold locally than hitherto, probably due to the narrowing down of the 'between market' differences in gum prices.

Another postulate that has received attention in this chapter is that availability of water could help to stimulate interest in gum-tapping. Already, it has been shown how the drilling of deep bores could help to hasten the tempo at which the people are exposed to the exchange and monetary economy. This exposure, it has been further demonstrated, would be made manifest in a rise in the people's level of wants and consumption. To be able to pay for this rise, the level of income has to go up correspondingly. Increased gum production is one of the surest ways to achieve this objective, at least in the immediate future, in

South-Western Kordofan.

So far in this chapter, the discussion of the gum industry seems to have focused an undue attention to the need to maintain a certain level of gum production every year and that the attainment of this level is crucial not only to the future of the gum industry but also to the future of the whole economy of South-Western Kordofan. The tendency for this seemingly undue focus has resulted largely from the nature of the demand for and the price of gum arabic. The Republic of the Sudan, whose current annual average production of gum arabic stands at 42,000 tons, is the largest world producer ~~production~~ of gum arabic, and accounts for between 85 and 90 per cent of the world trade in this commodity.[27] In spite of the virtually complete monopoly which the Sudan enjoys in the supply market of gum arabic, she cannot do much to influence the demand for, and the world market price of this commodity. The elasticity of demand for gum arabic is low. The main market for the commodity is confectionery which takes 60 to 65 per cent of the present out put, and unless there is a drastic change in the world's sweet-eating habits, confectionery will continue to be gum arabic's main outlet.[28] The low elasticity of demand for gum arabic has a direct effect on its market price whose elasticity is also low. For example, the average price per Kantar of gum arabic sold at El Obeid Market has varied but little since

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27. Ibid., p. 99.

28. Ibid., pp. 99 - 100.

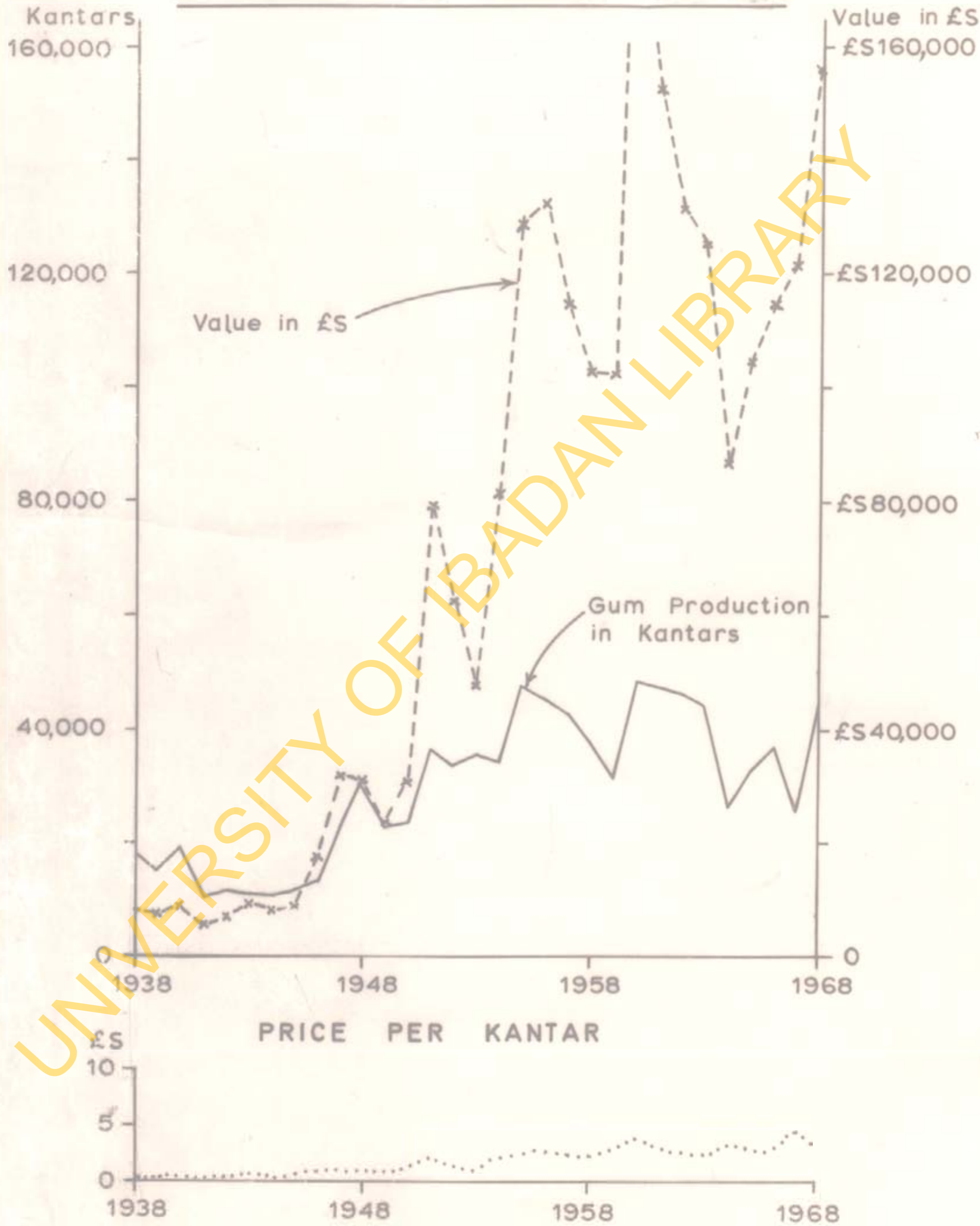
1958, (See Table 36, Figure X and Appendix III). As a result of the low elasticity of the market price of gum arabic, the annual revenue from this commodity in most years depends on the volume or production. This is why the discussion on the gum industry has placed much emphasis on the need for increased gum production in South-Western Kordofan where other sources of earning money in the dry season are not available.

On a careful examination of the movements of the market price of gum arabic over time, the wisdom for calling for uncontrolled increases in the level of gum production might seem questionable. The demand for gum arabic is very limited; therefore, indiscriminate increases in the level of gum production may lead to over-production and a consequent lowering of the market price. This is what seemed to have happened to the price of gum in the early part of 1960 and between 1967 and 1968, (See Appendix III). Between 1960 and 1963, the annual production of gum-arabic stood at about 450,000 kantars. These high production figures helped to bring down the 1960 high average price of £S 4.058 per kantar, (which followed the 1959 low production figures of almost 310,000 kantars), successively to £S 3.224, £S 2.864 and £S 2.860 in 1961, 1963 and 1962 respectively. Similarly, the relative high production figures of over 428,000 kantars in 1968 led to a lowering of the 1967 high price (which accompanied that year's low production figures of under 253,000 kantars) from £S 4.811 to

Fig. X.

GUM SALES AT

EL OBEID CROP MARKET 1938-1968



£S 3.726 per kantar. From the above analysis, there appears to be a tendency for price and production levels of gum arabic to move in opposite directions. Under such a situation, increase in level of gum production may have only very little or no significant effect on the level of revenue. Thus, return on investment of extra labour in gum tapping and collecting could be very low or even nil.

The volume of gum sales at El Obeid, the largest gum market in the world, has been used to test the validity or otherwise of the above assumptions. Already, it has been proved in chapter five that crop production has been increasing as the number of water points increases in the study region. This, in effect, means more revenue from crop production. An examination of Table 36 which shows the five yearly means of gum marketed both by weight and by value at El Obeid since 1938, has revealed an upward trend, except for the periods 1943 - 47 and 1963 - 67. However, average price per kantar has been showing a small but steady and significant rise annually, which means greater revenue still. Since both the price and production levels of gum have shown upward trends, it could be reasonably concluded that the provision of cheap water in South-Western Kordofan has not diminished the people's interest in the gum industry. Therefore, any fall in production level in any one year should be attributed to other factors of gum production, particularly climatic factors. In as much as revenues from both gum and crop sales have gone up, it could be inferred that the peoples' level of consumption has gone up and that this has been due more to the exposure influence of water, (that is deep bores), than to anything else.

The provision of deep bores has had several implications for the land tenure system. It has been claimed earlier on in this chapter that rehabilitation of 'gum-gardens' has been taking place since the deep bore programmes began. With this rehabilitation process, has developed

TABLE 36

GUM SALES AT EL OBEID CROP MARKET: FIVE - YEARLY AVERAGES, 1938 - 1968.

Period	Volume (Kantar)	Value (£S)	Value per Kantar (£S)
1938 - 42	148,746	74,466	0.507
1943 - 47	138,166	154,784	1.120
1948 - 52	292,281	454,915	1.556
1953 - 57	410,389	1,011,623	2.465
1958 - 62	420,406	1,368,096	3.254
1963 - 67	325,494	1,104,820	3.494
1968	428,083	1,594,991	3.726
Over-all Mean	293,724	723,171	2.462

Source: El Obeid Crop Market, El Obeid, Charts Showing Gum Sales at El Obeid, 1938 - 1968.

the propensity to acquire proprietory rights not only over rehabilitated 'gum-gardens', but also over the land on which the gum gardens are situated. In response to this highly desirable tendency, the systems of ownership of land and and gum-gardens have been undergoing some form of modification and change. This change has been from communal-to individual-ownership. Since land is the basis of all forms of economic activities in this zone, such a change is both a fundamental and revolutionary departure from the traditional concept of land ownership. This change, desirable as it may seem, is bound to lead initially to inter-personal and inter-communal conflicts which if not carefully and properly resolved, may develop into clashes some of which could be bloody.

Taking the view expressed above as a base, the number and frequency of occurrence of disputes over ownership of particular gum-gardens, before and since the beginning of the deep bore programmes, could be used to measure the extent to which the people have become aware of the economic benefits derivable from the gum industry. The assumption here is that at a particular point in time, the greater the awareness, the larger would be the number of disputes over gum-gardens. Thus, we would expect to find a larger number of disputed claims to gum-gardens at settlements with water as well as in the post deep bore period, than at settlements without water and also in the pre-deep bore era. Unfortunately this was not practicable because disputes get settled by the Sheikhs or the Omdas or the Nazirs, and these keep no records.

There was, however, overwhelming oral evidence to prove that since the commencement of the well drilling programmes, disputes over ownership of gum gardens have become a feature of frequent occurrence. As a matter of fact, all the Sheikhs, Omdas and the Nazirs who were interviewed reported that a very large proportion of the litigation brought before them had to do with disputed claims to 'gum-gardens', and that these were of more frequent occurrence than before there was water. They claimed that occasionally, some of these disputes did lead to violent clashes. The bloodiest of such clashes was reported to have occurred in November 1968 at Abu Rufa'i between Awlad Kamil and Ben 'Umran from Darfur. The latter were tenant cultivators on the former's tribal land, and had tapped gum from their 'gum-gardens' unchallenged for many years. However, in the gum season of 1968/69, Awlad Kamil decided to assert their right to the ownership of all gum-gardens on their tribal land, and made known their intention to Ben 'Umran who rejected this assertion. So, when several of Awlad Kamil men went to tap gum in their tribal territory, Ben 'Umran attacked them and hacked two of them to death. A sound basis for bloody inter-communal disturbance had been duly laid. Nasir Babo Nimr Ali Jula knew this, and also perceived how violently his people would react to this flagrant insult to, and assault on their tribe. To avert the bloody reprisals that would certainly follow the return of Awlad Kamil from the bahr, irrespective of what punishment might be legally meted out to the criminals, Nasir Babo Nimr ordered 'Ben Umran to return to their dar in Dafur Province.[29] And so was painfully terminated over-night the Ben

29. Personal interview with (1) Babo Nimr 'Ali Jula, Nasir General of the Messeriya Tribe, and (2) 'Ali 'Ali Jula, Nasir for the Humr Section of the Messeriya Tribe in March and August, 1969 respectively.

'Umran's several years' tenancy at Abu Rufa'i over a clash resulting from disputed claims to tap gum.

Clashes notwithstanding, a movement away from communal-to individual-ownership of 'gum-gardens' is an innovation, and is very conducive to making improvements. The recognition of the proprietory right of a farmer to a particular piece of 'gum-garden' confers on him security of tenure. This gives him incentive to make improvements since he is now sure that the benefits acruing from such improvements are his. In consequence, all 'gum-garden' owners have been rehabilitating them by sowing seeds of Acacia senegal, by assisting their re-establishment, and by propagating better varieties of seed. What has been happening in effect, is that the peasants have started to establish what can be described as 'semi-plantations' of gum with higher densities of much better gum-yielding varieties than the 'gum-gardens'. This augurs well for the future of the gum industry. Gum tapping and collecting would both be more rapid and more efficient as less time would now be spent on moving from one tree to another; in addition, larger revenue from gum per unit area of land would be generated.

SUMMARY AND CONCLUSION

Although gum has lost its dominant position in the economy of the Sudan, it is still a significant contributor to the economy, being the second and third most valuable export at the local and national levels respectively. Still the gum industry has the potentials to improve significantly on its present position, so that in spite of the general broadening of the base of the economy the initial momentum of which is attributable to the provision of water supplies the gum industry will continue to be a significant branch of the economy.

In this chapter, it has been proved, that contrary to general belief, the provision of cheap water supplies to water-deficient areas has not had a negative effect on the gum industry. Rather, the industry has continued to grow in spite of the growth in the number of water points, and in spite of spectacular growth in other sectors of the economy, notably, agriculture. The fact that the gum production has actually gone up rather than declined, means that alternative avenues for absorbing the revenue formerly spent on purchasing water has been found. This trend points to a bright future for the gum industry.

Finally, it has been demonstrated that with the growth in the number of deep bores, areas under cultivation have been expanding at the expense of gum-bearing areas. This has been found not to adversely affect, at least in the long run, the level of gum production. To maintain and possibly increase the level of gum production, gum-gardens have been rehabilitated in cultivated areas. Rehabilitation of gum-gardens has been accompanied by fundamental and revolutionary changes in the traditional systems of ownership of gum-gardens and land. These highly desirable changes which are being triggered off by the gum industry, are likely to form the basis for a gradual modernization of the society and its economy.

CHAPTER SEVEN

DEEP BORES AND SOCIAL SERVICES

The introduction of permanent and adequate sources of water supplies to an environment plagued by seasonal or perennial water shortages makes the establishment of permanent settlements possible. Already it has been pointed out in chapter I that in a water - deficient environment, not only do human beings seek to concentrate, but also services get located at the few settlements that are fortunate enough to have permanent water-base. The settlements that get established with the introduction of water become functionally central places because they perform certain services not only for their communities but also for the communities of neighbouring areas that lack water. In consequence, water may be regarded as one of the most important elements which induce the growth of central places. Therefore within a semi-arid region any settlement which has a permanent water-base, whatever its geographical location relative to other centres of population in terms of either distance and/or accessibility, has central place functions imposed on it. Thus, the deep bore drilling programmes must have turned many settlements in South-Western Kordofan with serious and perennial problems of water shortage into central places.

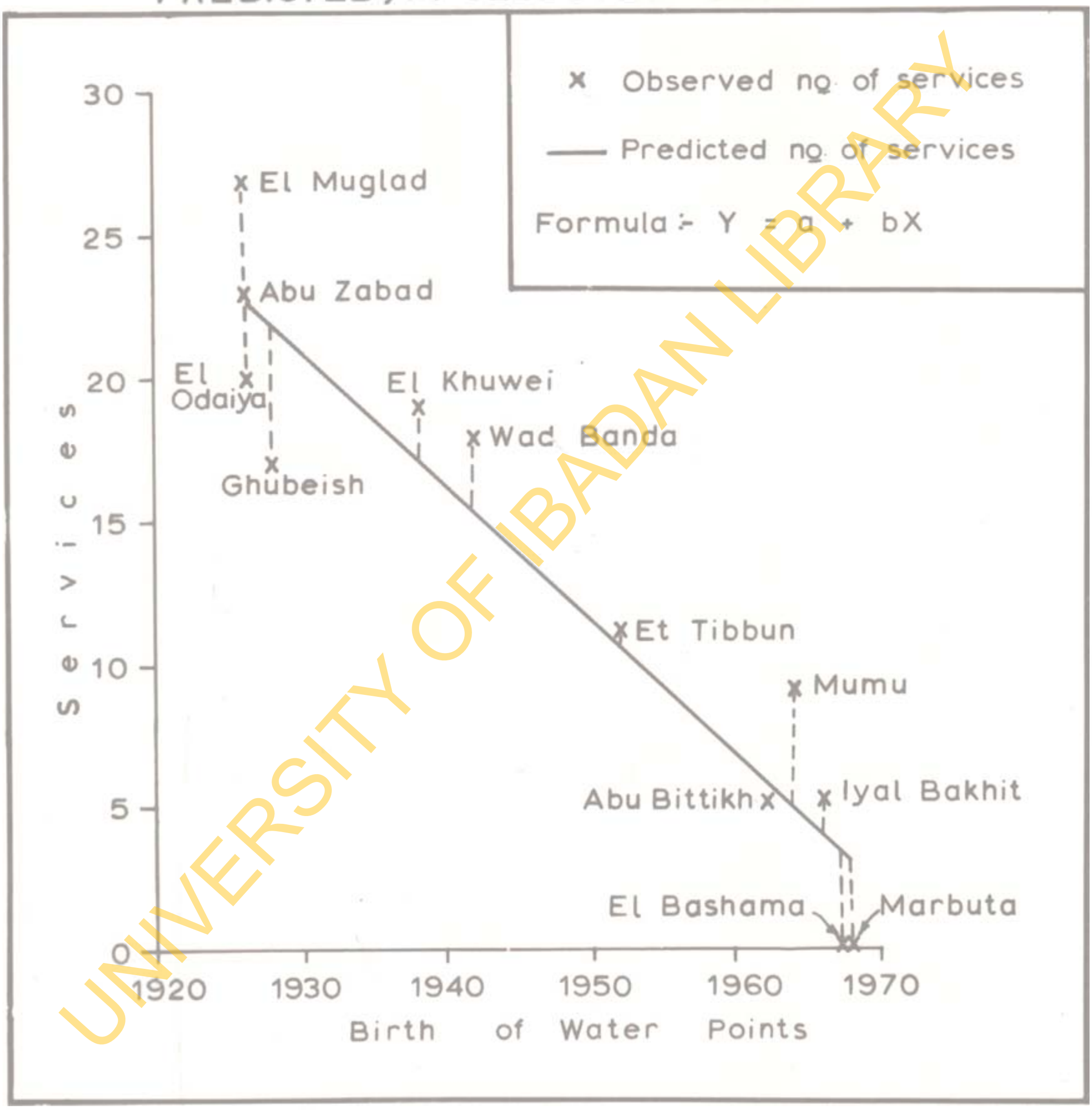
From the fore-going exposition, a hypothesis has been developed. This hypothesis states that in a semi-arid area of a given population size and density and with less than the optimum number of water points, the size of a settlement and the range and number of its services are determined by the quantity of water it yields and the length of time since it has been available. For operational purposes, the quantity of water and the length of time since it has been available refer to the number of deep bores and the date when the first well was drilled respectively. Services in this context refer to those amenities provided either by government or by private organisations or through communal efforts for the rural population. Such amenities include facilities for education, health, civil and legal administration, security, food processing and marketing. In this study, the range of services refers to the different types of services available to the population of a settlement, while the number of services is determined by adding together points awarded to each type of service. These points are awarded on the basis of the number of avenues through which each service is rendered to the population, (See Table 37 below). It has been found necessary to introduce the concept of the number and level of services because types of services co-vary. For example, in South-Western Kordofan, markets can be classified into ordinary (for buying and selling everyday needs) and special (crop and livestock) markets. An ordinary market is awarded a point, and for every special function it performs, it gets an additional point. Thus, a market which serves as a crop and livestock market receives three points. Similarly, while a dispensary receives one point, a health centre or a mini-hospital is awarded two points. Educationally, the number of points

Villages	1		2	3			4		5		6	7	8	9			10		11	12	13
				a	b	c	a	b						a	b	c					
1. Abu Zabad	1923*	A	@		@		@		@		@	@	@		@		@		@	@	11
		B	1	1	–	1	1	1	4	2	1	2	1	1	1	1		2	2	1	23
2. El Odaiya	1923*	A	@		@		@		@		@	@	@		@		@		@	@	11
		B	1	1	–	1	2	1	5	1	1	1	1	1	1	1		2	1	1	20
3. El Muglad	1923	A	@		@		@		@		@	@	@		@		@		@	@	11
		B	1	4	4	1	2	1	7	1	1	2	1	1	1	1		2	2	1	27
4. Ghubeish	1928	A	@		@		@		@		@	@	@		@		@		@	@	11
		B	1	–	–	1	–	1	3	–	1	2	1	1	1	1		2	1	1	17
5. El Khuwei	1938	A	@		@		@		@		@	@	@		@		@		@	@	11
		B	1	–	–	1	1	1	3	–	1	2	1	1	1	1		2	2	1	19
6. Wad Banda	1942	A	@		@		@		@		@	@	–		@		@		@	@	10
		B	1	1	–	1	–	1	3	1	1	2	–	1	1	1		2	1	1	18
7. Et Tibbun	1952	A	@		–			–	@		@	@	–		@		@		@	@	8
		B	1	–	–	–	–	– –	2	–	1	1	– 1	1	1	1		1	1	1	11
8. Abu Bittikih	1962	A	@		–			–	@		–	@	–		@		@		–	–	5
		B	1	–	–	–		– –	1	–	–	1	–	1	–	–		1	–	–	5
9. Mumu	1964	A	@		–			–	@			@	–		@		@		–	–	6
		B	1	–	–	–	–	– –	1	–	–	1	–	1	1	1	1	2	1	–	9
10. Iyal Bakhit	1966**	A	@		–			@	–		–	@	–		@		–		–	–	4
		B	1	–	–	–	–	1	–	–	–	1	–	1	6	1	–		–	–	5
11. El Bashama	1967	A	–		–			–	–	–	–	–	–		–		–	–	–	–	–
		B	–	–	–	–	–	–	–		–	–	–	–	–	–		–	–	–	–
12. Marbuta	1968**	A	–		–			–	–		–	–	–		–			–	–	–	–
		B	–	–	–	–	–	–	–		–	–	–	–	–	–		–	–	–	–

**– 1– 2– 3– 4– 5– 6– 7– 8– 9– 10– 11– 12– 13– @–

Fig. XI.

NUMBER OF SERVICES *(OBSERVED AND PREDICTED)* IN SELECTED SETTLEMENTS



crucial factor that influenced their being chosen in 1953[1] as administrative centres was that they possessed permanent water-base. The same is true for El Muglad and Wad Banda. Originally, El Muglad became the headquarters of the Humr tribe because of its good prospects of water supplies. These prospects have been further heightened by its six deep bores, the first two of which were sunk in 1923. In 1953, after the creation of the Messeriya Rural District Council from the former local government administrative area of Western Kordofan which comprised both Dar Hamar and Dar Messeriya, El Muglad, already a tribal headquarters, was chosen as the Rural Council Sub-Centre for Dar Humr. This choice was no doubt consequent upon the excellent prospects of permanent water supplies which El Muglad possessed. The selection of El Muglad as the headquarters of modern administration has given it immense political advantage over all other settlements in Dar Humr. This explains to a very large extent why it has been able to attract a much larger number of services than any other settlement in Dar Humr. Wad Banda which had its first deep bore in 1942 also became a Rural - Council Sub-centre for Northern Hamar about 1953 largely because it had a permanent water - base. In the second place, except for El Muglad, Abu Zabad and El Odaiya, where the exact ages of some services are unknown, all the other services post-dated their deep bores.

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1. Sudan Government, Khartoum, 1953, <u>Annual Report on Kordofan Province, 1952/53</u>, p. 5.

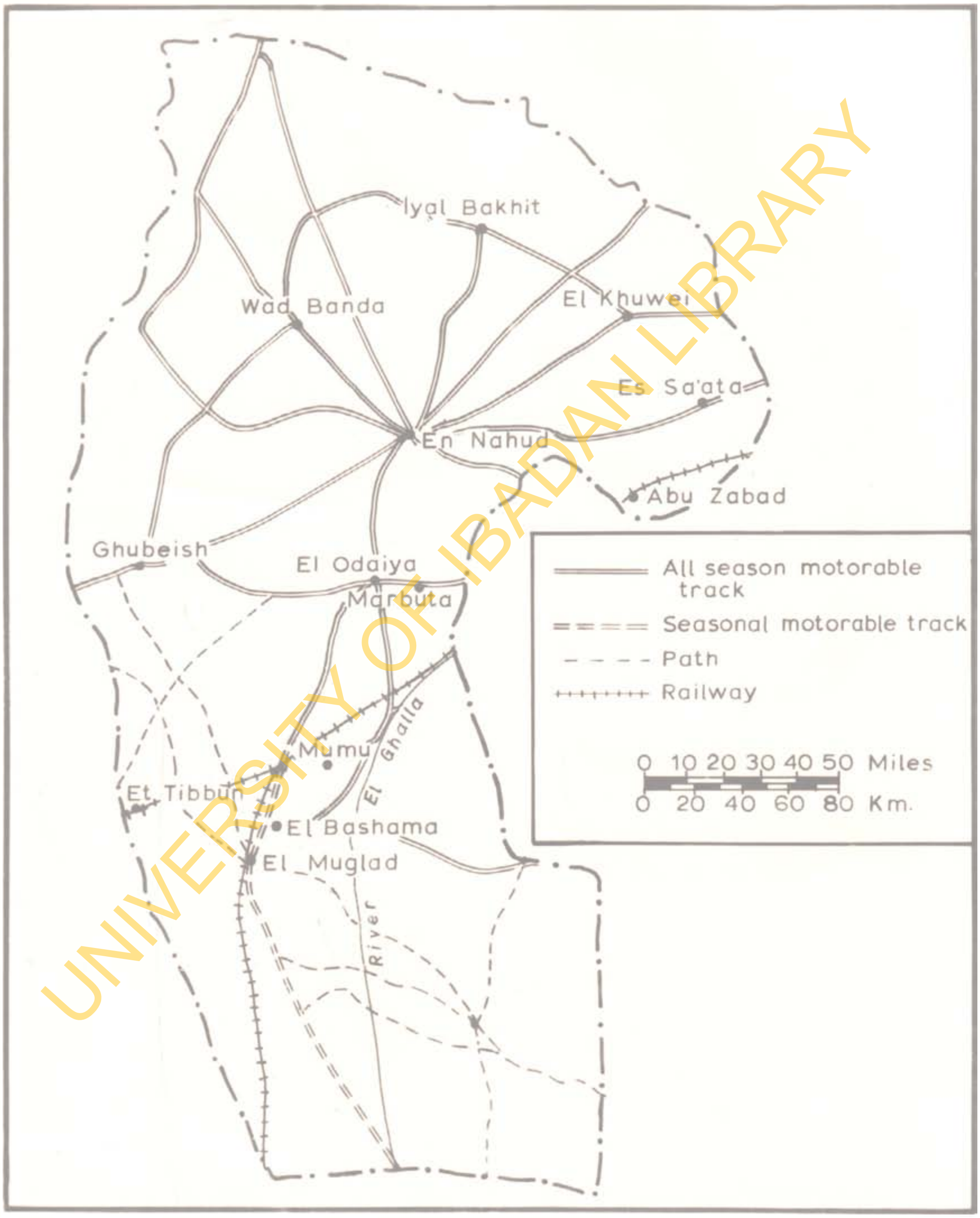
As pointed out above, Fig. XI reveals some anomalies in the relationship between the number of services and the ages of water points. The greatest anomalies have been noticed at El Bashama which has no services at all and at Mumu, whose observed services are more than the predicted by 80 per cent. Positive anomalies, though of a lesser degree, have also been observed at Iyal Bakhit, Wad Banda and El Muglad with observed services exceeding predicted by 25, 20 and 17 per cent respectively; at Ghubeish, Abu Bittikh and El Odaiya, on the other hand, observed services are fewer than the predicted by 23, 17 and 13 per cent respectively.

The reasons for these anomalies are varied and numerous. El Bashama's anomaly is due partly to the age of its deep bore and partly to its geographical location in relation to other settlements with permanent water-base. El Bashama's deep bore was very young, being only two years old at the time this survey took place in 1969. It is also very near El Muglad and Babanusa, 16 km (10 miles) and 18 km (11 miles) away to the south and north respectively. With larger population and older deep bores, they are much better placed for attracting services. Similarly, the anomalies noticed at Abu Bittikh can be attributed to its location in relation to El Muglad and Et Tibbun, 27 km (17 miles) and 46 km (29 miles) away respectively, and those of Ghubeish and El Odaiya to their location in relation to other centres which are equally favourably sited for other services. On the other hand, Mumu has been able to attract more services because of its favourable location on the En Nahud -

El Muglad motorable track. The same is true for Wad Banda which is located on the El Obeid - El Fasher road (See Fig.XIII).

For El Muglad, which has the largest number of services, the following reasons may be offered. First, as already pointed out in this chapter, it is the headquarters of the Messeriya Humr. Secondly, until the 1950's it over-shadowed all other settlements in Dar Messeriya, where, as pointed out in chapter three, the growth of deep bores is a post - 1950 phenomenon, whereas El Muglad alone could boast of two separate water yards with five wells by 1950. Thirdly, it is the home of the very influential Babo Nimr 'Aly (the Nazir General of the Messeriya), and 'Aly Nimr 'Aly (the Nazir of the Messeriya Humr). These two, especially the former, have always been in a position to use their influence to attract services to their village. Fourthly, before the dawn of the era of deep bores, El Muglad had always had water from natural pools for a greater part of the year. Iyal Bakhit's case is simply that of a man who became king of the city of the blind because he happened to be the only person fortunate enough to have one eye. Although it has no permanent water-base, its water needs are now met by a lorry tanker owned by the Hamar Rural Council. Thus, the anomalies noticed in the number of services in South-Western Kordofan are due to one or a combination of the following: political influence, accessibility and location of settlements vis-a-vis other settlements with similar services.

Fig. XII.
COMMUNICATIONS



While the provision of water to a village enhances its fortune functionally it at the same time, impairs that of neighbouring ones. For example, Baggara has grown at the expense of Kijeira, about 8 km (5 miles) away, and in the same Omodia with Baggara, (See Fig.VI). Until the later 1950's, the latter which depended on surface wells for its water supplies, was more important than the former, for it had a sub-grade school and a market. But in 1958, a deep bore was drilled at Baggara, and soon afterwards, the school at Kijeira was not only transferred to Baggara, but also had its status raised to that of elementary school; and when in 1967 a dispensary was allocated to that omodia, it naturally got located at Baggara. Kijeira has, however, remained as the omodia's most important market centre; and now that Kijeira has been provided with a deep bore, it would be interesting to watch the trend of future developments in the two settlements.

Functionally, El Odaiya has declined with the provision of a deep bore at Muma, 48 km (30 miles) away and formerly dependent upon El Odaiya's well-field for its dry season water supplies. On the other hand, Abu Zabad has been growing consistently. This is because it is a major railway station on the Er Rahad - Nyala railway, and it now has a borehole to supplement water from its well-field.

Although El Muglad has not shown any obvious signs of decline, there is no doubt that Babanusa, 34 km (21 miles), Et Tibbun, 74 km (46 miles), and Abu Bittikh, 27 km (17 miles) away from El Muglad are now in a position to compete with it for services, having been provided with boreholes since 1951, 1952 and 1962 respectively. In fact Babanusa, which is as accessible by rail and road as El Muglad, has witnessed a spectacular growth in size and functions within the last fifteen years. This is because of its favourable location at the point where the Wau branch railway line links with the main Er Rahad - Nyala line. Secondly, since 1967, it has become the centre of the milk processing industry of South-Western Kordofan. Thirdly its water supply prospects are much better than El Muglad's, for the railways and the Milk Processing Factory have special deep bores for operating their industries and for the use of their employees. Consequently, Babanusa has become the leading commercial centre in Dar Messeriya.

Revenue Collection.

Many services are provided by local councils. It is therefore appropriate at this stage to examine the councils' sources of revenue and determine how the availability of water facilities their collection.

Most local councils in Kordofan Province, as elsewhere in the Sudan, depend on two major sources for their revenue. These are ushur and qibana (crop tax and market and weighing fees on crops sold in the markets respectively), and dariba (animal tax). As indicated in chapter five, ushur is seven per cent ad valorem of the value of the crop sold in the market while qibana is charged at the rate of three per cent of the value of the crops marketed. Neither Ushur nor qibana is as difficult to collect as *dariba* since they are paid by those who buy the crops. Furthermore, in South-Western Kordofan, crop tax is not as important as livestock tax, because it contributes much less to the total revenue than animal tax. For example, in the 1967/68 financial year, while *ushur* and *qibana* yielded a total revenue of £S 11,728 and £S 29,185 in Dar Humr and Dar Hamar respectively, the corresponding figures from animal tax were £S 557,229 and £S 552,331 respectively.[2] Therefore, this section deals mainly with the problems of collecting animal tax and examines how the provision of deep bores could assist in their solution.

Livestock Tax-Assessment and Collection.

In the Sudan every animal owner is expected to pay tax, the value of which depends on the number and type of animals owned. The rate payable varies from time to time and from one council to another, but in Dar Humr and Dar Hamar, the current rate is £S 0.60, £S 0.35, £S 0.10 and £S 0.065, per head of camel, cattle, sheep and goat respectively. The amount to be paid by a tribe is levied by the Council, while the details of determining what individuals should pay and the actual collection are left to the *Nazirs*, their *omdas* and *sheikhs*. It is the *sheikhs* in particular who have the onerous duty of collecting directly from the animal owners. This they find difficult to do, and where the people concerned are nomads, the difficulty becomes further

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2. For more information on this, see (A) Annual Reports on Crop-Markets in Hamar and Messeriya Rural Councils, 1967/68, and (b) Animal Tax Registers for Hamar and Messeriya Rural Councils, 1967/68; at En Nahud and Rigl el Fula.

aggravated.

It has been shown that the search for water is one of the principal factors which determine the choice of nomadism as a way of life. Since the provision of adequate and permanent sources of water supplies to a water-deficient area would induce the nomads to become settled, the prospects of finding solutions to the two major problems associated with animal tax collection would be greatly improved. The first problem is concerned with assessing the tax to be paid by individuals. In theory, assessment is based on the type and size of stock of an individual. In an environment which suffers from seasonal shortage of water, the pastoralists are always on the move. In consequence, actual enumeration of animals for the purpose of taxation is not only difficult but expensive. The council officials are therefore forced to rely on whatever figures are given by the <u>sheikhs</u>, who always collaborate with many of their subjects either to evade assessment completely, or to grossly understate the size of their livestock. This system results in loss of revenue to the council, which is thus hampered financially in the performance of its functions.

If the situation described above were true, then the multiplication of water points in South-Western Kordofan should enable the councils to increase their revenue from animal tax for the following reasons. First, the councils would now be in a position to assess fairly accurately the tax to be paid by an individual. This is because an actual census of the animal population could be carried out much more easily and cheaply. Secondly, the prospects of evading assessment or payment of tax or both would be greatly reduced.

To evaluate the probable effect of availability of water on revenue collection, the proportion of estimated revenue from animal tax which was actually collected has been compared over time and between places with different modes of living. Table 38 below supports the view that it is much easier to collect tax from sedentary than from nomadic population. For example, over the entire period, while Dar Hamar collected almost 91 per cent of its estimated revenue from animal tax, Dar Humr with a larger nomadic population than Dar Hamar, succeeded in collecting only about 71 per cent. Within Dar Hamar itself, there exists conclusive evidence supporting this claim, for while over 99 per cent of the estimated revenue in respect of the settled omodias was collected, the percentage for the nomadic omodias was only 85.

In Dar Hamar both anticipated revenue and the proportion collected have consistently shown an upward trend throughout the period. For Dar Humr, while the anticipated revenue from animal tax has shown an upward trend, the proportion collected has flunctuated. In the 1962/63 to 1964/65 period, the proportion collected rose from 78 (1959/60 to 1961/62) to 88 per cent, but then fell to 55 per cent in the 1965/66 to 1967/68 period. This fall notwithstanding, the revenue actually collected was 18 per cent higher than that of 1959/60 to 1961/62. The reason for this downward trend was due to the fact that at the time the survey took place,

tax collection for the 1967/68 financial year was still in progress. During his field work in Dar Humr, the writer met several council officials who were on "pay your tax-drive". They were, in fact, virtually chasing about the Baggara Arabs from market to market. This situation has thrown light on yet another fact, that tax collection among settled population takes much less time than among nomadic population.

The next enquiry to make is to find out if the provision of deep bores can help to improve on the proportion of the possible revenue that is collected annually. It has been shown in chapter three that the animal population given by the Messeriya and Hamar Rural Councils fell short of that given by the Ministry of Animal Resources by 57, 37, 61 and 53 per cent for camels, cattle, sheep and goats respectively. On the basis of the Ministry's estimate, which has been accepted as the more reliable of the two, the Hamar Rural Council's expected revenue from animal tax should be £S 93,879 and that of Messeriya Rural Council £S 126,118 (excluding camel tax), in the most unlikely event that none evades payment nor makes false declarations. These figures have been arrived at by using the percentage of underestimation for each type of animal to correct the Councils' estimates. The corrected figures were then multiplied by the rate payable on each type of animal which is £S 0.60 (camel), £S 0.35 (cattle), £S 0.10 (sheep) and £S 0.065 (goat). The figures obtained were then compared with the Councils' anticipated revenue and the revenue actually collected over the period 1959/60 to 1967/68 for which fairly reliable records existed.

The position has been simplified in Table 39 below. A glance at the table reveals that anticipated revenue forms a larger proportion of possible revenue in Dar Humr than in Dar Hamar (59 as against 52 per cent). This is rather surprising for it tends to falsify the claim made in an earlier section of this chapter. However, these figures are

TABLE 39

COMPARISON OF POSSIBLE* AND EXPECTED** REVENUE FROM ANIMAL TAX AND THE AMOUNT ACTUALLY COLLECTED IN DAR HAMAR AND DAR HUMR

COUNCIL	a (£S)	b (£S)	b/a%	c (£S)	c/b %	c/a %
Hamar	93879	48355	52	46588	96	50
Humr	126118	74170	59	56599	76	45
Total	219997	122525	56	103187	84	47

Notes: a - Possible revenue from animal tax.
b - Anticipated revenue from animal tax.
c - Amount collected as animal tax - average for 9 years : 1959/60 to 1967/68.
* - Based on estimates by the Ministry of Animal Resources.
** - Based on Council estimates.

Sources: 1. En Nahud, Hamar Rural Council, Animal Tax Register, 1959/60 to 1967/68.
2. Rigl el Fula, Messeriya Rural Council, Animal Tax Register, 1959/60 to 1967/68.
3. Khartoum, Ministry of Animal Resources, Annual Report on the Animal Industry in the Sudan, 1968.

not to be taken at their face value. This is because possible revenue from animal tax in Dar Humr still suffers from some measure of underestimation as it does not include camel tax. With actual money collected, the position is different. In Dar Hamar, it forms 96 and 50 per cent of anticipated and possible revenue respectively. For Dar Humr, the corresponding figures are 76 and 45 per cent respectively. One or more several reasons may explain this situation. Either Dar Hamar has an unusual monopoly of the most efficient local administrators; or more likely, that reluctance to pay tax among the Hamar is not as strong as among the Humr, or more likely still, that the prospects of successfully evading assessment for and payment of tax are less bright in Dar Hamar. From the above discussions, it becomes quite obvious that revenue collection is much easier among sedentary than among migratory populations. Since the availability of permanent sources of water supplies enables nomadic people to become settled, it can be safely inferred that the deep bore drilling programmes, by increasing the number of settlements with permanent water - base will facilitate tax collection.

<u>Primary Education.</u>

Education is an important attribute of, and a pre-requisite to modernization. This is why priority is given to accelerating the process of reducing the rate of illiteracy among the population where social and economic revolution is desirable.

Yet in the Sudan where such need is very great, the illiteracy rate is very high. According to the 1955 census, no more than 3 per cent of the adults were literate and no more than 4 per cent of the children went to school with a chance to secure some education.[3] There were, according to the same census, 1,565,000 children aged 7 to 14, but according to the Ministry of Education, there were only 160,000 seats in both elementary and sub-grade schools.[4] That is, there was room for just 10 per cent of the school-going-age children. Since then, however, spectacular progress has been made. By 1959/60, of the 1,240,000 children aged 7 to 10, 290,274 (22 per cent) had been enrolled in the elementary and sub-grade schools.[5] In the 1966/67 school year, the enrolment had gone up to 27 per cent,[6] although this rate varies widely from as low as just one per cent in Bahr al Ghazal to as high as just under 80 per cent in Khartoum Province.

In this exercise, only elementary education is considered. This is because elementary and sub-grade schools could be built anywhere provided there is adequate permanent water supply. On the other hand, intermediate and secondary schools of all forms must continue to seek locations at selected centres.

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3. Krotki, K.J., 1958, First Population Census of Sudan, 1955/56: 21 Facts About the Sudanese, p. 29.
4. Ibid., p. 31.
5. Khartoum, Ministry of Education, 1961, Educational Statistics, 1959/60 - See Section on Elementary and Junior Elementary Schools.
6. Khartoum, Ministry of Education, 1968, Educational Statistics, 1966/67, pp. 26 - 27.

<u>Boarding and day schools.</u>

On the basis of the census figures, 1,450,000 children still needed to be provided places in elementary schools in the Sudan. Most of the schools have boarding facilities, and to provide places for all these children it was estimated that schools to the value of £S 300 million would have to be built. The same estimate also showed that if the rate of building schools prevailing at that time were maintained, that would take 500 years to accomplish.[7]

Nevertheless, there seems to be little doubt that day schools would be cheaper not only to build but also to run than boarding schools. A study undertaken in the Sudan has claimed that three day schools could be built for the cost of one boarding school, which must, in addition to class rooms, have sleeping and dining accommodations and toilet facilities. The same study had shown that four or five day schools could be run at the cost of running one boarding school.[8] The children would not only have to be fed at government expense, but also the kitchen staff, the water-carrier and the porter would have to be paid.

Comparison of per capita expenditure on day pupils and boarders over a period of eight years has lent support to the findings of the study reported above (See Table 40 below). From this table, it is clear that it costs about two and a half times as much to maintain a child

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7. Krotki, K.J., 1958, <u>op. cit.</u>, p. 31.
8. <u>Ibid.</u>, p. 32.

in an elementary boarding school than in a day school. In the subgrade school, the gap is even much wider, because for every child maintained as a boarder, five children could be maintained as day students.

TABLE 40

ANNUAL EXPENDITURE PER PUPIL: DAY PUPILS VERSUS BOARDERS IN BOTH ELEMENTARY AND SUBGRADE SCHOOLS; (VALUE IN £S)

	DAY PUPIL			BOARDER		
	Tuition	Board and Lodging	Total	Tuition	Board and Lodging	Total
Elementary*	11.082	-	11.082	11.082	16.289	27.911
Subgrade**	4.267	-	4.267	4.267	18.390	22.667

* - Average for eight years; 1959/60 to 1966/67.

** - Figure for 1964/65 only.

Source: Computed from Educational Statistics: 1959/60 to 1966/67, Ministry of Education, Khartoum.

Most of the countries of the world, according to Krotki, are satisfied with the system of day schools without apparent detrimental effect to the development of their children. He has then found it difficult to understand why Sudan with one of the lowest income in the world should have chosen to educate her children in the most expensive way.

Krotki has gone further to attribute this to three main factors.[9] The first among these is the very low population density of the Sudan which, according to the 1955 census, is only 4 persons per $km.^2$, and this indicates a very large land - population ratio. In a semi - arid environment, permanent settlements exist only in those centres with permanent water-base and such centres are very few are far between. Schools which are normally built at centres with permanent population are even fewer and further apart from each other than permanent settlements. Consequently, these few schools cannot provide education for most children whose homes are scattered over wide areas if these children have to walk to and back from school daily. To enable a large proportion of the children to benefit from the education provided by the very few schools, many children have to be brought together from their widely scattered homes and boarding facilities have to be provided for them. It can be seen therefore that the very large area in relation to population and the great distances seperating children's homes from schools are the two most valid geographical arguments for boarding schools. To overcome the problem associated with large space, Krotki has recommended that a conscious policy of favouring educationally areas of higher population density be followed. He has, however, failed to mention that a higher population density could be induced at a particular place by providing it with adequate permanent water supplies (if it lacks water) or by increasing its sources of water supplies (if it already had).

9. Ibid., pp. 31 - 32.

In further attempts to fully explain the reasons for the system of boarding schools in the Sudan, Krotki has made references to the cultural background of the people and their attitudes to education. He has claimed that little desire for education existed outside the more sophisticated towns until the very recent. This claim has been supported by Cunnison, Asad and Hill who have asserted that the Baggara Arabs have rejected education because it conflicts with their traditional values.[10] The author has also found that it was true that initially, parents had to be persuaded to send their children to school. Persuasions were first directed on the Nazirs, Omdas and Sheikhs being leaders of and very often the most influential members in their communities. Since the children who came from very wide areas were to attend schools far away from their parents, it was found necessary to provide boarding facilities for them to encourage their parents surrender them for education. While there is no doubt that the situation described above was true at a particular point in time, the position had certainly changed for the better by 1969. Obviously, greater desire for education now exists on the part of all sections of the population. In fact, evidence abounds to show that demand for education is now so overwhelming that every year, many children are turned away from school because there are no places for them. A more vivid picture of the situation is given in Table 41 below.

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10. For more information on the views of Cunnison, Hill and Asad on the attitude of the Baggara Arabs to education, see Cunnison, I., Hill, L.G., and Asad, T., 1966, op. cit., pp. 102 - 125.

TABLE 41

CHILDREN WHO SOUGHT FOR, AND THOSE WHO GOT ADMISSION AT ELEMENTARY SCHOOLS IN FOUR SELECTED VILLAGES IN SOUTH-WESTERN KORDOFAN DURING THE 1969/70 SCHOOL YEAR.

CENTRE	APPLICATION.	ADMISSION	% ADMISSION
Lagawa Elementary School A & B	213	100	46
El Muglad Elementary Schools A & B	342	100	29
El Khuwei Elementary Schools A & B	259	100	39
Et Tibbun Elementary Schools	145	50	34
Total	959	350	36

Source: Data were supplied by the headmasters of the above schools between July and September, 1969.

This table shows that of the 959 children who sought for admission in seven elementary schools at El Muglad, Lagawa, Et Tibbun and El Khuwei in the 1969/70 school year only 350, that is, under 36 per cent, were successful. It could be said with confidence that the indifference to education referred to by Krotki, and Cunnison, Asad and Hill has virtually disappeared.

Apart from the statistical evidence offered by table 41 in support of the above claim, the writer had received abundant corroborating oral evidence from those whom he interviewed during his field research in South-Western Kordofan. The author had asked the <u>Nazirs</u> of the Hamar and Messeriya, and the <u>Omdas</u> and <u>Sheikhs</u> of the sampled settlements to enumerate in order of priority the most immediate pressing needs of their people. These people were unanimous in their replies that what their people needed most urgently were more sources of perennial water supplies. They were equally unanimous in their answers that the next most urgent needs of their people were more educational facilities for their children. The other urgent needs of the people on whose placings in the order of priority there was no unanimous agreement included improved marketing facilities for their animal and agricultural products, and more medical and veterinary services. The two <u>Nazir</u> - Generals interviewed disclosed to the author that some of their subjects, particularly those whose children had failed to find places in the few existing schools, had started to feel dissatisfied with their leadership for their inability to get the government to build more schools in their <u>dars</u> (tribal territories)

Secondly, all the 360 people who were interviewed in the twelve sampled villages, except two (and these were nomads) had expressed the desire to send their children to school. Of these 360, 59 already had one or two children in either elementary or subgrade schools; and 43 others would have had their children in school if they had found places for them.

Thirdly, Krotki also claimed that the social pattern in an average

Sudanese household is such that sustained work at home was difficult or even impossible due to frequent visitors on prolonged visits, lack of domestic libraries, regular eating and sleeping hours. None of these conditions, except perhaps the first one, are unique to the Sudan and as such cannot be regarded as insummountable obstacles to the system of day schools. Afterall, elementary schools in the towns have no boarding facilities. Also, in every boarding school, a certain number of pupils, especially those whose parents are resident in the village where the school is located, are day pupils. And it may be assumed that there has not been any evidence which shows that boarders do much better academically than day pupils, otherwise the parents of the day pupils would have protested over the exclusion of their children from boarding houses.

Two other factors to which Krotki had not referred in his exposition on boarding schools, and which must have considerably influenced the authorities to provide boarding facilities for village elementary school pupils are mentioned below. First, it was a means of persuading reluctant Arabs to allow their children to receive Western Education by presenting them with an educational institution which does not show major structural differences from the traditional Quranic school where boys had been used to living and learning with the faki (Quranic teacher). Secondly, it was designed at removing the fear that schools would be full of sons of poor cultivators while richer pastoral families migrated.

In the light of the above, it is being postulated that the provision of adequate all-season water supplies in appropriate places, by inducing nomads to settle down, would help reduce the per capita cost of education. This is because it would not be necessary any longer to keep children in boarding houses. The savings made, it is hoped, would be used in providing more places for, and maintaining more children in schools. This would hasten the rate at which illiteracy is being eradicated from among the population.

The summary of enrolment in elementary and subgrade schools for Sudan, Kordofan province and Hamar and Messeriya Rural Councils for the period 1959/60 to 1966/67 is presented in table 42 below. In the next table also is presented what the position of enrolment would be if all the money voted for elementary education were expended in providing places for children in day schools only.

Table 42 reveals that whereas only 16 per cent of the pupils in elementary and subgrade schools throughout the country are boarders, the corresponding figures are 36 and 48 per cent for Kordofan Province and the Hamar and Messeriya Rural Councils respectively. As for Table 43, it shows that by abolishing the system of boarding schools, over 140,000 additional places could be made available for children in both elementary and subgrade schools. This figure represents an increase of 38 per cent in the present level of enrolment in the two type of schools. This percentage increase, however, is far from being uniform throughout the country. In Kordofan Province, it is 86 per cent, while it is as high as 114 per cent for the Hamar and Messeriya Rural Councils. The comparatively

TABLE 42

ENROLMENT IN ELEMENTARY AND SUBGRADE SCHOOLS

	Sudan			Kordofan			Hamar and Humr R.C		
	Elementary* Schools	Sub grade*** Schools	Total	Elementary* Schools	Sub grade *** Schools	Total	Elementary** Schools	Sub grade** Schools	Total
No. on roll	231176	142289	373465	31340	15730	47070	9668	3145	12813
Boarders	41946	17776	59723	11240	5832	17072	4360	1909	6134
% Boarders	18.1	12.5	16.0	35.9	37.1	36.3	43.9	60.7	47.8

Notes: * - Average for eight years: 1959/60 - 1966/67.
** - Average for three years: 1966/67 - 1968/69.
*** - Figures for 1964/65 only.

Sources:
1. Khartoum, Ministry of Education, Educational Statistics, 1959/60 - 1966/67.
2. En Nahud, Hamar Rural Council, Annual Report on Education, 1959/60 - 1966/67.
3. Rigl el Fula, Messeriya Rural Council, Annual Report on Education, 1968/67 - 1968/69.

TABLE 43

HYPOTHETICAL INCREASE IN NUMBER OF PLACES IN ELEMENTARY AND SUBGRADE SCHOOLS IF ALL SCHOOLS WERE DAY SCHOOLS.

	S u d a n			Kordofan Province			Hamar and Humr R.C.		
	Elementary* Schools	Sub grade *** Schools	T o t a l	Elementary* Schools	Sub grade*** Schools	T o t a l	Elementary** Schools	Sub grade ** Schools	T o t a l
Present Enrolment	231176	142289	373465	31340	15730	47070	9668	3145	12813
Hypothetical Increase	63699	76611	140310	17069	23179	40248	6401	8227	14628
Increase %	27.5	53.8	37.5	54.4	147.3	85.5	66.2	261.5	114.1
Hypothetical Enrolment	294875	218900	513775	48409	38909	87318	16069	11372	27441

Notes: * - Calculations were based on average per capita expenditure for eight years, 1959/60 - 1966/67

** - Calculations were based on average expenditure per pupil for three years, 1966/67 - 1968/69.

*** - Calculations were based on the per capita expenditure for the year 1964/65 only.

Sources: See Table 42 above.

low percentage increase for the whole country and for Kordofan Province is due to the inclusion of large towns whose elementary and subgrade schools have no boarding facilities. The same reason explains why the proportion of pupils in elementary and subgrade schools who are boarders is rather higher in the study region than in Kordofan Province, and much higher than in the whole country.

One important fact that has been suggested from the two tables is that the proportion of pupils who are boarders in an area is determined largely by the mode of life of its people. This fact has also been borne out by the situation in Dar Hamar and Dar Messeriya which is presented in Table 44 below. As expected, Dar Messeriya with a larger nomadic population than Dar Hamar, has a larger proportion of its pupils as boarders (53 per cent) than Dar Hamar (44 per cent). The table also reveals that the percentage of pupils who are boarders has been declining but at a faster rate in Dar Messeriya. For example, during the 1966/67 school year, 58 per cent of the pupils in Dar Hamar were boarders; but in the 1968/69 school year, this percentage has fallen to just under 50. For Dar Hamar, the corresponding percentages for the two periods are 47 and 42 respectively. The fall in the proportion of pupils who are boarders is an indication that more people are abandoning nomadism for settled life, and that this is due largely to the recent growth in the number of water points. This trend augurs well for the future advancement of primary education in South-Western Kordofan.

Markets and Marketing Facilities.

In Kordofan Province, two types of markets similar to Hodder's daily

TABLE 44

ENROLMENT IN ELEMENTARY AND SUBGRADE SCHOOLS IN HAMAR AND MESSERIYA RURAL COUNCILS, 1966/67 – 1968/69

	Hamar			Messeriya			Hamar and Messeriya		
	No. on roll	Boarders	% Boarders	No. on roll	Boarders	% Boarders	No. on roll	Boarders	% Boarders
1966/67	6496	3048	46.9	4864	2825	58.1	11360	5873	51.7
1967/68	7338	3158	43.0	6083	3167	52.1	113421	6325	47.1
1968/69	7490	3120	41.7	6167	3053	49.5	13657	6173	45.2
Average	7108	3109	43.7	5705	3025	53.0	12813	6134	47.9

Sources: 1. En Nahud, Hamar Rural Council, Annual Reports on Education, 1966/67 to 1968/69.

2. Rigl el Fula, Messeriya Rural Council, Annual Reports on Education, 1966/67 to 1968/69.

and periodic markets in Yoruba-land have been distinguished.[11] These are the "daily" and the "once - or twice - weekly" markets. The two, however, differ in functions. While all markets act as distributing points for imported goods and products of local craft industry, the sales of animals, gum, groundnut and surplus food crops take place only in the daily markets and a few of the weekly ones. Consequently, discussion of the effects of deep bores on markets and marketing facilities in South-Western Kordofan has been focused on the functions performed by each type of markets.

For ease of reference, centres which act as crop and/or livestock markets have been designated "council" markets. If they are held daily, they are referred to as "daily council markets", otherwise they are called "weekly council markets". The word "council" has been used to describe these markets because it is the council which creates them, and gives them the necessary apparatus (especially weighing machines) and personnel for operating them. At present there are eleven and seven such markets in Dar Hamar and Dar Humr respectively. All other markets of which there are many are simply called weekly markets.

In water-deficient regions, the presence of water exercises decisive control on the number and location of markets and their functions. In consequence, the growth of deep bores has had a definite effect in increasing the number of markets in South-Western Kordofan, in the same way as

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11. Hodder, B.W. and Ukwu, U.I., 1969, Markets in West Africa, pp. 58 - 59.

construction of modern ~~net-work~~ network of roads had done in West Africa. For example, of the twelve settlements selected for study, ten now have permanent sources of water supplies. Eight of these depend solely on deep bores and the remaining two on rahads (natural pools of water). All the ten settlements except El Bashama, now have markets of one type or another. The two settlements that depend on natural sources of water (Abu Zabad and El Odaiya), and the four settlements with the oldest deep bores (El Muglad, 1923, Ghubeish, 1928, El Khuwei, 1938, and Wad Banda, 1942) have "daily council markets". Although these four already had markets before their deep bores, these were weekly markets, and functioned in the rainy season only. In addition, these markets, except that at El Khuwei, originally had their locations at some distance away from their present sites where they had been moved to only after their boreholes had been drilled so that they could be near water. These markets have thus acquired their present sites and status only after they had been provided with deep bores.

Two other settlements whose boreholes are of relatively older age - Et Tibbun (1952) and Mumu (1964) - have twice - weekly council markets. Abu Bittikh, whose deep bore is older than Mumu's, is however, served by a weekly market only. ~~Though~~ Although the market has been growing ~~but~~ it has not been doing so fast enough because it has been hampered by its nearness to El Muglad. El Bashama got a deep bore in 1967, but it has not got any market yet, and the chances that it will get one soon are very slim.

This is because it is hemmed in by El Muglad in the South and Babanusa in the north - 16 km. (ten miles) and 18 km. (eleven miles) away respectively.

Iyal Bakhit has no permanent water-base, yet it has a weekly council market. This market used to function in the rainy season only until 1966 when the Hamar Rural Council lorry tanker started to supply its inhabitants with water in the dry season. Like Iyal Bakhit, Marbuta has no permanent sources of water supplies and its water needs in the dry season are supplied by a commercial lorry tanker. But unlike Iyal Bakhit, Marbuta has no market, simply because of its nearness to El Odaiya.

Increase in the number of markets is achieved through the following mechanisms. Once a place in a water - deficient environment gets a permanent water - base, it assumes the importance of a central place. First, it becomes, inevitably, the new most convenient meeting centre for the people of its immediate neighbour-hood who, in the recent past, used to go to a more distant water point. Secondly, merchants, especially the most enterprising ones, are quick to recognize the trading opportunities offered by the new centre, and are attracted there. Initially, they may start going there with their merchandise every week, their movements being facilitated by the motorable track that has been generated by the new deep bore. Very soon, the desire by the people to do their buying and selling as close as possible to their homes, whether temporary or permanent, soon leads to the growth of a market at the new meeting centre.

Later, the council may decide to further enhance its growth and importance by constituting it into a crop - and livestock - market. This, of course, depends on several factors which include its location in relation to other "council markets", the volume of its agricultural produce and the number of animals available for sale. The growth in the number of "council markets" has enabled farmers and pastoralists to dispose of their produce and animals much more easily and quickly and at fair prices and without having to travel long distances to markets. They are assisted in this by the motorable tracks generated by deep bores which now make the assemblage and evacuation of farm products more efficient.

Apart from their economic functions, markets fulfil several social functions. There are no groups that attach greater importance to the social functions performed by markets than nomadic populations. Attending a market forms a part of the Arab's way of life, particularly for the men, rather (very much) as it forms part of a Yoruba woman's way of life.[12] In South-Western Kordofan, bachelors and spinsters who go to the market do so not for the purpose of buying or selling, but mainly for courtship, hence they are gaily dressed. In Kordofan Province, as in West Africa, markets are effective meeting places for settled and nomadic populations on the one hand and for urban and rural culture on the other.[13] Since

12. Hodder, B.W. and Ukwu, U.I., 1969, op. cit., pp. 50 - 51.

13. Ibid., p. 53.

meetings and contacts take place more readily at market centres and mostly on market days, markets play a significant role in bringing social change to dwellers of rural areas.

The creation of all season water points in an environment where water is lacking and markets are inadequate would be accompanied by an increase in the number of markets. It should be pointed out, however, that once all parts of the region are assured of adequate sources of water supplies the optimum number of markets in the region will, invariably, depend on the interplay of its size, population and wealth. An increase in the number of markets would offer the people greater prospects of meeting more frequently as shorter distances would now be travelled to and from markets. Thus, the provision of deep bores by increasing the frequency of contacts among people of different cultures helps to hasten the tempo of social change among the rural population.

Food Processing Facilities.

In South-Western Kordofan, the multiplication of water points has made possible the successful introduction and adoption of several innovations. Among these are food processing facilities of which the most important is the sorghum or pennisetum mill which now renders very invaluable services to the people. The Hamar and Humr people eat meals of *asida* (porridge) for breakfast and dinner, and *kisra* (thin flat unleavened bread) for lunch. In the study region, *asida* and *kisra* are made from sorghum or pennisetum flour, though elsewhere in the country especially in the urban areas, *kisra* can be and is made from wheat flour.

Traditionally, to reduce sorghum/pennisetum to flour, the corns are first broken up by pounding with mortar and pestles, and then refined by grinding with stone. Both operations, performed mostly by women, are slow, difficult and tiring. The introduction of the sorghum/pennisetum mill has now relieved most women of this very unpleasant task.

As might be expected, the private entrepreneurs who own the sorghum/pennisetum mills seek to locate them at centres with permanent water-base. Consequently, water points are also mill centres. Of the twelve settlements selected for study, all the ten centres with permanent sources of water supplies, except El Bashama, have at least one mill. All the mills except those at Abu Zabad and El Odaiya were installed after the places had been provided with deep bores.

Already, the traditional method of turning sorghum/pennisetum into flour has been abandoned by a very large section of the population. The only exceptions are the people who live far away from permanent water points because these are also the mill centres. Even among these people the traditional method is now used only occasionally, for they now do a lot of their milling on market days. Incidentally, every market centre has at least one sorghum/pennisetum mill and a household sends at least one of its members to the market at least once a week in the rainy season, and every other day in the dry season. The rapid adoption of the modern method of milling grains has been facilitated by one fact, namely that the mills are found together with other services at the same centre.

Therefore, the women do not need to make extra trips to have their grain milled.

Already, one clear pattern in the relationship between availability of water and the location of sorghum/pennisetum mills has emerged. When a settlement in a semi-arid environment is provided with water, a mill is always the next amenity it gets. It can be reasonably said, therefore, that a growth in the number of water points is always accompanied by an increase in the number of grain mills. To the women, this is a happy and most welcome trend, for most of them can now hope to enjoy some hours of leisure in their home life.

Medical Facilities.

The presence of water exercises a decisive control on the location of medical services, as it does on other services. In South-Western Kordofan, there are 34 dispensaries and health centres. 33 of these are located at settlements with permanent water-base. The only exception is Iyal Bakhit which got a dispensary located there three years ago only when it was assured of regular supply of water by a lorry tanker belonging to the Hamar Rural Council. Out of the 33 dispensaries, thirty are sited at deep bore centres, and all these except the two at En Nahud and El Muglad post-dated their deep bores.

Whether or not a place with a permanent water-base would have a dispensary depends on several factors of which two of value may be mentioned. These are the age of its water-base and its location in relation to others with similar services. Table 45 below shows that all but three

TABLE 45

DEEP BORES AND DISPENSARIES / HEALTH CENTRES IN SOUTH-WESTERN KORDOFAN

Period	No. of Deep Bores	No. of Health Centres/ Dispensaries	% of Deep Bores having Health Centres
Pre - 1945	13	10	77
1946 - 1955	15	8	53
1956 - 1965	16	6	38
1966 - 1969	61	6	10
Total	105	30	29

Source: En Nahud, General Hospital, Annual Reports on Health in Western Kordofan, 1968/69.

of the centres which had their deep bores before 1945 had a dispensary or health centre. The three exceptions, Abu Qalb, Umm Defeis, and Umm Qeilima are very near other centres with similar services. For example, Abu Qalb and Umm Defeis are about 20 miles away from Es Saata, while Umm Qeilima is just three miles away from Ghubeish and just five miles away from Umm Qeileiza. On the other hand, only 6 of the 61 boreholes drilled since 1966 have dispensaries.

In several ways, the provision of water contributes immensely to improving the health of the people. First, it helps to reduce the chance of infection caused by drinking bad water. Secondly, it enables government to increase its medical services to its people. This is because, as already pointed out in the introductory chapter, migratory populations can be served effectively only by expensive mobile health centres. Now that the people would settle down if and when given adequate water, health services can be provided more cheaply. Thirdly, improvement in people's health can be achieved by eating improved diet. According to Henin, migratory population suffer from malnutrition seasonally. For example, during parts of the year, the Baggara Pastoral nomads separate, one section goes with the cattle, leaving the other around the headquarters while the millet crop is harvested. The former would have enough milk but little millet and vice-versa. If they were to become settled, the two sections would benefit from meals of millet and milk at all seasons.[14]

By locating dispensaries and health centres at places with permanent water-base, their use by a very large section of the population is assured. There are many people who are indifferent to the efficacy of modern cure for diseases. These people will not readily attend dispensaries/health centres if they are ill, especially if the health centres are some distance away from their homes. However, since other services are concentrated at water centres, it is necessary for them to go there often to do one or more of several things - fetch water, attend the market, see his child at school and grind his millet. If they happen to be ill

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14. Henin, R.A.M., 1966, op. cit., pp. 189 - 191.

about the time of their visit to the service - centres they may include a call at the health centre in the list of things they have to do on a particular trip.

It appears from table 46 below as if this is precisely what has been happening in South-Western Kordofan. The table is quite instructive concerning the influence of markets on attendance at health centres/dispensaries, for it shows very clearly that the health centres/dispensaries cater for more people on market days than on any other day.

There are still two other spheres in which the multiplication of water points could contribute to the improvement of the health of the nation in general and the nomads in particular. The first concerns the cure of diseases. Continuous treatment desired for the cure of certain diseases, which is unattainable under nomadic conditions, become possible once the nomads become settled. The other deals with the spread and prevention of communicable diseases. Nomads, in their wanderings, are known not only to contact but also to disseminate several infectious diseases such as cerebrospinal meningitis, malaria,[15] relapsing fever, and small pox. Also, control of epidemics usually necessitates certain restrictions on movements. Among nomads, such measures are difficult to apply.[16] By becoming settled, the nomad's prospects of contracting and spreading infectious diseases are considerably reduced. And finally in the event

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15. Prothero, R.M., 1961, op. cit., pp. 405 - 425.

16. El Nagar, H., and Baashar, T., 1961, op. cit., pp. 34 - 35.

TABLE 46

DAILY ATTENDANCE AT HEALTH CENTRES/DISPENSARIES IN FIVE SELECTED VILLAGES FOR A WEEK - SUNDAY 20TH JULY TO SATURDAY, 26TH JULY, 1969.

Day and Date	Abu Bittikh	Mumu	Ghubeish	El Khuwei	Iyal Bakhit
Sunday (20th July, 1969)	71*	33	252	93	24
Monday (21st " ")	23	58*	336*	141*	30
Tuesday (22nd " ")	30	42	284	85	38
Wednesday (23rd " ")	27	38	271	107	29
Thursday (24th " ")	24	45	288	100	63*
Friday (25th " ")	39	73*	379*	154*	41
Saturday (26th " ")	32	25	227	66	35
A v e r a g e	35	45	291	107	36

* Market days.

Source: Culled from daily returns of attendance at dispensaries/ Health Centres of the selected villages during the author's field survey, 1969.

Note: Market day at Abu Bittikh is Sunday and at Iyal Bakhit, Thursday. Market is held twice a week at Mumu - Mondays and Fridays. Although Ghubeish and El Khuwei have daily markets, special markets are held twice weekly for people from distant areas on Mondays and Fridays.

of an outbreak of epidemics, their control becomes not only much easier, but more effective.

Police-posts.

In addition to enabling the people to live a more healthy life, the multiplication of settlements with permanent water-base helps to improve the nation's security. This it does by making possible the creation of more permanent police-posts. This is highly desirable among people who easily become violent over trivial matters, and among whom the chances of threats to life and property are great. In South-Western Kordofan, account of the distribution of police-posts is simply a repetition of that of the distribution of dispensaries/health centres. All the centres with permanent water-base, except those at El Muglad, Abu Zabad and El Odaiya, were post-deep bore creations. Iyal Bakhit is the only centre without permanent water-base to have a permanent police-post, and the reason for this is the same as that offered for other services which are located there.

Relationship Between Optimum Number of Water Points and Location of Services.

In this chapter it has been proved that availability of water acts as a constraint over the distribution of social services in space and time. Therefore, since government has overall control over the allocation and siting of deep bores, it can influence the distribution of social services merely by manipulating the allocation and siting of wells.

In exercising its power, the government is constrained by several factors. There is going to be a stage when the optimum number of water points has been reached. The stage could be reached either when the water needs of the populations have been fully met, or when further sinking of more wells would disturb the balance between withdrawal from and replenishment of underground water. When this stage is reached, would it be possible for every water point (bearing in mind the size of water and the per capita minimum daily water requirement of the populations) to have human population large enough to support a school, a health centre and a market?

For optimum use of services, a certain population size is required. Each type of services, however, has its own optimum population size and two types of services rarely have the same optimum population size. This in effect means that it is possible to reach the optimum population size in terms of service X, but not in terms of service Y or service Z. A satisfactory determination of common optimum population size for several services is therefore crucial to the success of any multi-purpose rural water supplies policy.

The determination of the optimum population size for services should be approached within the context of the existing forms and limitations of resource utilization. In this exercise, the existence of a basic problem has to be recognized. Population is a dynamic element, but how is the progressive increase in population size over time to be taken care of in our determination of optimum population size of service?

In chapter three, an attempt was made to determine hypothetically the inter - water - point distances both for cultivation and for grazing, and the human and animal populations that a twin-well water yard could support at per capita daily minimum water need only. It is therefore appropriate at this juncture to attempt to find out whether or not these hypothetical populations would be of appropriate size that would make possible the optimum utilization of each of the major services of education, health and market facilities.

According to the Ministry of Education, there were in 1956, 1,060,000 children aged seven to ten in the Sudan; that is to say, children of primary school age formed just ten per cent of the population. Thus, under a policy of universal primary education, about ten per cent of the total population of any region in the Sudan, should be attending elementary school. On the basis of the per capita minimum daily water needs, a twin-well water point would support 270 families and their animals - assuming that both human and animal populations were evenly distributed in space, (Re - Chapter three). The average family size in the Sudan being five, a water point of the size stated above would thus support 1,350 people. This is rather less than the population size to support a single - stream elementary school of four classes, each of fifty pupils, even under a policy of universal primary education, since class sizes would be 34 only.

However, the Sudan government is yet to adopt a policy of universal primary education. As late as the 1966/67 school year, of the 1,654,000 children aged between seven and ten years, only 445,145 (Just 27 per cent) were enrolled in Sudan's public elementary and subgrade schools. In Kordofan Province, the corresponding percentage was only 23, and that for South-Western Kordofan, would no doubt, be much lower still.[17]

Under a policy of universal elementary education, about 400 families would be needed to support a single-stream school. On this basis, Northern and Eastern Hamar with an average of 526 families per water point have population size larger than the optimum required for a single-stream school. Southern Hamar with 357 families per water point probably has about the right initial population size to support a school. On the other hand, Dar Humr with only 107 families per water point would need at least three water points to support a school.

The problem is, however, more complex than the one stated above. This is because the Sudan does not operate a system of mixed schools except at the University level. Thus, at any one centre, to cater for the interests of both male and female children, there should be two elementary schools. For the facilities provided in the schools to be optimally used, the population of that centre has to be about 4,000, that is, about 800 families. A four-well water yard would be needed to satisfy the water needs of the population of this size. Under the present system of making water available to the people, the idea of a four-well water yard cannot be contemplated, for already, existing twin-well water yards suffer from severe congestion culminating in long

17. Khartoum, Ministry of Education, 1968, op. cit., pp. 9 - 10.

delays. At any water-yard, there is only one entrace for both men and animals, and there is also only one clerk to issue out tickets to and collect money from water-fetchers. Even if it were possible to provide enough water for population of such a size, there would not be sufficient usable land for the cultivators nor enough grazeable pasture for the pastoralists' herds.

A satisfactory solution to this problem can be found in the system of mixed schools in Dar Hamar. In Dar Humr, however, a system of mixed schools will provide a partial solution only. And for economic use of educational facilities, two or more water points would need to be grouped for the purpose of elementary education. Unless the school can be sited at a day's walking distance from these water points, the system of boarding schools, strongly frowned at earlier on in this chapter, would have to continue. This is one of the items of costs that must be incurred to overcome the problems of spaciousness.

For optimum utilization of health facilities, larger populations than for primary schools are needed. Since it would be difficult to meet the water and/or land needs of such populations at a single water yard, several water points would have to rely on a health centre. But if these water points are too distant from the health centre, their inhabitants might not take full advantage of the service it offers.

Another service whose population size for its optimum utilization is worth considering is the market. For social and economic reasons, a market should be able to serve about 20,000 people. In South-Western Kordofan, where population is sparsely distributed, this implies that a market has to serve a very large area. The size of the area served by a market has introduced us to another concept - accessibility, which acts as a constraint on size. In South-Western Kordofan, where the problems of large area in terms of human occupance are real, the desired size can be achieved only at a great financial sacrifice. This is because getting to a distant market is not easy. Lorry transportation is uncomfortable, slow and expensive. In the modern sense, there are no roads but merely motorable tracks in South-Western Kordofan, and very large sections of these tracks particularly those in Southern Dar Humr are unpassable by motor lorries in the kharif. In addition to the poor state of the tracks, there are no special passenger - motor lorries except along the 34 km (21 miles) stretch of motorable track linking El Muglad with Babanusa and plied daily by two buses. Elsewhere, the tracks are plied by heavy motor lorries and receive the bulk of their to and from traffic from imported consumer goods and agricultural produce respectively. Any person wishing to travel on any of these lorries unless he finds a place in the front seat, should be prepared to keep company with sacks of agricultural produce or wooden and cardboard boxes of imported goods which would provide him with seat The other means of getting to the market are by riding or walking. Riding on donkey or camel over a great distance is tiring, while walking in sand is not only slow but also difficult. Under such a situation, each water point could be regarded as a market centre of the minimum population size where to buy the indispensable items of daily life. In addition, there ought to exist a few periodic markets of higher status serving a group of water points for the purchase of higher order goods and for the sales of agricultural produce.

SUMMARY

It has been shown that in South-Western Kordofan, there exists a strong positive correlation between the number of services in a settlement and the age of its permanent water-base. This correlation, suggestive as it may be, has been found to be due largely to the fact that most of the services owe their locations to the water-base, rather than the services being responsible for the location of the water-base.

It has also been shown that the multiplication of water points could be used to achieve several objectives. It could be used to increase the number of central places, increase revenue from animal tax, and make its collection much easier and cheaper. In addition, it could be used to bring down the per capita cost of elementary education without lowering standards, and subsequently to make more places available to the children. This can be achieved by abolishing the ~~steym~~ system of 'expensive' boarding schools. This is highly desirable in a country where the right to education is still largely a matter of chance.

Finally, it has been demonstrated that conflicts exist not only in the population size for optimum utilization of resources, but also in the population size for the optimum utilization of different services and amenities. The optimum population size of any water point is determined by the amount of water and usable land available. On the other hand, the provision of services is dependent upon population size. But, usable land is dependent upon availability of water. In this ~~wise~~ way, water becomes the most important independent variable for all other things in South-Western Kordofan.

Therefore, to achieve maximum results, any policy designed to effect social and economic change in a water-deficient region as South-Western Kordofan, should give periority to increasing the number of centres with permanent water-base.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

In water-deficient South-Western Kordofan, the provision of rural water supplies has been used to stimulate economic and social development. The rural water supplies' programmes, which have concentrated mainly on sinking deep wells, started officially in 1947; by 1969, one hundred and five water points had been created in South-Western Kordofan alone. These water points cannot, however, satisfy the minimum water needs of the present human and animal populations. To do this at least one hundred and thirty-nine additional twin-well water points will have to be created.

In pursuit of its rural water supplies' policy, government has shifted emphasis in its programmes on three different occasions. Initially, emphasis was placed on providing rural water supplies in order to conserve the soil. About the middle of the 1950's emphasis shifted to providing rural water supplies as a means of land use planning. Since 1966, attention has been focused on using the rural water supplies programmes to stimulate economic growth.

In formulating and executing its rural water supplies' programmes, government seems to have been influenced by two conflicting principles. These are the principle of need and the principle of balanced utilization of resources. The former principle involves making water available wherever there are people and animals. The latter, on the other hand, envisages sinking wells only in those places where their use would not lead to a deterioration of the local resources. Neither of the two principles has been strictly adhered to. Strict adherence to the first principle would negate the latter, because in semi-arid environments, men and animals usually crowd at the few centres with permanent sources of water supplies and tend to over-use the land resources around those centres. If the second principle were to be strictly followed, most of the existing bore holes would have been sunk and subsequent ones would have to be drilled away from existing centres of population concentration, and in that case, we would expect to find many deep bores which would be older than their settlements.

It should ordinarily not be difficult to achieve the latter objective for two main reasons. First, it is the government that prospects for underground water, allocates wells and finances their drilling. Secondly, wherever there is water in an environment generally lacking it, men and animals from less favoured areas have to go there to settle if only seasonally. This claim has been attested to by the existence of several settlements in South-Western Kordofan which postdate their deep bores, two notable examples being Abu Bittikh and Dijdeij.

The needs of and demands by the communities of a country with several physically and/or culturally heterogeneous component regions are likely to be very varied. Since heterogeneous people within a nation and particularly those living near the margin of subsistence, are often narrow-minded, biased and selfish in their demands, they often opt for short-sighted policies which, in most cases, are at variance with the country's national objectives. If the government of such a country attempted to meet the varying demands by all its communities in order to maintain economic, social and political peace, it would find itself involved in numerous contradictions when formulating and executing development policies.

The situation described above is very true for the Sudan where there are persistent and heavy demands for water by numerous tribes. Therefore, the Sudan government has been much influenced by the two principles of need and of conservative utilization of resources in allocating deep bores in time and space. This is why it has not been possible in this study to explain the present pattern of the distribution of deep bores in South-Western Kordofan in terms of any single principle.

The sinking of deep bores has contributed significantly to agricultural production. This claim is supported by the records of annual crop sales both in the various local markets, and at El Obeid Crop Market on behalf of South-Western Kordofan. These records have shown upward trends since the programmes for rural water supplies began. Increased crop sales have been shown to be due to expansion in production. There is evidence also to prove that expansion in cropped area has been taking place. Evidence in support of this is to be found in the annual estimates of cropped area by the Ministry of Agriculture and in the results of the sample survey into pre- and post-deep bore programmes' farm size, the limitations of the estimates and surveys notwithstanding. It has also been shown that the expansion in cropped area has been made possible largely by the rural water supplies' programmes.

It is, however, very surprising that comparison of the mean farm size of centres with permanent water-base and the mean farm size of those without, has not provided us with any conclusive evidence about the degree of contribution which the creation of more water points has made to the expansion in cropped area noted above. For example, the mean farm size for villages with the oldest permanent water-base, is smaller than that for villages without permanent water-base. This anomalous situation is the result of the interplay of several factors. First, the Hamar and the Humr, the two main tribes of South-Western Kordofan, differ significantly in their attitudes to cultivation. Secondly, the inhabitants of villages with permanent water-base and the inhabitants of those without, have differing felt needs for immediate cash. For example, the residents of villages which do not possess permanent sources of water supplies now have water brought to them by lorry tankers. These people pay much higher prices for water than those who live in the villageswith permanent water-base. While a four-gallon tin of water costs nothing at El Odaiya and costs two milliems (£S0.002) at any of the centres with deep bores, it costs between five and ten piastres (£S0.05 and £S0.10) in Marbuta and Iyal Bakhit. The inhabitants of villages without permanent water-base are therefore compelled to cultivate more by the need to get more money to pay for water. Thirdly, there is intense competition for the land near and about water points. Consequently, culivators who want to make abnormally large farms have to travel far out, and this not many people are prepared to do.

It should be pointed out at this juncture, however, that reference to farm size alone does not tell the whole story. By and large, the lands near and around water points are more intensely used, (many crops being commonly grown together), are cultivated for longer periods, and are rested for shorter duration than lands situated elsewhere.

The drilling of deep bores has decisively modified the way of life of the pastoral nomads and their economic organization. The wells have already led to a shortening in the cycle of transhumance and a consequent tendency to sedentarization. In addition, the pastoral Arabs on settling down, have been taking to cultivation. The decision to take to cultivation to produce at least part of their food, and if possible to have surplus for sale to pay their livestock tax, has introduced a new dimension into the pastoral economy. The pastoral nomads are known not to possess a purely mercenary attitude to their animals. Their economy does not, however, allow them to be self-sufficient, and they are obliged to make purchases from the settled population so as to meet their basic subsistence needs. To pay for these needs, and also to pay their annual animal tax, they need cash; they are therefore forced to sell a few of their animals. Now that they combine crop production with animal rearing, their cash needs have become less. Some might even have extra cash which could be invested in livestock, for unlike many other Africans they show little interest in investment in educating their children, while their felt needs for consumer goods are still very low. The pastoral Arabs of the Sudan are not alone in this practice. The pastoral Fulani of northern Nigeria behave essentially in the same way.[1]

Two other factors operate to reduce the urge to sell animals by the pastoralists. First, there are now opportunities for selling milk; one such opportunity is offered by the Babanusa milk-processing factory. Another is offered by the demand for milk products among the rapidly growing non-livestock owning population of settlements with permanent water-base. Secondly, the time that the pastoral nomads of this region save by watering at deep bores is used to increase their gathering of gum, which brings them appreciable secondary income. In this they resemble the nomadic Fulani of Senegal.[2]

The situation described above could have two far-reaching economic and ecological implications for South-Western Kordofan. First, fewer animals would now reach the meat markets and these at higher prices.

1. Dupire, M., 1965, Trade and Markets in the Economy of the Nomadic Fulani of Niger (Bororo), in (Ed.) Bohanam, P. and Dalton, G., Op. cit pp. 353 - 354.

2. Ibid., pp. 360 - 361

Meat consumers would therefore have to pay more for meat. Secondly, there would be a rapid increase in the animal population with serious consequences for water and grazing. In this respect, the influence of the creation of mechanical wells on the nomadic Arabs of South-Western Kordofan differs markedly from that which the sinking of deep wells is having on the Fula of Guinea. "In Guinea", writes Dupire, "the Fula who have become sedentary have modified their pastoral ideas to such an extent that in this area the trade in livestock has reached disquieting proportions and wealth in livestock is likely to disappear."[3]

From the situation described above, it is obvious that the multiplication of water points is haiing some undesirable effects on the pastoral economy and these would pose serious planning problems. The pastoral Arabs, like the Wodaabe, "have probably never calculated the total yearly income from their herds nor that part of it which they could dispose of while maintaining a necessary margin of safety."[4] One of their essential preoccupations is not only to maintain, but also to increase, at all costs, the size of their herds. The reason for this attitude is that until very recently, the pastoralists used to suffer great periodic losses in their herds through drought, exhaustion of pasture and epizootics disease or by a combination of these.

Periodic occurrences of drought and outbreaks of epidemics can, however, no longer be relied upon to keep down the animal population. The

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3. Ibid., p. 361

4. Ibid. p. 337

battle against loss from drought is being successfully waged, and substantial achievements have also been made in the fight against epizootics. Apart from the fact that great advances have been made in Veterinary Medicine the pastoral Arabs have learnt to take advantage of the veterinary services offered by the government. Thus, of the three major elements that used to operate singly or jointly to reduce the livestock population, only one - pasture exhaustion, is yet to receive any satisfactory solution.

In the light of the situations described above, several questions should now be engaging the minds of administrators and planners. In the context of availability of water and usable land, what ought to be the optimum population size of a water point? Would such a population be of the optimum size for the provision of services? Bearing in mind that populations (human and animal) are dynamic elements, what measures should be imposed to ensure that the optimum population size would not be exceeded? The pastoral Arabs of South-Western Kordofan place high premium on the size of their herds. In the recent past, they had valid reasons for maintaining this attitude. One of the most important reasons is the real threats posed to the herds by drought, diseases and shortage of pasture. Now that these threats are being removed, could the animal owners be persuaded to modify their attitude to their herds accordingly?

It is desirable to maintain a balance between water, grazing and animal population. The crucial question to ask is, "What could and should be done to persuade the animal owners to keep down the size of their herds within the limit of available water and pasture?" For a start, a calculation should be made of the total possible yearly income from herds of average size, and of that part of it which could be disposed of while still maintaining a necessary margin of safety. A calculation such as the one suggested above would have a useful practical application when the optimum livestock population size is reached. As long as the present system of operating the pastoral industry of South-Western Kordofan continues, it is the view of the writer that the optimum livestock population should be determined by the minimum amount of fodder which is available in a bad year. A safe calculation of what the minimum amount of fodder available in a bad year is, will require several years' joint research by climatologists and agronomists. Once the optimum livestock population is known, pastoralists should be encouraged to dispose of every year, the equivalents of the annual increase in the size of their herds.

There are several ways through which this objective could be achieved. One of such ways is by manipulating watering prices and livestock taxes to favour owners of small herds. Alternatively, the responsibilities for paying for veterinary services and water supplies could be transferred to local authorities who would compel the uses of these services to pay for them according to the size of their herds. Another way is to increase the cash needs of the pastoralists by opening new avenues of expenditure to them. At present, the people spend mostly on water, food, beverages, and clothing. They spend very little both on shelter (the pastoral nomads live in portable tents while those who are settled live in simple houses built of local materials), and on household goods. Pastoral Arabs possess very few items of household goods. The fewness of their possessions has been attributed to the transhumant nature of their life. Now that they are becoming sedentary, they may wish to increase the number and range of their household goods. An enquiry that is worth making is, "To what extent would the pastoral Arabs invest in housing and household effects? What other consumer goods would interest them?" Unless satisfactory solutions are found to these questions, the problems of water shortage and grazing exhaustion and deterioration would persist.

The multiplication of water points in South-Western Kordofan has led to a contraction of the area under gum trees (due to expansion of cultivation), but a rise in the level of gum production (results of efforts at rehabilitating gum-gardens, and greater intensity of gum-gathering). Gum-garden rehabilitation has been accompanied by highly desirable fundamental and revolutionary changes in the traditional system of ownership of gum-gardens and land. However, one major question which still remains to be answered is, "Would people continue to invest their efforts in gum-gathering if there were other employment opportunities in the dry season?"

This study has shown that in water-deficient South-Western Kordofan, availability of water supplies on a perennial basis has a strong influence on the spatial location of social services, and also that the number and range of services available in a settlement at any point in time are a function of the age of the settlement's water-base. The evidence for the first of these two claims exists in the fact that with the exception of the health centre at El Muglad, all the services in the settlements with deep bores were established after the drilling of their bore-holes. Similarly, the latter claim is evident in the fact that the number of services and the ages of permanent water-base in the sampled villages are strongly positively correlated.

This study has also shown how the deep bore programmes, by encouraging the nomadic population to settle down, have affected and might further affect the provision and use of social services. First, the deep bore programmes have already started to facilitate revenue collection. This augurs well for the future development of South-Western Kordofan, as the local authorities would have more money which they might use to increase the number of services in the area or improve existing ones. Secondly, the deep bore programmes would reduce the need for boarding facilities in elementary schools and the cost of education per elementary school pupil. The savings made from this would, no doubt, help to build more elementary schools for which these are great demands. The deep bore programmes would also encourage a greater proportion of the sick to make use of the medical facilities provided by the government. The indication that this would happen is provided by records of daily attendants at five selected dispensaries/health centres in the sampled settlements. These records show that more people patronise the dispensaries/health centres on market days than on ordinary days. Once the nomadic population are completely settled, it would, under normal circumstances be easier to combat successfully the spread of infectious diseases among various communities. This would, no doubt, serve to bring about considerable improvement in the health of the people of the study region.

Finally, the deep bore programmes have made possible the successful introduction and acceptance of several cultural innovations, of which the sorghum/pennisetum mill is the most notable example. The use of the mill has brought much relief to the adult female population who are always hard-pressed with domestic duties.

In this thesis the attempt to determine a common optimum population size that would make economic use of all the basic services provided in a settlement had to be given up because it was beset with many problems. The most important of these problems relates to the fact that the optimum population size in any centre with permanent water-base is dependent upon the amount of water and the size of usable land available. Such an optimum population size is rarely large enough for economic use of any other services. Since different services have different optimum population sizes for their economic use, the author is of the view that the creation of 'service areas' might offer the best solution to the problems outlined above. A 'service area' comprising one or a number of settlements with permanent water-base would be required for each type of service. The size of a 'service area' would vary according to type of service; thus a settlement might simultaneously be a member of several 'service areas'.

From what has been written so far, it should not surprise anybody that the Sudan government has taken the solution to the problem of scarcity of water to be the basis for solving all other social and economic problems in South-Western Kordofan. Already, the government has spent a lot of money on the provision of rural water supplies. The money spent should be regarded both as economic investments (since they enable the population to increase their productions and consequently, their incomes), and as social investments (since they enable the population to improve the conditions in which they live). So far, the government's rural water supplies programmes, as an anti-thirst measure, has achieved a spectacular success. However, because the solution to the problem of water-deficiency has been largely sought in isolation, several complex problems associated with the utilization of resources and services have cropped up. The emergence of such problems has clearly pointed out the need for more comprehensive plans designed to solving the existing social, economic and ecological problems of South-Western Kordofan. In an arid or semi-arid environment, availability of water occupies a unique position among factors which induce favourable social and economic change. The provision of rural water supplies should, therefore, continue to be recognized and used as a fundamental key to spatial organization of social and economic activities not only in South-Western Kordofan, but also in the whole Central Sudan.

APPENDIX I

DISTRIBUTION PATTERN OF DEEP BORES IN SOUTH-WESTERN KORDOFAN - THE USE OF NEAREST NEIGHBOUR TECHNIQUE

Nearest Neighbour Technique(1)

$R = \dfrac{\bar{r}_A}{\bar{r}_E}$ where A = Observed value, and E = Expected value.

$\bar{r}_A = \sum \dfrac{d}{N}$ where d = Distance between any point and its nearest neighbour; and N = No. of points.

$\bar{r}_E = \dfrac{1}{2\sqrt{P}}$ where $P = \dfrac{N}{A}$ that is $\dfrac{\text{No. of points}}{\text{Area}}$

R = Nearest Neighbour Measure.

Result

1 = Randomness

0 = Cluster

2.1491 = Maximum dispersal

Notation:

i = Well No.

ii = Nearest Neighbour

iii = Distance between them (km)

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(1) Clark, P.J. and Evans, F., 1954, Distance to Nearest Neighbour, as a Measure of Spatial Relationships in Populations, Ecology, 35, pp. 445-453.

(a) Pre - 1946

i	ii	iii	i	ii	iii	i	ii	iii
1	2	32.5	6	7	47.5	10	12	5.0
2	3	25.0	7	6	47.5	11	3	45.0
3	2	25.0	8	13	117.5	12	10	5.0
4	3	35.0	9	6	57.5	13	12	7.5
5	4	52.5						

$\bar{r}_A = 38.65$

$\bar{r}_E = 41.67$

$r = 0.90$

(b) 1946 - 1955

i	ii	iii	i	ii	iii	i	ii	iii
1	2	32.5	10	12	5.0	19	26	57.5
2	3	25.0	11	14	5.0	20	7	20.0
3	24	22.5	12	10	5.0	21	22	25.0
4	24	17.5	13	12	7.5	22	23	20.0
5	16	17.5	14	11	5.0	23	18	7.5
6	27	47.5	15	28	15.0	24	4	17.5
7	20	20.0	16	5	17.5	25	28	35.0
8	26	30.0	17	24	17.5	26	8	30.0
9	27	22.5	18	23	7.5	27	9	22.5
						28	15	15.0

$\bar{r}_A = 20.36$ $r = 0.70$

$\bar{r}_E = 27.78$

(c) 1956 - 1965

i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii
1	37	7.5	12	10	5.0	23	18	7.5	34	18	30.0
2	3	25.0	13	12	7.5	24	4	17.5	35	9	22.5
3	24	22.5	14	11	5.0	25	38	32.5	36	42	12.5
4	24	17.5	15	28	15.0	26	36	20.0	37	1	7.5
5	16	17.5	16	5	17.5	27	9	22.5	38	8	22.5
6	33	35.0	17	24	17.5	28	15	15.0	39	43	20.0
7	20	20.0	18	23	7.5	29	7	25.0	40	11	12.5
8	38	22.5	19	42	32.5	30	15	15.0	41	19	50.0
9	27	22.5	20	7	20.0	31	21	17.5	42	36	12.5
10	12	5.0	21	31	17.5	32	28	20.0	43	39	20.0
11	14	5.0	22	23	20.0	33	7	25.0	44	39	80.0

$\bar{r}_A = 19.83$

$\bar{r}_E = 21.74$

$r = 0.91$

(a) 1966 - 1969

i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii
1	37	7.5	28	15	15.0	54	55	15.0	80	41	22.5
2	63	15.0	29	66	17.5	55	54	15.0	81	32	5.0
3	2	25.0	30	15	15.0	56	33	15.0	82	81	22.5
4	61	7.5	31	21	17.5	57	6	20.0	83	38	10.0
5	16	17.5	32	81	5.0	58	59	20.0	84	26	15.0
6	56	22.5	33	52	15.0	59	60	15.0	85	36	5.0
7	66	7.5	34	74	10.0	60	59	15.0	86	85	5.0
8	38	22.5	35	49	20.0	61	4	7.5	87	88	22.5
9	49	7.5	36	85	5.0	62	2	15.0	88	87	22.5
10	12	5.0	37	1	7.5	63	2	15.0	89	90	12.5
11	45	2.5	38	83	10.0	64	20	15.0	90	89	12.5
12	10	5.0	39	97	12.5	65	7	10.0	91	43	7.5
13	12	7.5	40	11	12.5	66	7	7.5	92	92	10.0
14	11	5.0	41	75	17.5	67	66	10.0	93	94	10.0
15	28	15.0	42	85	10.0	68	29	25.0	94	95	7.5
16	5	17.5	43	91	7.5	69	68	27.5	95	94	7.5
17	24	17.5	44	102	7.5	70	68	27.5	96	98	5.0
18	23	7.5	45	11	2.5	71	22	17.5	97	39	12.5
19	42	32.5	46	47	25.0	72	18	12.5	98	96	5.0
20	65	12.5	47	27	10.0	73	34	20.0	99	39	12.5
21	31	17.5	48	51	10.0	74	34	10.0	100	101	12.5
22	72	15.0	49	9	7.5	75	76	10.0	101	100	12.5
23	18	7.5	50	64	20.0	76	75	10.0	102	44	7.5
24	4	17.5	51	52	7.5	77	13	10.0	103	104	40.0
25	83	30.0	52	51	7.5	78	77	17.5	104	44	32.5
26	84	17.5	53	52	10.0	79	15	12.5	105	102	42.5
27	47	10.0									

$\bar{r}_A = 13.86$

$\bar{r}_E = 15.63$

$r = 0.89$

APPENDIX III

GUM SALES AT EL OBEID CROP MARKET, 1938 - 1968

Year	Volume (Kantar)	Value (£S)	Value Per Kantar (£S)
1938	183,447	82,981	0.452
39	153,801	78,506	0.562
40	187,675	88,660	0.466
41	107,828	54,851	0.513
1942	110,980	67,130	0.605
43	109,521	93,536	0.854
44	108,235	80,326	0.742
45	110,416	91,985	0.833
46	134,142	171,662	1.279
47	228,516	316,411	1.384
48	302,426	309,124	1.022
49	226,971	235,728	1.039
1950	236,212	308,435	1.306
51	360,662	795,432	2.205
52	335,133	625,855	1.862
53	354,260	473,813	1.343
54	340,433	814,169	2.392
1955	469,929	1,299,796	2.765
56	456,531	1,324,295	2.901
57	430,791	1,144,040	2.656
58	378,210	1,024,436	2.708
59	309,570	1,021,775	3.301
1960	482,404	1,957,791	4.058
61	471,520	1,520,125	3.224
62	460,324	1,316,355	2.860
63	438,466	1,255,480	2.864
64	246,386	865,999	3.515
65	325,474	1,042,331	3.203
66	364,615	1,144,253	3.139
67	252,529	1,216,035	4.811
68	428,083	1,594,991	3.726
Average	293,724	723,171	2.462

Source: These figures have been culled from Charts showing crop sales at El Obeid Crop Market between 1938 and 1968 - El Obeid Urban Council Office, El Obeid, 1969.

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