A THEORETICAL APPROACH TO THE STUDY OF RURAL
SETTLEMENT SYSTEM IN THE GEZIRA IRRIGATED
AREA OF THE SUDAN

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ABSTRACT

Growth and spatial patterns in the various forms of human agglomeration are the outcome of a complex interaction between human demands and the physical environment, between functions and their locations. A conceptual and methodological framework in planning is essential for the maintenance of a coherent approach to such many-sided situations. Hence, the increasing use of general theories in planning, particularly spatial theories, seems to be a logical step towards achieving some form of operational yardstick to reduce the element of subjectivity in assessment.

This thesis sets out to search for a theoretical framework of reference to verify the existing functional pattern of service provisions in the Gezira Irrigated Area where a definite need exists for their rational distribution on a regional rather than a local basis. In the absence of an acceptable scale of reference to assess their adequacy, and considering the need to derive principles and formulate policies according to which present and future demands may most adequately be met, the Central Place Theory would seem to be of great relevance to the study area.

The importance of rural development planning in the Sudan and in particular the need to plan the Gezira settlements on a sound scientific basis is stressed in Chapter I where some conceptual definitions are also introduced.
A detailed account of the study area has been presented in Chapter 2 pointing out the prevailing difficulties pertaining to processes and trends in the scheme and their future implications, specially in view of its increasing integration with the national economy.

Chapter 3 reviews the conceptual definitions and classifications of Models and their Limitations in the planning process and Chapter 4 discusses in greater depth the potential relevance of Christaller's Spatial Model as a planning tool.

While in the main, attention is focused on the functional and spatial aspects of settlement pattern, Chapter 5 stresses the desirability of integrating spatial planning and concepts with other relevant scientific disciplines in an operational whole. A critical review of some central place studies has been introduced to demonstrate the various attempts in trying to apply the theory, and a wealth of classification techniques is thereby revealed which may guide any subsequent statistical analyses.

Finally in attempting to assess the validity of the central place theory as a potential yard stick for the future planning of the Giza scheme, a questionnaire has been designed to help verify the existing functional patterns and also to serve as a point of departure for further research into the optimal forms of rural settlement.
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economic and environmental conditions in which people live. The poor nations are variously described as developing, backward and underdeveloped, by those who either have taken the interest to study, or those who have been assigned to report on illiteracy, bad housing, lack of medical care and malnutrition, which are relatively prevalent throughout most of Africa, Asia, the Middle East and Latin America.

In most of these developing countries, governments are now closely concerned with the development of their country's natural and human resources. In the face of competing demands for economic and physical development, social welfare and physical infrastructure, governments look to 'planning' to decide on trends and priorities as well as comprehensive policies with a degree of objectivity and authority. These masters had previously been the concern of traditional leaders and local authorities, and were therefore limited by municipal or territorial boundaries coupled with the subjective measures of assessment and the influence of pressure groups. However, this by no means indicates the existence of a truly comprehensive system of development to cope with the increasing problems, apart from the national planning policies entrusted mostly to economists and which have been more concerned with the allocation of funds to various sectors than with the location of projects and their impact on regional and national development.

Comparatively few governments have, until very recently, concerned themselves much with the locational and spatial aspects of their national, economic and social planning. The
generality inherent in most development plans and schemes is largely due to the substantial absence of applied and pure research and the lack of advanced techniques to construct a predictable framework within which the whole or part of a plan could rationally be examined and decided upon. Moreover, the synchronisation of these and the essential administrative machinery needs re-enforcing and restructuring to keep pace with the desired progress, in view of the constraints of slender economies and budgetary restraints.

1.2 Between Urban and Rural

Throughout the world, governments and institutions are showing increasing concern over the development and improvement of their rural environments. This subject is of special importance to the developing countries since the greater part of their population is engaged in agriculture and accordingly dwells in rural areas.

The Sudan is by no means an exception. According to its first population census (1955/56), it was found that only 8.3% of the total population dwelt in so-called urban areas enjoying relatively better services and amenities. The prime impulse for the limited growth of urban centres stemmed not from the growth of manufacturing, as in 19th century Europe, but mostly from the Sudanese tradition of administration,

trading, religious and tribal factors serving as major focal points which recently attracted foreign investors to introduce some scanty industrial activities. The generalisation then, based on history, that urbanisation enhances development may not be wholly applicable nor, I believe, wisely encouraged at the present stage of development.

Some writers have stressed the wide social and cultural gulf that exists between urban and rural settlements in some developing countries and that this gap is being widened rather than narrowed by recent development. This might be true perhaps in cases of over concentration of developments and investments in certain areas hence the characteristic dichotomy between urban and rural settlements. However, it could be argued that urban settlements in the Sudan are but large agglomerations of villages in the sense that the urban inhabitants remain rural in outlook and the village ecological structure is carried over into the urban environment. Contrary to the general supposition, it is not the most depressed rural inhabitants who decide to move to urban areas, but often the young, educated social elite in search of better opportunities, who frequently communicate with their home villages. Hence it could be stated that there is a rural-urban continuum. The rather arbitrary distinction between urban and rural settlements can be defined either in a demographic context or by the existence of relatively more specialised services.

Although rural life in the Sudan is hard, the drastic rural-urban migration witnessed in other developing countries
has not as yet occurred. The village settlement still plays a prominent part as a mode of living for the great majority of the Sudanese people, and as a dominant social, economic and political unit in the Sudanese community, irrespective of its form, size, function and degree of isolation and regional location. Thus the study of rural settlements in the Sudan is an essential task for any planning scheme aimed at the betterment of the living conditions, especially at this stage of development, while there is still the chance to direct healthy patterns of growth in a rational way.

This is essential in such a predominantly agricultural country—particularly in the Gezira Irrigated Area, the subject matter of the research, which is one of the outstanding attempts to establish large-scale agricultural schemes for cotton production which is the mainstay of the Sudanese economy. The basic concept of this scheme is the gravity irrigation system, covering almost two million acres, exploited primarily for agricultural production and inhabited by over three-quarters of a million people according to the 1955/56 census.

The introduction of this scheme induced the change from subsistence to cash economy which manifests itself in the declining emphasis on traditional agricultural techniques and in the rise of a relatively advanced agricultural technology and system of administration. The stable, though rather rigid, conditions of relative isolation and economic, social and self-sufficiency of small groups of settlers are
new giving place to a relatively dynamic situation, point-
ing to growing communities and greater spatial interdepend-
ence.

1.3 Definition of the Problem

Despite the considerable achievements of the various
governments and their policies for increasing cotton produc-
tion in the Gezira Irrigated Area, the symptoms of the fund-
amental problem of service provision and location do exist.
This has raised numerous and complex problems related to the
growth and functioning of the various developing settlements.
A social and political dissatisfaction in the issues of soc-
ial services and amenities, which are demanding attention
in their rational distribution and convenient accessibility,
is being generated to various levels by the increasing aware-
ness of the inhabitants. Thus it would appear that not en-
ough attention has been given to the regional setting in
proposed development of service centres. However, that the
government is already cognizant of this particular need is
evidenced by the attempts the Social Development Department
of the scheme is making to introduce group service centres
for a number of villages. Development is inevitably a norm-
ative concept; thus economic efficiency cannot be the only
goal, community facilities and social welfare need to be
introduced. In the Gezira, a big step has been taken to
introduce an economic impetus. Although in the past the
physical and social aspects were not adequately considered
it is now clearly evident that there is a desire to achieve truly integrated planning, taking into account the social and physical as well as the economic aspects.

1.4 The Study of Rural Settlement Systems - Some Conceptual Definitions and Aspects of Investigation

Since the term settlement is basic to this research it is felt necessary at this stage to show the various ways in which it is used and which I believe will help to explain its relevance in the context of the work since it has already been studied from different aspects and in different sets of relationships.

Settlements are essentially groups of structures housing population groups occupying an area, hence the study of settlements involves that of the people. As defined by Sears, a human settlement is "... an archaeologically discernible site, a unit of space which was characterized during some culturally definable period of time by the presence of one or more dwellings or other structures." In this respect the dwelling house can be seen as an elemental component of settlement structure and indeed is the basic planning, social and economic unit of the settlement system.

Rural settlements are features of the cultural landscape. They are a concrete expression of the workings of

society and economy over time in a single place. In their forms are expressed the ideas, attitudes and feelings of the occupants, both past and present. It is the recognition of this fact that led archaeologists in the past few years to try to discover the character of their extinct societies through detailed investigations of settlement patterns. There are those who limit the concept to mean the overall plan of a single community like the village, that is the spatial arrangement of the individual houses and other structures with respect to one another in the same community. It is, however, difficult to try to study the location and structure of settlements if only a few components, either physical or cultural, are examined; "... one set of factors physical or human is an insufficient key to the entire problem of settlement distribution." since so many factors are involved, at different points in time, and also of varying intensity and importance.

In the study of rural settlements, Dickinson has pointed out three aspects: there is the physical structure of the settlement, the mode of grouping of its buildings and streets; there is the process which determines the structure - the

social and economic character of the community; and third, there is the stage in the historical development. Dickenson, however, emphasises that history should be made subsidiary to the main object of the study; this point will be discussed in subsequent Chapters.

There is certainly a strong link between settlement pattern and economic activity and as an area undergoes economic development the settlement pattern will likewise undergo structural and functional alternations; "... is it not a basic principle of social science that the critical developments in the evolution of the pattern and functional organization of human occupancy are best understandable as the outgrowth of human creative choice in a frame of the total setting of resources and culture in space and time?" 6

1.4.1 Settlements and Special Interaction.

The question of what formal and functional relationships link agricultural systems and settlement patterns has long engaged the interest of anthropologists, geographers and other social scientists. The question of locational relationships or accessibility has itself recently emerged

7. Locational: "a location is an area commonly recognized and defined, in which human activities take place; ... depending on the scale of observation, can range in size from an office within a building to a large city." See: Morrill, E.H., The Special Organization of Society. California. 1976. p.4.
as a leading goal of physical planning. The constant concern of these questions is simply to provide men with better living and working conditions or in the deepest sense, is a policy that should result in "... the spatial arrangement of human institutions in a way that best satisfies men's aspirations" both materially and spiritually. Geddes identified three main elements in the whole spectrum of change which people undertake or consider - developmental, locational and behavioural. These could be applied to people's activities and the spaces in which they occur on the one hand and their communications and channels in which these flow on the other. Throughout history spatial interdependence between communities has been gradually extended to various levels, depending on their needs and requirements and controlled by means of communication thus resulting in a more intricate pattern of spatial organisation and individual levels of spatial awareness. In advanced countries, higher incomes, high quality transportation and communication, greater freedom of choice, enhanced mobility, both in terms of length, speed and frequency of travel. In technologically underdeveloped communities the individual awareness of space and areas and people far from him is limited by

his direct experience. Thus a small organisational unit, such as a village or tribal area, can be self-sufficient for most purposes and accordingly the spatial interdependence and spatial awareness are largely confined to the village and its land and the neighbouring villages.

Land form, climate, soil, vegetation and mineral resources, all part of the natural environment, have been investigated by geographers, archaeologists and historians in relation to man's use of space and therefore their combined influence on settlement pattern and spatial interaction cannot be denied, no matter how tempting it may be to stress their individual importance.

As communities develop technologies and learn about other areas, they often become more specialised and increase their inter-relationship with other areas, thus create greater degrees of interaction and more specialised nodes of population concentration.

1.4.2 Locational Problem and Decision Making:

In the linking up of the discussion on settlement system and spatial interaction with the kind of social and economic system that exists in a particular locality, it would appear that the process of decision making on the location of activities, the process of economic development and therefore the management of the physical environment, is a rather intricate matter and has far-reaching implications. A decision which was considered optimum some time
ago, regardless of political intervention, might not have the same value in the face of economic and technological change and ever changing requirements.

Accepting the fact that the forecasting of human behaviour is a hazardous task since cultural attitudes, beliefs and practices influence the economic potential of the people and are ever changing, planning must needs be flexible and thus the inter-disciplinary view of planning can be strongly argued.

In developing communities a conventional attitude can always be observed in relation to the location of minor activities and functions. Considering the relative importance of certain functions one can also sense the element of competition among tribal groups and localities to acquire such functions applying varied pressures and using persuasive means on the local authorities in an endeavour to attain higher status and prestige. Notwithstanding the logic and reasoning of economists in considering the comparative advantage of a certain area in preference to another for a particular investment it could be stated that most human locational decisions depend as much on previous experience that among the existing patterns there are some nodal centres which are relatively attractive and thus their claim for investment is strongly reinforced. Therefore research will always be necessary for the control and management of the physical environment as the equilibrium in the social and economic system is extremely dynamic.
1.5 The Management of the Physical Environment:

Thus the first step in the right direction to aid planning decisions, is a thorough understanding and realistic interpretation of the mechanism of man's social and economic system based on fundamental goals and objectives in relation to his physical environment within a flexible framework that would cater for future change. As Schlippe stated "... if only we could interpret a traditional practice in terms of its environment and traditional limitations, we would certainly find the way to its improvement. If only we could bring ourselves to think in terms of the local environment instead of terms of our upbringing, we could certainly bridge the gap." What remains then is the development of the techniques for investigation and the advancement in the methods of analysis to understand the complex systems of man’s activities.

The techniques of investigation stemmed from the concept of 'survey before plan' which dates back to the ideas of Patrick Geddes, the pioneer planner, who recognized in 1915 this fundamental need for information which is so essential to the understanding and analysis of problems confronting man's physical environment, and so relevant to the betterment of the future goals. The importance of survey

and the limitation of the concept can be seen clearly from his statement regarding city development: "... we cannot too fully survey and interpret the city for which we are to plan - survey it at its highest in the past, in the present, and above all, since planning is the problem, foresee its opening future."

In view of the changes in outlook which have occurred in the planning world today, survey as a hub around which planning methodologies and techniques have been developed cannot be disputed. Thus the need for information is fundamental to the concept of order and essential for the management and control of man's physical environment.

At this juncture, I would like to state that there is little doubt that a comprehensive approach is difficult, both in developed and developing countries, but the need for research into information requirements and the need for a system in which to organise the data is essential. This is very necessary to avoid the obsession that the 'data bank' is totally divorced from the planning system, since the process of obtaining information is a costly and time-consuming task.

This statement will automatically highlight the various constraints which structure the type of information required and the methods used to collect, analyse and store it. Therefore, the information which the planner or decision maker uses at any point in time must be an integral part of a

system for continuing future research and building up relevant background information. Notwithstanding the difficulty in defining the role of a planning system in a particular locality, its relation with other decision making processes must be clearly identified and considered. A fundamental aspect of the planning system is the planning process itself which involves the search for theories or models which will help planners and decision makers to understand the basic concepts of how an urban or rural system changes in time and space and hence to find an optimum solution. The focus of interest is thus upon the theory which accounts for order in the system, and upon the variables which are defined by the theory. It is fairly clear then, that the "information bank" must be closely interconnected with the theory or model which is used to describe, analyse or project the reality of the situation.

The process of observation, description, problem definition, analysis, design, testing and evaluation will recur through time, thus the process of adaptation to suit reality is necessary in the management and control of the physical environment.
CHAPTER TWO

THE FIELD OF INVESTIGATION: THE GEZIRA IRRIGATED AREA

2.1 General Introduction

Before considering the theoretical search into the techniques for investigation and information requirements it will be necessary to understand the field of investigation which is the Gezira Irrigation Scheme of the Sudan by underlining the basic spirit of the scheme, its location, historical evolution, and the description of what it looks like at present pointing out the prevailing difficulties pertaining to processes and trends in the scheme and their future implications. In studying the emerging trends of change taking place in the rural settlement system as a result of the socio-economic impact of the scheme a brief introduction of the Sudan is felt necessary at this stage in order to establish the background to which the study area is related, emphasizing its importance and the emerging characteristics as well as the lines of research that are needed.

In thousands of years of its history life in the Sudan depended almost exclusively on the River Nile which crosses the country from South to North with its main tributaries the White Nile flowing from Lake Victoria and the Blue Nile which flows from Lake Tana to meet the
FIG. 1: THE SUDAN’S PROVINCIAL AND NATIONAL BOUNDARIES AND THE NEIGHBOURING COUNTRIES.
former at Khartoum, the capital of the Sudan, see fig. 1.

The Sudan is the largest state in Africa of about one million square miles in area and almost eleven million of population according to the first census carried out in 1955/56: 8.3% of the total population was said to live in urban areas, see fig. 2, 78% was rural sedentary and 13.7% was nomadic. The relatively rapid rate of population growth is estimated at 2.8% per annum. Such a mode of living shows clearly trends towards reality rather than urbanisation. Its latitudinal extent is from 3½°N on the border with Uganda to 23°N on the Red Sea coast. Its western extremity is in longitude 21°34' and the farthest point East is on the Red Sea Coast in longitude 38°0'E, see fig. 1.

By virtue of its geographical location its borders touch nine African nations: Egypt, Libya, Ethiopia, Eritrea, Uganda, Kenya, Congo, Chad and Central African Republic. With the exception of certain areas beside the River Nile the density of population is generally low, see fig. 3, even in the Gezira, where cultivation is secured by irrigation, there are "...less than 200 persons per sq. Km. and ... a density higher than 200/sq.Km. is exceptional."¹

The Sudan is characterised by its diversity of life. It includes many regions which are almost completely different in social and economic structure due to severe geographic and climatic conditions. Many parts are still

living the isolation of bad communication, which is a major characteristic of most developing countries.

The climate of the Sudan is classed as "tropical continental" which actually ranges from hot desert in the North, where there is rarely any rainfall, through a belt of summer rainfall of varying intensity and duration to an almost equatorial type of climate in the extreme South where the dry season is very short, see fig. 4. "Because of the absence of any mountain barriers between the North and the South there is a gradual change of conditions with latitude and it is not easy to indicate obvious divisions between one type of climatic region of the Sudan and the other." 3

The Sudan's economy is mainly dependent on agriculture and livestock. 85% of its population depends completely on agricultural production. 4 It is estimated that 80% of these work in the traditional sector of agriculture, with poor inefficient methods of cultivation and 25% are engaged in modern ones. Livestock is not as yet fully utilised and comparatively little effort is made to improve their quality and production.

The economic good sense of rural development is beginning to be recognised in many developing countries. For many years the idea of transforming rural areas both

Fig. 4  Sudan: Climate

For eighteen representative stations, mean monthly rainfall is shown by black columns. The Curves above show the annual march of mean daily maximum and mean daily minimum temperatures.

economically and socially has been a real problem and a great ambition for many governments in developing countries. The Sudan is an emerging country which lacks money more than anything else in developing its resources. The importance of agriculture and its related activities to the economy as a whole can hardly be over-emphasised. On this account it should be stressed that efforts to improve and develop agricultural production are integral parts of the management of the physical environment, stressing the role of rural settlement planning and its environmental effect, which would greatly advance the standard of living and efficiency in many other activities.

The Gezira Irrigation scheme is well known as one of the outstandingly successful attempts to establish large-scale agricultural projects in Africa. Its importance can be judged by its great yield of cotton, the mainstay of Sudanese economy "... which constitutes about 40% of Sudan's total revenue."5 The importance of the scheme and the admiration it has gained in many parts of the world are not only limited to the vast area it covers or to the material success it has achieved, but they are also related to the special characteristics that were adopted in its administration system. In addition to providing the capital for its own extensions the scheme has proved a major source of government revenue and thus has financed numerous development schemes throughout the country.

One of these important characteristics is the 'triple partnership' on which the scheme is run. The three partners at the start of the scheme in 1923 were the government, the tenants and the British concession company, now transformed into the Sudan Gezira Board. The Gezira canalization scheme is not the only development plan in the Sudan. Thousands of nomads and semi-nomads are gradually being integrated with new agricultural development schemes in the Gash and Yokar deltas, in the Hiba Mountains, in Khsam El-Girba and in several of the private pump schemes which stretch along the Blue and White Nile, see Figs. 5 and 6.

Although there are various inherent human, administrative, economic and physical problems in the Gezira scheme, and in spite of the associated transitional forces and strains occurring in the course of its historical development and the change in its rural economy, its functional structure and accumulating experience represents for all those people and the rest of the country a new type of rural life and illustrates the advantages of modern techniques in irrigation.

2.2 The Physical, Cultural and Economic Background of the Area

2.2.1 Geographical Location:

The Gezira Irrigated area, as delimited by the existing outer limits of the pattern of canalization, is located in that part of the central clay plain of the Sudan, flanked by the Blue and the White Nile Rivers, stretching
Fig. 1 The Distribution of Agricultural Development Schemes

in a triangular shape from the junction of the two Niles at Khartoum, almost 200 miles southwards; and is terminated by the railway line joining the towns of Sennar and Kosti, see figs. 7 and 6.

The Arabic meaning of the term 'Gezira' is island or peninsula; however it denotes the formerly semi-arid plain which lies mostly within the boundaries of the Blue Nile Province, described by Toshill as being of alluvial origin, covering approximately five million feddans of which "... three million are irrigable." The existing irrigated area is over two million feddans, stretching within, and delimited by, approximately $13^\circ-30'$ and $15^\circ-15'$ North latitude and $32^\circ-30'$ and $33^\circ-30'$ East longitude.

2.2.2 Nature and Extent of the Area.

The Gezira Irrigated area is the product of two major phases of development, namely the 'Gezira-Plain', where the first part of the scheme was made in 1913, spreading extensively parallel to the Blue Nile after the completion of the Sennar dam in 1925, and of variable width reaching 30 miles at its widest part; and the Managil S.W. Extension, commenced in 1956, on a vertical axis to the 'Gezira-Plain', rather centrally between the two Niles,

7. Feddan = 1.038 acres or 0.420 Hectares.
Fig. 9 The Gezira Irrigated Area 1953, with the then proposed Manasil S.W. Extension.

see fig. 10. The gross irrigated area is now two million feddans, 800,000 of which constitute the Manasil Extension, which was brought into full production in July 1962.

The main features of the Gezira landscape are the spectacular patterns of canalisation and the extreme evenness of the plain, which is tilted slightly downwards to the North and West: 10cm./Km.\(^9\), thus allowing for gravity irrigation\(^9\), the basic concept of the Gezira scheme, see fig. 11. Hence water and vegetation are duly considered as the main aspects of the physical environment to be associated with the rural settlement study of the scheme.

10. There are in fact pumps at Bondal, Mariatta, Bag Abdalla and Wad el-Naw, which supplement the main canal, particularly during summer - April to July - specially for domestic water supply. However, the irrigation costs in the Gezira are considered to be the lowest in the world. The total capital investment for supplying water ranges between "£1-10 per feddan." See: The Sudan Gezira Board, Ministry of Information and Social Affairs and Administration: 1966-67. p.4.
£1 = £1-24 sterling and U.S.$2.872.

The total irrigation cost per feddan for the Manasil Extension was £560, that is for bush clearance, land levelling, canal construction and associated works. See: Shaw, D.J., "The Manasil South Western Extension: An Extension to the Gezira Scheme". (Wageningen: The International Institute of Land Reclama- tion and Improvement, Bulletin No. 9: 1965. p.13.

This however compares favourably with irrigation works elsewhere in the world where costs of over £890 per feddan occur for irrigation projects using high dams but in which only the main canals are included in the public costs, and over £920 per feddan where detailed distribution works are included." See:/...
Diagram 11: The two major phases of the Gemira Irrigated Area.

Source: D.J. Elow, "The Panjshir S.M. Extension", International Institute for Land Reclama-
2.2.3 Climatic Conditions

2.2.3.1 Temperature and Relative Humidity:

In considering very broadly the climatic variations within the extremities of the central clay plain in which the Gezira Irrigated Area is located it could be said that it lies within that part of tropical Africa subject to a 'continental climate' characterised by very hot summers and cool dry winters. The coolest month at Khartoum in the extreme North of the plain has a mean temperature of 23.7°C (74.7°F) in January. At Malakal in the extreme South, it is 27.1°C (81.0°F). The hot dry season is the hottest period of the year. The North wind blows as in winter, but by April and May it becomes very hot and dry as it blows across the Sahara desert. The mean daily temperature reaches 34.2°C (93.4°F) in Khartoum in June. In Malakal the peak is earlier and lower, 37°C (98.6°F) in April and 32.2°C (90°F) in May, because the rainy season begins in the latter month.

In the Northern half of the region dust storms are frequent towards the end of summer, but farther South the denser vegetation reduces their severity. Relative humidity in Khartoum at midday in April is 14% and the Pichte evaporation 20 mm; at Malakal 25% and 129 mm.

The local climate of the Gezira area is classified as hot and "semi-arid". At Wad Medani, the daily maximum temperature, in the year, could fluctuate between 32°C and 44°C, and the daily minimum temperature between 12°C and 26°C. However, it should be realised that from year to year there is considerable irregularity, especially in the magnitude, intensity and distribution of rainfall.

2.2.3.2 Rainfall:

Rainfall ranges from a 150 mm. in the extreme North to about 550 mm. in the extreme South and this is liable to a considerable variation, see fig. 12. The configuration of isohyets numbered 1-6 is a clear indication that the generalised pattern of the thirty year isohyets "... strongly suggest that the more humid environment of the Gezira scheme, as compared to the semi-arid surroundings exerts an influence on the rainfall." The rainfall is less in the North and increases as one moves to the southern part of the area. At Wad Medani the total annual rainfall had fluctuated between 240 mm. and over 550 mm. All the effective rainfall occurs in

Fig. 12 Rainfall in the Gezira Irrigated Area.

three months, July to September; however the mean annual rainfall at the Gezira research farm in the central area is 89-406 mm. (16"), falling mainly during July and August. See Table 1.

Although the crops of the Gezira scheme are grown primarily under irrigation, rainfall affects cotton yield chiefly by its influence on the incidence of disease and the labour costs in clearing weeds. Also "... the undulating nature of the Managil surface in the western parts of the extension has led to waterlogging during the rainy season and call for greater skill in water management" and efficient drainage systems.

2.2.4 Natural Vegetation:

The vegetation of the Gezira area would be classed as "Acacia short grass scrub". Before the development of the irrigation scheme there were considerable areas of closed Acacia bush which had to be cleared though elsewhere grazing and cultivation had resulted in large areas of open grassland. Irrigation has brought changes in the natural vegetation and there is now a well established "weed flora".


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within the scheme.

Considering that rainfall is scanty in the North and is relatively heavy towards the Southern part of the scheme where the acacia bush increases in density the cost of development is appreciably higher since it maintains a "rather woodland type of country particularly in part II stage 3 of the Managil Extension." 19

2.2.5 Soil Fertility:

Several attempts have been made since the inception of the Gezira scheme to identify and classify the soils based upon their physical characteristics and chemical properties and their productive capacities as regards the yields of cotton 20, see fig. 13.

As described by Tothill 21, in the plain, the alluvial material varies in colour and/or texture between strata with the surface horizon (½ to 1½ metres) having mostly a brownish colour. The Gezira soil has certain characteristics being alkaline cracking clay of great depth and superfinely uniform. The clay fraction varies around 60% and, as there is a high sodium content, the soil is very impermeable with a very low percentage of organic matter. The

salt content varies from under 0.2% to over 0.5% in the top four feet, tending to be higher in the areas of lower rainfall to the North and West of the scheme.\(^{22}\)

In the tropics and subtropics, the soil nitrogen is always very low and the Gezira is no exception.\(^{23}\). The Gezira soils contain adequate amounts of all plant food except nitrogen. Soil nitrate vary throughout the season, but are always very low and application of nitrogenous fertilizers always gives significant increases in yield. The amount of fertilizer applied is determined, in general, by the fertility, type, cropping history, and management of the soil and the requirements of the crop\(^{24}\).

When the scheme started, scientists who were familiar with irrigation schemes in Egypt, India and elsewhere were extremely worried about the accumulation of salts in the Gezira soil and consequent deterioration of the scheme. This has not developed into the danger that was feared, but it was a further reason for being cautious about intensive irrigation. Thus the introduction of 'fallow' in the crop rotation was of great importance in building up fertility, controlling of weeds and pests and guarding the scheme against such deterioration.

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22. Ferguson, R., op.cit. p.4.
Fig. 3. Cross section of the Ganges-Chill Pud irrigation system

The extremely impermeable character of the Gezira soil has an important bearing on irrigation in as much as the irrigation canals do not need lining and there is virtually no seepage even from canals above ground level.  

2.2.6 Conditions Prior to the Irrigation Scheme:

2.2.6.1 Population Pattern and Land Settlement:

The Gezira plain was known from ancient times to be inhabited. In the absence of relevant data and sufficient historic evidence it is as yet rather difficult to trace specifically the structural pattern and function of the various settlements and their population movement that evolved prior to the introduction of the irrigation scheme.

Among the fundamental factors in determining the mode of living and economic and social activities in the plain the climatic and physical aspects i.e. the soil fertility and the two Niles surrounding the plain are the dominating elements; however the importance of religious groupings, tribal structures and successive political events should not be underestimated since their effect on the settlement.

25. Ferguson, H., address given on 10th October, 1964, at Basakat Headquarters by Ferguson, Chief of the Agricultural Research Division, on "Intensification and Diversification and Integration." See also: Ferguson, H. op.cit. 1952. p.5.

patterns and influence on population movement can still be felt. By and large sedentarism and tribalism could be considered responsible for determining the pattern, demographic features and type of many settlements in the Sudan and this must be understood and carefully evaluated if social needs and development programmes are to be set.

Due to the scarcity and unreliability of rainfall the whole area was terminally cultivated and such conditions dictated to a great extent the location of settlements, the movement of the nomads and the code of living, see fig. 14.

In the Northern part of the scheme where rainfall was doubtful the settled villages were mainly on the river banks. Those on the plain were seasonal encampments and mainly suitable for raising camels and sheep. The economy here was directed predominantly to the 'Ganala' or camel herdsmen. The centre was most populated where this hope of rain and not too much growth of weeds occurred. Many permanent villages and settlements are where drinking water was found in deep wells and 'aftatars'. This, however, would help to explain the existing problem of waterlogging in certain settlements during the rainy season due to their initial siting. The Southern part entered the long grass and thorn acacia country, where the soil was richer and looser but often too difficult to hoe. Here the pattern of settled villages returned again to the river banks. The 'Ganala' tribes who migrated that far had to substitute cattle for

Fig. 14  Homes and approximate areas of certain of the more important Sudanic tribes.

their camels and become "Bayara" or cattle herders. They treat their cattle as they had previously treated their camels, using them for transport or milk and only to a minor degree for food.

2.2.6.2 Ethnic Origin and Tribal Organisation:
The indigenous inhabitants of the Gezira plain are of Arab and Negro extraction of various tribal groupings. They live in a typical hereditary tribal structure of a kind originally developed amongst nomadic Arabs.

Going back into history there is evidence that prior to the 10th century Arabs were entering the Sudan from the North and East in search of better pasture and political security. Most of the major changes that affected human life and formulated the social values and traditions of the people, especially in the North and Central Sudan, began in the early 16th century, when the Arabs allied with the "Yang Kingdom" to overthrow the dominating Christian kingdom of "Alwa." Since then tribalism and Islamic

29. Ibid.
31. "Alwa" is the Southern counterpart of the Christian Sudian Kingdom (940-1804 A.D.) from which it was separated in 940 A.D. and had its capital at Soba on the East bank of the Blue Nile about 12 miles S.E. of Khartoum. The "Yang Kingdom" lasted for over three centuries (1204-1821) with its capital at Sennar, other settlements like Atbari, Mangil, etc., had assumed an extremely important role as religious, administrative and commercial centres in the plain. Followed by the Turco-Egyptian occupation (1851-1885), the National uprising during the Mahdiya (1885-1888), the Condominium Government (1889-1955) and now the Democratic Republic of the Sudan.

See: Crawford, O.G.S., The Yang Kingdom of Sennar/
teachings, as a system of social relationship have developed. It should be noted that the tribe, as a social unit, provided its individuals with economic, social and self-protective, so did the religious leaders who helped to develop new social relationships and co-operation between the different tribes, based on Islamic ideals which are contrary to the introverted tribal outlook.

The concept of the tribal system is that each individual is a member of a household, where he may be the head or a dependent. Each household whether in a settled village or among a group of nomads comes under the control of a 'sheikh' who is responsible for collecting taxes, conveying to his people the instructions of the government and for maintenance of order. The sheikh in turn is subordinate to an 'Emda' who may have a number of sheikhs beneath him, ranging from "... ten to forty or more." The emda is in his turn one of several subordinates to a tribal leader or 'Nazir'. Nazirates usually vary considerably in size and every tribe consists of a number of omdas.

Considering the geographical location of the Gezira plain as was traversed by caravan routes from West Africa to Arabia, the historical need for agricultural labour to work during the rainy season, the various socio-political and religious motives for immigration from within the Sudan and other African countries particularly in the early 16th

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century and the introduction of Islamic religion and the later economic opportunities created as a result of the introduction of the irrigation scheme, it will be of great interest to draw attention to the existing heterogeneity of the Gezira population and the relatively greater degree of ethnic and tribal mixture in comparison to other parts of the Sudan.

2.2.6.3 Agricultural Organisation and Traditional Irrigation Systems:

The economic activities in the Gezira plain were a direct response to the physical landscape and the climatic conditions which dictated a largely pastoral economy. The cattle herders as well as the camel herders had to rely for their food on sedentary or semi-sedentary agriculturists living on the Nile banks or on the rain lands. Certain tribes developed a pattern of co-operation within their own communities, some of their people remaining to carry on cultivation during the rainy season from "June to August," having sent their cattle away with the young people to the pasture lands of the North. Usually the herdsmen provided the capital for growing millet and cotton.

It is known that two types of agriculture were practised in the Gezira before the launching of the canalisation scheme, namely 'riverin' and 'rain land' agriculture. Along the river banks land was cultivated in two ways:

a) the sloping margins or the lower parts of the river

banks called 'garf' were cultivated after being flooded by the Nile.

b) the higher terraces of the river banks, which were rarely or never flooded, were irrigated by means of 'shadouf', or waterwheels.

Further inland, where there was no possibility of flooding by high river water or by traditional irrigation methods, the inhabitants had to rely exclusively on the rains, crop production being insured by earth banks or terraces to conserve water. Because rains are always problematic it was advisable for a farmer with sufficient capital to disperse his holdings so that a failure in one locality might be compensated by success elsewhere.

Judging from the historical evidence available, it could be argued that among the Arabian tribes in the plain some are less patient with agricultural activities; however, Randell emphasizes that the value of animals in the process of transition from pastoralism to cultivation lies in the security they provide in an environment which is marginal for sedentary agriculture. It is evident for Randell that the bulk of the population in the Gezira was not riverain, but was supported instead by the growing of grain on unirrigated land. This would clearly indicate the existence and association of satellite settlements.

34. 'Shadouf' is a hand-operated lever for lifting irrigation water from the river.
35. Randell, J., Land Use on the Arid Margin of Clays in Blue Nile Province.
and seasonal encampments with the rain settlements initially sited along the Nile banks. The tendency to go inland was generated largely by the need for more grazing land and cultivation; however, religious convictions and tribal allegiances, especially during the Fung Kingdom and the commercial caravan routes had contributed largely to the permanent settlement and growth of a considerable number of these rain land settlements.

The overall picture was thus one of numerous religious and political centres in a land where the habitat and culture was basically oriented to a pastoral economy. Socially most of these centres have grown out of settlements occupied initially by one or two families, a group of nomads, a religious man or at a cross-roads or near 'affairs' and have evolved extremely close kinship ties over the ages.

2.3 The Gezira Irrigation Scheme

2.3.1 History of Development:

Before the reconquest of the Sudan by Lord Kitchener in 1898, the Gezira economy declined due to the political unrest throughout the 19th century, the heavy

36. The Fung Kingdom had its capital at Sennar at the Southern end of the Gezira about 180 miles from Khartoum on the West bank of the Blue Nile. The Fung Kings were well known for their respect to religious leaders and other learned men who were encouraged to settle in the plain by the generous gifts of agricultural lands for their people and followers.

taxation of the Turkish rule, the Mahdist wars, and finally the abolition of slavery in the British-Egyptian condominium. Turned the dam on in many places, water wheels and shadow fell into disrepair, and wells and water reservoirs crumbled in the rains.

It was of vital importance for the Sudan government at that time to emerge rapidly from this economic depression and to establish a point of take-off from which development in other aspects of life could be made possible. It had already become obvious that without the introduction of some export crop and an increase in government revenue, it was going to be very difficult to establish any kind of effective administration in the newly reconquered Sudan.

1.1. Irrigation Possibilities

In 1904, Sir Milner Garstin, an official of the Ministry of Public Works in Egypt, reported that "... the great plain lying between the Blue and the White Nile South of Khartoum and called the Gezira offered possibilities of irrigation by gravity flow if a dam was built on the Blue Nile near Fennar about 150 miles upstream from ..."

38. It was in 1885 when the 'Kalifa', the successor of El-Mahdi, accused the 'behraf', the close supporters of El-Mahdi, of conspiracy and forced them to leave northern Gezira and settle in Khartoum, the capital where they could be closely watched.

Khartoum. The Gezira, his report concluded, offered the best means of increasing the area of cultivated land and thus from its one possible source the revenue necessary to meet the growing requirements of public expenditure, and to assist the Sudanese peasant by improved means of irrigation.

2.3.1.2 Pilot Pumping Stations:

A scientific approach has characterised the project from its inception. A detailed survey of the region and a systematic study of the whole problem was carried out. To provide evidence that the idea of a canalisation scheme was economically sound the government in 1911 erected a pump irrigation pilot project at Tevibba on the Blue Nile, some few miles North of Wad Medani to grow cotton and wheat. In 1913 after cotton had been grown successfully the building of a dam at Sennar on the Blue Nile was finally approved. The dam was started in 1914, but the First World War delayed its completion until 1925. In the meantime three other pumping irrigation schemes were started in different parts of the Central Gezira, in Barakat - 1914, Hag Abdalla (El-Nosh) - 1921 and Wad El-Neu - 1923. See fig. 15.

42. For further reading, see: The Gezira Scheme from Within, ed. by the Press and Information Officer, Barakat: 1963. pp.6-9.
Fig. 15 Expansion of the Gezira Irrigated Area 1930 31.

Fig. 11 The Gezira Plain, showing major features of the Irrigation Scheme

2.2.3 Climatic Conditions

2.2.3.1 Temperature and Relative Humidity:

In considering very broadly the climatic variations within the extremities of the central clay plain in which the Gezira Irrigated Area is located it could be said that it lies within that part of tropical Africa subject to a 'continental climate' characterised by very hot summers and cool dry winters.\(^11\) The coolest month at Khartoum in the extreme North of the plain has a mean temperature of 23.7°C (74.7°F) in January. At Malakal in the extreme South, it is 27.1°C (80.8°F). The hot dry season is the hottest period of the year. The North wind blows as in winter, but by April and May it becomes very hot and dry as it blows across the Sahara desert. The mean daily temperature reaches 34.1°C (93.4°F) in Khartoum in June. In Malakal the peak is earlier and lower, 37°C (98.6°F) in April and 32.2°C (90°F) in May, because the rainy season begins in the latter month.

In the Northern half of the region dust storms are frequent towards the end of summer, but farther south the denser vegetation reduces their severity. Relative humidity in Khartoum at midday in April is 14% and the Dichte evaporation 20 mm; at Malakal 25% and 129 mm.

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The local climate of the Gezira area is classified as hot and "semi-arid". At Wad Madani, the daily maximum temperature, in the year, could fluctuate between 32° C and 44° C, and the daily minimum temperature between 12° C and 26° C. However, it should be realized that from year to year there is considerable irregularity, especially in the magnitude, intensity and distribution of rainfall.

2.2.3.2 Rainfall:

Rainfall ranges from a 150 mm. in the extreme North to about 550 mm. in the extreme South and this is liable to a considerable variation, see fig. 12. The configuration of isohyets numbered 1-6 is a clear indication that the generalized pattern of the thirty year isohyets "... strongly suggest that the more humid environment of the Gezira scheme, as compared to the semi-arid surroundings exerts an influence on the rainfall." The rainfall is less in the North and increases as one moves to the southern part of the area. At Wad Madani the total annual rainfall had fluctuated between 240 mm. and over 550 mm. All the effective rainfall occurs in

Fig. 12 Rainfall in the Gezira Irrigated Area.

three months, July to September; however the mean annual rainfall at the Gezira research farm in the central area is 406 mm. (16"), falling mainly during July and August. See Table 1.

Although the crops of the Gezira scheme are grown primarily under irrigation, rainfall affects cotton yield chiefly by its influence on the incidence of disease and the labour costs in clearing weeds. Also "... the undulating nature of the Managil surface in the western parts of the extension has led to waterlogging during the rainy season and call for greater skill in water management" and efficient drainage systems.

2.2.4 Natural Vegetation:

The vegetation of the Gezira area would be classed as "Acacia short grass scrub". Before the development of the irrigation scheme there were considerable areas of closed Acacia bush which had to be cleared though elsewhere grazing and cultivation had resulted in large areas of open grassland. Irrigation has brought changes in the natural vegetation and there is now a well established 'weed flora'


<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall mm</th>
<th>Max. Temp. °C</th>
<th>Min. Temp. °C</th>
<th>Evaporation mm</th>
<th>Rel. Humidity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0</td>
<td>33.9</td>
<td>13.7</td>
<td>14.4</td>
<td>30</td>
</tr>
<tr>
<td>February</td>
<td>0</td>
<td>35.4</td>
<td>14.8</td>
<td>17.1</td>
<td>20</td>
</tr>
<tr>
<td>March</td>
<td>Tr</td>
<td>38.5</td>
<td>17.5</td>
<td>20.8</td>
<td>13</td>
</tr>
<tr>
<td>April</td>
<td>3</td>
<td>41.0</td>
<td>21.0</td>
<td>22.9</td>
<td>15</td>
</tr>
<tr>
<td>May</td>
<td>16</td>
<td>41.2</td>
<td>21.7</td>
<td>20.8</td>
<td>24</td>
</tr>
<tr>
<td>June</td>
<td>11</td>
<td>39.6</td>
<td>24.6</td>
<td>18.8</td>
<td>36</td>
</tr>
<tr>
<td>July</td>
<td>122</td>
<td>35.6</td>
<td>22.8</td>
<td>11.6</td>
<td>57</td>
</tr>
<tr>
<td>August</td>
<td>123</td>
<td>33.1</td>
<td>21.9</td>
<td>7.0</td>
<td>69</td>
</tr>
<tr>
<td>September</td>
<td>25</td>
<td>35.2</td>
<td>21.8</td>
<td>5.0</td>
<td>63</td>
</tr>
<tr>
<td>October</td>
<td>16</td>
<td>38.0</td>
<td>21.6</td>
<td>11.6</td>
<td>44</td>
</tr>
<tr>
<td>November</td>
<td>1</td>
<td>36.7</td>
<td>17.8</td>
<td>14.8</td>
<td>31</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>34.1</td>
<td>14.6</td>
<td>13.5</td>
<td>34</td>
</tr>
</tbody>
</table>

within the scheme.

Considering that rainfall is scanty in the North and is relatively heavy towards the Southern part of the scheme where the acaia bush increases in density the cost of development is appreciably higher since it maintains a "rather woodland type of country particularly in part II stage 3 of the Managil Extension."19

2.2.5 Soil Fertility:

Several attempts have been made since the inception of the Gezira scheme to identify and classify the soils based upon their physical characteristics and chemical properties and their productive capacities as regards the yields of cotton20, see fig. 13.

As described by Tothill21, in the plain, the alluvial material varies in colour and/or texture between strata with the surface horizon (½ to 1½ metres) having mostly a brownish colour. The Gezira soil has certain characteristics being alkaline cracking clay of great depth and superficially uniform. The clay fraction varies around 60% and, as there is a high sodium content, the soil is very impermeable with a very low percentage of organic matter. The

salt content varies from under 0.25% to over 0.5% in the top four feet, tending to be higher in the areas of lower rainfall to the North and West of the scheme.22

In the tropics and subtropics, the soil nitrogen is always very low and the Gesira is no exception.22 The Gesira soils contain adequate amounts of all plant food except nitrogen. Soil nitrate vary throughout the season, but are always very low and application of nitrogenous fertilisers always gives significant increases in yield. The amount of fertiliser applied is determined, in general, by the fertility, type, cropping history, and management of the soil and the requirements of the crop24.

When the scheme started, scientists who were familiar with irrigation schemes in Egypt, India and elsewhere were extremely worried about the accumulation of salt in the Gesira soil and consequent deterioration of the scheme. This has not developed into the danger that was feared, but it was a further reason for being cautious about intensive irrigation. Thus the introduction of 'fallow' in the crop rotation was of great importance in building up fertility, controlling of weeds and pests and guarding the scheme against such deterioration.

22. Ferguson, R., op.cit. p.4.
See also: Hal, E.D., op.cit. pp.152-60.
Fig. 3. Streams in the Gezira Irrigation Scheme. Formed through the Gezira Scheme, reprinted from World Crops, Vol. 1, Nos. 2 and 3, 1952, p. 12.
The extremely impermeable character of the Gezira soil has an important bearing on irrigation in as much as the irrigation canals do not need lining and there is virtually no seepage even from canals above ground level.\(^{25}\)

2.2.6 Conditions Prior to the Irrigation Scheme:

2.2.6.1 Population Pattern and Land Settlement:

The Gezira plain was known from ancient times to be inhabited.\(^{26}\) In the absence of relevant data and sufficient historic evidence it is as yet rather difficult to trace specifically the structural pattern and function of the various settlements and their population movement that evolved prior to the introduction of the irrigation scheme.

Among the fundamental factors in determining the mode of living and economic and social activities in the plain the climatic and physical aspects i.e. the soil fertility and the two Niles surrounding the plain are the dominating elements; however the importance of religious groupings, tribal structures and successive political events should not be underestimated since their effect on the settlement

25. Ferguson, H., address given on 10th October, 1964, at Barakat Headquarters by Ferguson, Chief of the Agricultural Research Division, on "Intensification and Diversification and Integration." See also: Ferguson, H. op.cit. 1952. p.5.

patterns and influence on population movement can still be felt. By and large religion and tribalism could be considered responsible for determining the pattern, demographic features and type of many settlements in the Sudan and this must be understood and carefully evaluated if social needs and development programmes are to be met.

Due to the scarcity and unreliability of rainfall the whole area was terminally cultivated and such conditions dictated to a great extent the location of settlements, the movement of the nomads and the mode of living, see fig. 14.

In the Northern part of the scheme where rainfall was doubtful the settled villagers were mainly on the river banks. Those on the plain were seasonal encampments and mainly suitable for raising camels and sheep. The economy here was directed predominantly by the 'Gamala' or camel herders. The centre was most populated where fair hope of rain and not too much growth of weed encouraged many permanent villages and settlements are there drinking water was found in deep wells and 'boreholes'. This, however, would help to explain the existing problem of waterlogging in certain settlements during the rainy season due to their initial siting. The Southern part entered the long grass and thorn acacia country, where the soil was richer and looser but often too difficult to hoe. Here the pattern of settled villages returned again to the river banks. The Gamala tribes who migrated that far had to substitute cattle for

Fig. 14 Names and approximate areas of certain of the more important African tribes.

their camels and become 'Beqara' or cattle herders. They treat their cattle as they had previously treated their camels, using them for transport or milk and only to a minor degree for food

2.2.6.2 Ethnic Origin and Tribal Organisation:

The indigenous inhabitants of the Gezira plain are of Arab and Negro extraction of various tribal groupings. They live in a typical hereditary tribal structure of a kind originally developed amongst nomadic Arabs.

Going back into history there is evidence that prior to the 10th century Arabs were entering the Sudan from the north and east in search of better pastures and political security. Most of the major changes that affected human life and formulated the social values and traditions of the people, especially in the north and central Sudan, began in the early 16th century, when the Arabs allied with the 'fung Kingdom' to overthrow the dominating Christian kingdom of 'Alwa'. Since then tribalism and Islamic

29. Ibid.
31. 'Alwa' is the Southern counterpart of the Christian Nubian Kingdom (140-1504 A.D.) from which it was separated in 940 A.D. and had its capital at Soba on the East bank of the Blue Nile about 12 miles S.E. of Khartoum. The 'Fung Kingdom' lasted for over three centuries (1504-1821) with its capital at Sennar, other settlements like Itaeti, Managil, etc., had assumed an extremely important role as religious, administrative and commercial centres in the plain. Followed by the Turco-Egyptian occupation (1821-1885), the National uprising during the Mahdiya (1885-1898), the Condominium Government (1886-1959) and now the Democratic Republic of the Sudan.
See: Crawford, O.G.S., The Fung Kingdom of Sennar...
teachings, as a system of social relationship have developed. It should be noted that the tribe, as a social unit, pro-
vided its individuals with economic, social and self pro-
tection; so did the religious leaders who helped to develop
new social relationships and co-operation between the dif-
ferent tribes, based on Islamic ideals which are contrary
to the introverted tribal outlook.

The concept of the tribal system is that each individ-
ual is a member of a household, where he may be the head or
a dependant. Each household whether in a settled village
or among a group of nomads comes under the control of a
'sheikh' who is responsible for collecting taxes, conveying
to his people the instructions of the government and for
maintenance of order. The sheikh in turn is subordinate
to an 'Osma' who may have a number of sheikhs beneath him,
ranging from "... ten to forty or more.\(^{32}\) The osma is
in his turn one of several subordinates to a tribal leader
or 'Nasir'. Nasirates usually vary considerably in size
and every tribe consists of a number of omidas.

Considering the geographical location of the Gezira
plain as was traversed by caravan routes from West Africa to
Arabia, the historical need for agricultural labour to work
during the rainy season, the various socio-political and
religious motives for immigration from within the Sudan and
other African countries particularly in the early 16th

\(^{31}\) (cont'd.) 1951. pp.63-72; Shinnie, H., "New Light
On Medieval Nubia," The Journal of African History,
Vol. 6, No. 3. pp.263-74; also: A History of the

\(^{32}\) Population Mapping of the Sudan, "Africa Population."
century and the introduction of Islamic religion and the later economic opportunities created as a result of the introduction of the irrigation scheme it will be of great interest to draw attention to the existing heterogeneity of the Gezira population and the relatively greater degree of ethnic and tribal mixture in comparison to other parts of the Sudan.

2.2.6.3 Agricultural Organisation and Traditional Irrigation Systems:

The economic activities in the Gezira plain were a direct response to the physical landscape and the climatic conditions which dictated a largely pastoral economy. The cattle herders as well as the camel herders had to rely for their food on sedentary or semi-sedentary agriculturists living on the Nile banks or on the rain lands. Certain tribes developed a pattern of co-operation within their own communities, some of their people remaining to carry on cultivation during the rainy season from "June to August", having sent their cattle away with the young people to the pasture lands of the North. Usually the herdsman provided the capital for growing millet and cotton.

It is known that two types of agriculture were practised in the Gezira before the launching of the canalisation scheme, namely 'riverin' and 'rain land' agriculture. Along the river banks land was cultivated in two ways:

a) the sloping margins or the lower parts of the river

banks called 'garf' were cultivated after being flooded by the Nile.

b) the higher terraces of the river banks, which were rarely or never flooded, were irrigated by means of 'shadouf'34 or waterwheels.

Further inland, where there was no possibility of flooding by high river water or by traditional irrigation methods, the inhabitants had to rely exclusively on the rains, crop production being insured by earth banks or terraces to conserve water. Because rains are always problematic it was advisable for a farmer with sufficient capital to disperse his holdings so that a failure in one locality might be compensated by success elsewhere.

Judging from the historical evidence available, it could be argued that among the Arabian tribes in the plain some are less patient with agricultural activities; however, Randell35 emphasizes that the value of animals in the process of transition from pastoralism to cultivation sites in the security they provide in an environment which is marginal for sedentary agriculture. It is evident for Randell that the bulk of the population in the Cusira was not riverside, but was supported instead by the growing of grain on unirrigated land. This would clearly indicate the existence and association of satellite settlements.

34. 'Shadouf': is a hand-operated lever for lifting irrigation water from the river.
35. Randell, J., Land Use on the Arid Margin of Clays in the Lower Nile Province.
and seasonal encampments with the rain settlements initially sited along the Nile banks. The tendency to go inland was generated largely by the needs for more grazing land and cultivation; however, religious convictions and tribal allegiances, especially during the Fung Kingdom, and the commercial caravan routes had contributed largely to the permanent settlement and growth of a considerable number of these rain land settlements.

The overall picture was thus one of numerous religious and political centres in a land where the habitat and culture was basically oriented to a pastoral economy. Socially most of these centres have grown out of settlements occupied initially by one or two families, a group of nomads, a religious man or at a cross-road at near 'affairs' and have evolved extremely close kinship ties over the ages.

2.3 The Gezira Irrigation Scheme

2.3.1 History of Development:

Before the reconquest of the Sudan by Lord Herbert Kitchener in 1898, the Gezira economy declined due to the political unrest throughout the 19th century, the heavy

36. The Fung Kingdom had its capital at Sennar at the Southern end of the Gezira about 180 miles from Khartoum on the West bank of the Blue Nile. The Fung Kings were well known for their respect to religious leaders and other learned men who were encouraged to settle in the plain by the generous gifts of agricultural lands for their people and followers.

taxation of the Turkish rule, the Mahdist war, and finally the abolition of slavery in the British-Egyptian condominium. Water wells and channels fell into disrepair, and wells and water reservoirs crumbled in the rain lands.

It was of vital importance for the Sudan government at that time to emerge rapidly from this economic depression and to establish a point of take-off from which development in other aspects of life could be made possible. "It had already become obvious that without the introduction of some export crop and an increase in government revenue it was going to be very difficult to establish any kind of effective administration in the newly reconquered Sudan."  

2.3.1.1 Irrigation Possibilities.

In 1896 Sir William Garstin, an official of the Ministry of Public Works in Egypt, reported that "... the great plain lying between the Blue and the White Nile south of Khartoum and called the Gezira offered possibilities of irrigation by gravity flow if a dam was built on the Blue Nile near Kinneri about 150 miles upstream from

38. It was in 1888 when the ‘Khilifa’, the successor of El-Mahad, acceded the 'Hashim', the close supporters of El-Mahad, of conspiricy and forced them to leave northern Gezira and settle in Omdurman, the capital, where they could be closely watched.

Khartoum. The Gezira, his report concluded, offered the best means of increasing the area of cultivated land and thus from its one possible source the revenue necessary to meet the growing requirements of public expenditure, and to assist the Sudanese peasant by improved means of irrigation.

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A scientific approach has characterised the project from its inception. A detailed survey of the region and a systematic study of the whole problem was carried out. To provide evidence that the idea of a canalisation scheme was economically sound the government in 1911 erected a pump irrigation pilot project at Tayiba on the Blue Nile, some few miles North of Wad Medani to grow cotton and wheat. In 1913 after cotton had been grown successfully the building of a dam at Sennar on the Blue Nile was finally approved. The dam was started in 1914, but the First World War delayed its completion until 1925. In the meantime three other pumping irrigation schemes were started in different parts of the Central Gezira, in Barakat - 1914, Wad Abdalla (El-Yamdi) - 1921 and Wad El-Neu - 1923. See fig. 15.

42. For further reading, see: The Gezira Scheme from Within, ed. by the Press and Information Officer, Porakat: 1963. pp.1-8.
Fig. 15: Expansion of the Centre Irrigated Area 1910-21.

These small scale examples were established to give the inhabitants of the region the opportunity to accustom themselves to techniques of improved agriculture, and thus prepare for even greater technological change by high dam irrigation. Such progress encouraged the British Cotton Growing Company to activate the interest of the textile trade in Britain in the whole Gezira region thus playing a greater part in influencing the British Treasury to guarantee the Sudan loan.

The completion of the Sennar dam accelerated the increase of the irrigated cotton area from 80,031 feddans in 1925 to 207,440 feddans in 1950. The scheme spread rapidly, see Figs. 16 and 17. When a pump scheme or irrigation canals were established in one area, the immediately neighbouring areas were at once involved, since labour was drawn from them during the picking season. After a time this labour force was in its turn integrated into the scheme as tenants, while fresh labour was drawn towards it from other areas. Until the latest extension towards Harmatt, after independence in 1956, the land irrigated from the Blue Nile was kept to the Eastern side of the Gezira plain, with its main canal running along the watershed between the Blue and White Niles.

4.1. Land Titling and Management

The first step was to establish the title and register the ownership of all native owned land within the

Fig. 15  THE VARIOUS STAGES OF
THE CENTRAL POWER

Fig. 17  INFORMATIVE DIAGRAM: THE
SPECTRA INTERPRETED BY
THE MAP OF ENGLAND

Sources:
Garthor, K.R. The Republic
of the Poet, 1958

Sources: Guizot, J. The Gothic, 1959
lotment and surplus land went to land users who used to rent the land from the owners for the growing of millet.
Land was compulsorily rented from registered land owners for forty years standing at a fixed annual rent of approximately 2 shillings per feddan. Land was then consolidated and divided into holdings of originally 30 feddans, according to the first trials at Tayba in 1911, but changed to 40 feddans in 1913 which was considered at that time to be as much as one family could work.

People were classified into various categories for the purposes of land distribution. Right holders, who

45. "The development of the Gezira fringes between 1965/66 - 1968/69 necessitated the adoption of 20 feddan tenancies i.e. half of the Gezira standard tenancy of 40 feddans, because a survey of the Gezira scheme revealed that about 60% of the tenancies on the Gezira Main Scheme were subdivided into 20 feddan tenancies as a result of a rising rural population and labour problems." Quoted from paper by Taha El-Jack Taha, Senior Development Officer, Sudan Gezira Board: "Farm Management in Large Scale Irrigated Areas": 1969, p.2.
owned between 15-29 feddans were allotted one tenancy\textsuperscript{46}, those who owned between 30-44 feddans received three and those owning over 60 feddans were awarded four tenancies. Smaller land owners with 5-14 feddans were given one tenancy\textsuperscript{47}.

The large holders also had the right to nominate one or more persons (nominees) for a tenancy or tenancies within their entitlement - usually relatives. Land remaining after all large and small holders had been given tenancies was divided amongst persons who used to cultivate, but not own, land in the area, and who had not received a holding either through titlehold or nomination by a right holder. These persons (nomars) must have paid a crop tax (eshur). Owners still retain the title to their land and may dispose of it if they wish. However, to prevent any abuses only sales between natives of the region or government are allowed. The registered holders are assured that when they die their holdings will remain in their families. Few women were granted tenancies and tenancies awarded to persons under the age of 16 were registered in the names of guardians.

The government itself entered the land market and now \textsuperscript{57}\% of the Gezira Main area is government owned and \textsuperscript{41}\% is native land. The remaining land is taken up by village (harmar) lands and roads\textsuperscript{48}. The Managil S.W.

\textsuperscript{46} Tenancy of hawasha: a holding of land approximately 10 acres measured in relation to cotton holding.
\textsuperscript{48} Shaw, D.J., \textit{Managil South Western Extension}: 1962/3.
Extension which was started in 1956 and brought into full production in 1962 was governed by the same Gezira Land Ordinance 1927, with 62% of registered lands owned by government and 36% of native lands. The standard size of holding was made 15 feddans to suit the family labour composition on the one hand and to secure even distribution of benefits and returns to a large cross-section of the occupants.

"It is interesting to know that the majority of the 73,796 tenants in the scheme (32,563 Gezira Main and 41,233 Managil S.W. Extension 1962/63) are male but there is a significant number of female tenants in the Extension and a higher proportion of non-Sudanese in the Gezira Main area." However, there was a total of 78,798 farming tenant population in the Gezira scheme in 1968. See Table 2.

2.3.2.1 Crop Rotation:

The effects of different rotations on yield was one of the earliest aspects of cotton cultivation to be studied by the Agricultural Research Division since 1918. However, as a result of the agricultural researches carried out and as a consequence of the disastrously low

49. Shaw, B.J. op.cit.
50. Shaw, B.J. op.cit.
<table>
<thead>
<tr>
<th>No. of Tenants</th>
<th>5 Feds. &amp; Under</th>
<th>Over 5-9 Feds.</th>
<th>10-19 Feds.</th>
<th>20 Feds. &amp; Over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gesira Main</td>
<td>33,726</td>
<td>19,287</td>
<td>1,966</td>
<td>11,872 601</td>
</tr>
<tr>
<td>Managil S.W. Extension</td>
<td>45,072</td>
<td>36,614</td>
<td>1,733</td>
<td>6,085 640</td>
</tr>
<tr>
<td>Total</td>
<td>78,798</td>
<td>55,901</td>
<td>3,699</td>
<td>17,957 1,241</td>
</tr>
</tbody>
</table>

Note: All sizes in cotton holdings.

Extracted from a Paper by Tahs el-Jack Tahs, Senior Development Officer, Sudan Gesira Board: "Farm Management in Large Scale Irrigated Areas": 1969, p.3. (Unpublished.)
yields of 1930/31, which were attributed mainly to black-
arm and heavy weed infestation, the rotational pattern
was altered to the Gezira standard eight course rotation
in 1933/34. This rotation was applied to the standard
tenancy of 40 feddans; the main cash crop was the long-
staple cotton with subsidiary food crops (sorghum) and
'Rubia' (Holichos Leblab) and remained the basis for the
Gezira cropping up to the introduction of intensification
and diversification in 1962 which incorporated other crops
like wheat and groundnuts and the basic ideas of a mixed
farming system. See Table 3.

In the Gezira Nile the cropping was based on an eight
course rotation of cotton - fallow - 'dura' (Millet) -
Rubia/fallow - fallow - cotton - fallow - fallow. The
land was divided into 40 feddans, 10 feddans for cotton,
5 for dura and up to 2½ feddans of Rubia with 22½ feddans
resting each year.53

It was generally agreed, as early as 192654 that
even if a tenant and his family worked to the fullest ex-
tent possible, the size of holding was too large for them
to perform all the tasks required. They would have to
obtain outside help for certain operations, especially for
weeding and picking. This was a major reason for reduc-
ing the size of tenancy in the Managil Extension to 15
feddans. Here a six course rotation of cotton - Rubia -
dura - fallow - cotton - fallow was introduced; 5 feddans

54. Notes on the Gezira Irrigated Project, Anon/London,
McCorquodale & Co. p.82.
Table 3: The number of faddans in relation to the various crops in the Gezira Main and Managil S.W. Extension Seasons 1967/68 and 1968/69.

<table>
<thead>
<tr>
<th>Season</th>
<th>Cotton</th>
<th>Dura</th>
<th>Wheat</th>
<th>Ground Nuts</th>
<th>Lobia</th>
<th>Veg. Gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967/68</td>
<td>565,094</td>
<td>327,656</td>
<td>144,941½</td>
<td>104,388</td>
<td>77,139</td>
<td>25,450</td>
</tr>
<tr>
<td>1968/69</td>
<td>587,711½</td>
<td>299,202</td>
<td>150,000</td>
<td>85,790</td>
<td>173,266</td>
<td>33,495</td>
</tr>
</tbody>
</table>

Adapted from Taha El-Jack Taha, op.cit.: 1969. p.3.
were allocated for cotton, 2½ for dura and 2½ for lubia. Cropping is therefore more intensive in the Extension, some 67% of the land there is available for cropping in any one year, while in the Gezira Main Area, over 50% of the land is left fallow.55

With the intensification and diversification programme, eventually 75% of the rotational area would be cropped. This has brought about comprehensive agricultural-economic research into the effects of weeds on the rotation, the influence of additional crops on soil fertility, the shortage of labour, the use of machinery and the constraints of remodelling the canals to allow greater discharges, and the fundamental social and administrative implications.

2.3.2.2 System of Irrigation:

Because of the tilt of the Gezira plain down towards the North and West, it was decided to locate the main irrigation canal along the East side of the Gezira following a slight ridge that runs from Bag Abdalla to Masid, see fig. 11. In this way it would command not only the adjacent ground but also the more distant areas to the West, if it were ever desired to extend the irrigated area.

Within the irrigated area the siting of minor distribution canals is made easy by the remarkable flatness of the ground, "... the mean slopes being between 1:5000 and 1:10,000."56 It has thus been possible to adopt a

55. Shaw, D.J. op.cit. p.
standard layout which brings water to units, known as 'numbers', of 90 feddans, each being in turn divided into plots of 10 feddans. Each such plot comprises the cotton holding of a single tenant; and thus it is easy to supervise irrigation and cultivation practices by ensuring that all plots in any one number are always kept at the same point in rotation, see figs. 18, 19 and 20.

Watering is carried out by day only and the minor canals are so designed as to be able to be filled up overnight and store water for distribution next day. As mentioned previously, there is no fear of salt accumulation due to the fact that the waters of the Blue Nile are not heavily charged with salts and to the impermeability of the soil, which has its good side in reducing loss of water in the canals.

2.3.2.3 The Triple Partnership:

The three partners at the start of the scheme in 1925 were the government, the British concession company known as the Sudan Plantation Syndicate and the tenants.

57. The great credits contributed to the scheme by that Company were the success of growing cotton in the Sudan and the successful management of the pilot projects made at Fayika and Barakat to test the possibility of developing the Gezira plain. It is noteworthy that the idea was brought forward by Leigh Hunt, a wealthy American who persuaded Sir Reginald Wingate to grant him permission to establish the Sudan pump irrigation scheme, opposite the confluence of the Athbara River with the main Nile, for the resettlement of freed slaves from North America. When that failed it became the home of the Sudan Plantation Syndicate, a British company, which subsequently took over the management of the Gezira scheme in 1919 until its nationalisation in 1950. See: Tracey, C.B./...
Fig. 16. STANDARD GREEVA LAYOUT OF CANALISATION.

SCALE 1/30,000

Source: Sudan Survey Department, Khartoum. EID.47 - 1/310

This tripartite partnership set out the duties of the three partners and their proportionate shares in the profits of the cotton crop.

The government undertook the responsibility for the construction of the Semna dam and all the major canals as well as compulsorily renting the non-government land from its owners. In addition, the government is also responsible for the maintenance of the dam and the major canals.

The British concession company undertook the management of the scheme, the advances of loans to tenants to enable them to look after their cotton crop properly and the financing of the transport, ginning and marketing of the cotton crop.

The third partner, the tenants, is responsible for the cultivation of the cotton crop and making necessary expenditure in connection with its production up to the point of its delivery to the local collecting stations.

The responsibilities and returns of the three partners are laid down in the Sudan Gazira Act 1960:

- 40% of gross cotton profits for the tenants
- 40% to the government
- 20% to the British concession company.

57. (contd.) "The Zeilish Scheme" in Agriculture in the Sudan, ed. by Tothill, J.B.: 1948.
59. Ibid. Also: Grimkell, A. op.cit.: 1959, pp.79-82.

Note: The above returns have been changing.
Tenants also grow dura which is their main food crop and luuki (cotton crop). The return from these crops is given wholly to the tenants.

2.4 Nationalisation of the Scheme:

The Gezira was established as a cotton growing scheme, and up to nationalisation in 1950 the prime objective could be said to be the maximisation of cotton production. Since nationalisation the government avoided making major changes in the administration system established by the British company and which was taken over by an independent body called the 'Sudan Gezira Board'. Emphasis was no longer given to the maximisation of cotton production as such but rather to the creation of the maximum degree of social benefits.

Up till 1955/56 the gross area of the scheme was 980,000 feddans; however, the availability of additional irrigation water, consequent upon the conclusion of the 1959 'Nile Waters Agreement' with the United Arab Republic led to the completion of Phase 2,3 and 4 of the Managil S.W.

60. "This change was perhaps not immediately recognised and certainly there is no explicit reference to it in either the 1950 ordinance or the 1960 Act. Even now the continuance of profit sharing on the cotton crop alone, instead of the adoption of a less discriminatory form of rental payment, tends to obscure what should be the true objective." See: Simpson, I.G. "An Economic Evaluation of Cotton in the Gezira Rotations," Paper, Had Medani Symposium: 1969, p.1.
Furthermore, the construction of Roseires Dam in 1960 brought the additional stored water to the volume of 2.7 km³ cubic metres with the result that more than double the original area is now under irrigation. Accordingly 290,000 feddans in the Gezira Main were made available for further cropping with groundnuts, wheat, vegetables and fodder crops under the Intensification and Diversification Plan and similarly an extension of 200,000 feddans in phase 5 of the Managil S.W. Extension was approved under the Roseires Project, concluded in 1961. Furthermore, the semi-detailed soil survey and land suitability classification carried out lately has revealed a potential arable land of 100,000 feddans in the Central and Southern Gezira and 75,000 feddans in Managil S.W. Extension which is proposed for development under the public sector investment programme for 1969/74. Simpson pointed out that a more flexible approach is needed for consideration of the overall long term pattern of development in the Gezira: "... capital rather than labour or irrigation capacity can be looked upon as the over-riding constraint." 62

The Gezira scheme has proved successful in long-staple cotton production but the programme of intensification and diversification adopted under the ten year plan for Economic and Social Development 1961/62 - 1970/71 has brought some constraints which are receiving constant attention.

Indeed, the Gezira Irrigation Scheme is the biggest capital asset in the Sudan with much greater chance of more land and cropping utilization. This however would explain the apparently conflicting objectives in view of the national interest to improve financial resources on the one hand and the development and protection of tenant-farmers on a sound economic basis for commercial purposes on the other. Hence the introduction of a village farming experiment at Wad El-Naaim in Central Gezira, in 1951, with the objective of converting the tenant from purely a cotton producer into a farmer capable of growing various cash and fodder crops in addition to cotton, and also to interest him in mixed farming, in co-operatives, by experiments and demonstrations and the introduction of some agricultural machinery in order to relieve pressure of work and to cut down expenses.

Various attempts were made to review the basic concept, objectives and practices of the Gezira scheme. It is worthy of mention that the World Bank Study Mission of the scheme in 1965/66 and the Working Party Report (1963 - 66) on the intensification-diversification programme, which were submitted to the Ministry of Agriculture in 1966, contained sound recommendations for the improvement of production pattern in the scheme considering the pressure of change arising from the accessibility to the new resources and technology and from the process of human and social development.
2.4.1 Profit Sharing:

A revision of the return for the three partners was made after independence, as follows:

42% of gross cotton profits for tenants
42% to the government
10% to the Sudan Gezira Board

of the remaining 8%, 2% went to the Social Development Department, which came into being in July 1950, to pay for its social development programme, 2% went to the local government in the scheme (Rural Councils) and 2% to the Tenant Reserve Fund which serves to meet fluctuation in cotton returns.63

In view of the fluctuation of yields and prices tenants have always attempted to increase their direct share of the net proceeds of cotton sale to meet the rising cost of sowing seed, ploughing and picking which are their personal responsibilities on the ‘joint account’. Also due to the spread of machinery co-operatives as a result of the intensification-diversification programme the government’s share has dwindled. It should be remembered that the tripartite partnership was based on the tenants’ incentive to undertake manual operations efficiently. This, of course, would indicate the relatively low level of mechanisation in the scheme and which would have to be reviewed and carefully considered should there be further need for the use of machinery in the agricultural practices.

63. 'Social Development in the Gezira (1950-60)', Sudan Gezira Board Publication.
Table 4 will illustrate the net returns from cotton growing and the percentage of sharing for seasons 1964/65, 65/66 and 66/67.

2.4.2 Administrative Framework:

The Sudan Gezira Board was established in 1950 when the lease of the cotton concession company ended, and is an independent corporation. It is composed of a Managing Director, appointed by the government to act as a link between day-to-day management of the scheme and the government, representatives from the Ministries of Finance and Economics, Commerce, Industry and Supply, the Director of the Department of Agriculture (ex-officio) and the Commissioner of the Blue Nile Province in which the scheme is situated.

The Board is responsible to the government, through the Ministry of Finance and Economics, for:

1. managing and financing cotton production, transportation, ginning and marketing.
2. promoting social development to improve the standard of living of the tenants, and other persons living within the scheme area, and
3. promoting research to increase the productivity and stability of the scheme.

The headquarters of the Board is located at Baskat on the eastern side of the scheme.

A sub-headquarters has been set up in stage 2 of the Managil S.W. Extension for the overall administration of production in the new area. For the purpose of agricultural

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<td>c.</td>
<td>276,763</td>
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<td>f.</td>
<td>1,383,819</td>
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</table>

blocks in the delta and the

version. Each block is controlled by a Block Inspector
who is aided by two or three assistants, depending on the
size of the block. These in turn are supported by the
tenants (tenants) and by Village Councils in the running of
the block. The role of the Block Inspector and the Vil-
lage Councils could be summed up as the enforcement of the
class of the tenancy agreement. In a tenant falls be-
hind in any cotton operation the Block Inspector may hire
labour on behalf of the tenant to ensure that the work is
carried out in time. The cost of hired labour (tulba) is
charged to the profits from the sale of the tenant's cotton.
However, persuasion and supervision are gentle words to
use in view of the present critical transitional phase in
the history of the scheme.

2.4.2.1 The Block Inspector and Village Councils:

In order to ensure coordination and that there
is no isolation of problems, it is recommended that there
should be a unified approach to all the activities of the
Village Council through the Block Inspector. That is to
say, it should be recognised that the Block Inspector is the

h) the increase of the understanding by the villagers of

the reasons behind the instructions they receive, and

64. See: Abd El-Mahsin, Mahmoud (Governor, Blue Nile Pro-

vince): "A Directive on the Policy of Devolution in
c) The hearing of agricultural offences as well as the claims for improvement.

The meeting of the Village Council is normally held once a month on a fixed day and the village sheikh by virtue of his rank will be the permanent president of the Council. Elections of members are held once a year and Village Councils should arrange to hold general village meetings at least three times a year, headed by Block Inspectors.

So the creation of Village Councils in the Gezira, as a result of agricultural development, helped to provide the basis for democratic local institutions.

The Gezira irrigated area is now administered by five Rural Councils. "The setting up of Rural Councils in the Gezira has an important effect on the policy of devolution because the warranted village council is in future to be an official unit of local government. The aim of local government is to devolve responsibilities on to the local bodies, and the ultimate concept is that the local bodies shall manage their own affairs in an efficient manner." This means that for much of the non-agricultural side of devolution, which until now the Block Inspectors and their field staffs have been asked to undertake, will in future fall on the Rural Councils and its staff. This is a subject of great controversy that would need further investigation.

2.5 The Labour Force in the Gezira Scheme

In broad lines the core of the problem in the Gezira irrigated area is the increasing demand for and supplying of labour for cultivating the land due to a complex of historical, economic and social reasons.

When the scheme was first established in 1925 the population was in fact initially insufficient for the desired aim of each family working on one tenancy. Tenancies were thrown open to immigrants most of whom had come to the Sudan from either Nigeria or the Republic of Chad for political reasons or on their way to Mecca.

The Gezira tenant is not like the Egyptian or Indian peasant. His background is semi-nomadic or nomadic; continuous work in a settled place is still comparatively new to him. Before the scheme started rich men used slaves for field work and poorer men worked with their families on rain-land cultivation for not more than three months. Thus the first tradition established was that the tenant was mainly to be the manager of a unit largely dependent on hired labour and slaves.

The present irrigation scheme with its rigid timetable, demands constant attention; thus the problem of resorting to hired labour arise, due to the lack of hard working agricultural tradition. The tenant will avoid working in the field if he has the money to hire someone else; hence the

tendency towards less and less personal work. It also appeared that certain tasks are more respectable than others. Traditional duties like sowing, inter-crop weeding and perhaps a little picking may be indulged in but other unpleasant jobs like digging or pulling out of cotton stalks at the end of the season are given to hired labourers. Today there are also other additional reasons emphasising the importance of relying on hired labour. For instance, the introduction of the intensification-diversification programmes. However, whatever may be the reasons the development of the irrigation scheme has stimulated immigration from within the Sudan, especially from the Western provinces, French-Equatoria, and Nigeria, in addition to the annual influx of picking labourers from the neighbouring districts of the Blue Nile Province, see Table 5. Unfortunately, no accurate information is as yet available to aid scientific studies of the demographic characteristics, the degree of integration with the indigenous inhabitants, the points of concentration of the immigrants and the occupational structure within the irrigated area which are of prime importance in the proper assessment of needs and service requirements and their social, economic and political implications.

To grasp the magnitude of labour demand in the Ceniza irrigation scheme and the contempt for field work it is worth mentioning that the seasonal regime of the farming year begins in July and ends in June and is characterised by two peak periods: the rainy season (15th July - 15th October)
<table>
<thead>
<tr>
<th>Season</th>
<th>Blue Nile</th>
<th>White Nile</th>
<th>French Equatorial</th>
<th>Pelabat</th>
<th>Nubian</th>
<th>Others</th>
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<td>18,677</td>
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<td>18,000</td>
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<td>78,600</td>
<td>18,133</td>
<td>12,214</td>
<td>11,210</td>
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<td>226,521</td>
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<td>91,654</td>
<td>85,000</td>
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<td>11,460</td>
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<td>273,856</td>
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<td>1961-62</td>
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<td>79,519</td>
<td>18,507</td>
<td>74,026</td>
<td>18,492</td>
<td></td>
<td>351,220</td>
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Sources: The Gezira from Within. Reprinted by the Gezira and Information Officer, Sudan Gezira Board, Khartoum, 1965. p.32.
and the picking season (15th January-15th April).

During the rainy season, cotton, dura and other crops are sown and established. When the rains are late there is always an overlap of agricultural activities and when it rains heavily growth of weeds, damage to canal banks and field channels cause considerable interruption of work, however, heavy rains tend to bring good yields in rain-fed dura which necessitates a further labour force.

The picking season reaches its climax at the end of February and is governed by a restricted routine and labour is always needed at this very critical time to avoid substantial losses in the crop. It could be argued that the size, number and location of holdings among other physical and social factors necessitate further dependence on hired labour. Conversely in view of the present social, economic and religious considerations the tenant families' contribution to the labour force is seriously limited. With relatively increasing education a large percentage of children were taken out of the labour force. The Social Development Department, however, is well aware of the need for proper education and the creation of a well trained enthusiastic new generation of farmers.

Miss Culvekk in her study "Diet in the Gezira" pointed out that the imbalanced diet and general lack of green vegetables during the dry season resulted in diminished physical efficiency. The hard task of uprooting and destroying cotton stalks and the application of artificial fertilisers is usually carried out during the summer season (15th April -
15th July) at which time temperatures rise to about 100°F.

This is clearly one reason for the resentment of work at
such a time and mechanisation might well be welcomed in
view of competing prices of labour and labour demands. A
point to make is that before the development of Mansaai S.W.
Extension, 63.5% of the labour working in the Gesira Main,
season 1955/56, came from this recently developed area.
This labour force is now also acquiring similar status and
mentality of landlordship.

Simpson 68 thinks that due to development of other pri-
ivate pump irrigation schemes within the Blue Nile Province,
the tenants are in direct competition with those of the Ges-
ira. Others believe that the Economic and Social Develop-
ment Plan (1961:71), which embodied industrial projects for
a wide range of consumer goods in Khartoum Province created
a labour market which has its own advantages to the Gesira
scheme.

In practice and in view of the intensification-diversi-
ification programme the demand for labour goes much further
than the seasonal agricultural regime which also includes
the winter season (15th October - 15th January) and which

67. For further see: Shaw, D.J., "Labour Problems in the
Gesira Scheme," published in FCA/FAO Agricultural Eco-
Ia on p.28.

68. Simpson, J.G., member of the Working Party on secondment
from Lagos University. Unpublished paper addressed to
Note: 'One man to one faddem' was confirmed by the Tech-
over 271 (64,000) of the total picking labour force came
from the West." See Shaw, D.J., op.cit. p.16. See/...
dictates careful watering regimes and the intensive preparation of digging and ploughing for next season's activities.

In view of the seasonal fluctuations of the yield, see fig. 21, and the uncertain economic position of the tenants, some were said to have established shops and engaged in other commercial enterprises and treated their tenancies as a secondary source of income, thus not attaining the full objective of a true farming community in such a great economic enterprise under one large management.

2.6 Analytical Appraisal

2.6.1 Large-scale Agricultural Schemes in Under-developed Countries:

Agriculture assumes a significant role in the economic and social life in under-developed countries. It is widely thought that large-scale agricultural development schemes will do much to push ahead economic development in these countries. Some schemes have contributed to the advancement of certain depressed economies yet their histories very often are not of complete success. Generally, this is because agricultural productivity, either per man or per unit of land, is very low. These two measures could further be related to a number of factors such as nutritional deficiency, primitive and traditional agricultural methods, land tenure and division

Fig. 21  Seasonal fluctuation of cotton yields in the Gezira Irrigated Area, 1912-1951 (Average yields in kantara per feddan).

of land into uneconomic units, lack of fertilisers, poor irrigation, lack of incentive and efficient administrative set-up, education, the marketing system and instability of return. Moreover, the conflict which may occur in view of the customs, habits, traditions and other social values makes the task of agricultural development an extremely difficult one.

Within the framework of national production, agriculture should be developed so that it can contribute its utmost to the national economy; "... it is really hard to judge to what extent the development of agriculture should be stimulated in a given country," Dickinson's view that "... the making of major economic decisions, what and how much is to be produced, how, when and where it is to be produced and to whom it is to be allocated, by the conscious decision of an authority on the basis of a comprehensive survey of the economic system as a whole" would possibly emphasise the flexible attitude which should be adopted in the making of national development plans in developing countries as regards the development of this sector, specially in the light of conflicting objectives when it is to contribute to national welfare as well as being adopted as a mode of living. It is, however, a rather sensitive matter in the field of planning which should be considered

as an instrument to organise the desires of the people and which might be misinterpreted in the light of the definition of social freedom. Social freedom is reasonably defined by Bettelheim as a "... freedom which allows men to decide no longer individually but socially, what they shall produce, in what amount and on what conditions." Since the individual decisions related to such matters do not only interest the individuals who take the decisions, but interest the nation as a whole.

The Garia irrigation scheme is a typical large-scale agricultural scheme and for various reasons has introduced new problems as well as solving old ones. Forty-six years of regulated agricultural development is a true revolution in economic and social development planning and an equally noteworthy human story of a country which was called upon to adjust itself to a specialised economy for the national interest.

From the foregoing pages and in the light of the changing rural economy it can be seen that the irrigation scheme is on the threshold of a new historic epoch of radical change and as such is a typical example of national development planning which includes structural changes in the economic framework as well as the social institutions which

is contrary to the previous outlook of a purely economic development planning scheme.

2.6.2 The Impact of the Gezira Irrigation Scheme:

Over the centuries the fertile plain had seasonally attracted a large number of nomadic and semi-nomadic groups belonging to various tribal divisions and religious sects. Customary law provided the framework for everyday life. Land tenure and grazing rights were decided by tribal members, allied by bonds of kinship and political allegiance to tribal leaders in an environment which was dominated by a subsistence agricultural economy, where the marketing tradition would obviously operate in terms of kind.

Against this background the development of the Gezira scheme and the process of transforming the inhabitants into tenant farmers, thus undergoing a complete change in their way of life, is certainly one of the most intricate operations any administration can have to face towards establishing an external cash economy. The tenants are no longer free agents working only for three months in the year in the field, but are controlled by a rigid system of land tenure and disciplined by a calendar of agricultural activities which stretches over eleven months of the year. It would appear then that the gap between economic and social change is fairly clear, thus presents its own problems which of course cannot be dissociated from the physical aspect of the development of the environment. The far reaching technical and economic changes brought about by the canalisation
scheme have had their impact on the pattern of life of the inhabitants which could be discussed, largely, under the following two headings: socio-economic, and technical and physical factors.

2.6.2.1 Socio-Economic Factors:

It could be said that prior to the introduction of the canalisation scheme the traditional economic structure in the Gezira plain was relatively simple and was based primarily on seasonal cultivation of dura, the staple food of the inhabitants and the grazing of animals, a pastoral tradition, which was derived from the semi-nomadic tribes. Money economy, though rather insignificant, had developed during the Fung Kingdom 73 with the result that the plain had developed connections with other parts of the Sudan as well as Arabia and other African countries.

With the development of the irrigation scheme, the cotton crop was introduced basically for commercial purposes, thus establishing further connections with the outside world in an endeavour to obtain the highest possible cash return. The economic arguments against the Gezira scheme depending entirely on a single commercial crop are well known. However, the recent introduction of intensification and diversification of production is in part an attempt to find

73. In 1814, Sennar the capital of the Fung Kingdom was said to be trading in leather, ivory, gold, cotton cloth and slaves with many parts of the Sudan, Arabia and North Africa. For further reading, see: Brausch, G., 'Historical Introduction to a Sociological Analysis of the Gezira,' unpublished. p.19.
a more profitable crop and to counteract the economic instability as a result of the present world-wide fluctuation in cotton prices and demand. It is noteworthy that in the course of its development two historic periods, 1930 and 1950 had significant impact on the socio-economic structure of the scheme.

In 1930 the whole world was faced with economic depression. As a result, revenue from cotton was not encouraging and most of the tenancies were deserted. The Sudan Plantation Syndicate had to resort to direct labour and West African farmers were invited in and promised a good future if they took over the deserted fields; however, those who withstood the depression increased their holdings substantially. In support of this argument the Blue Nile Governor stated that "... without the West Africans the Gezira scheme could never have operated successfully during the depression period of 1930." West Africans proved to be indispensable in the Gezira scheme. Most of the secondary and tertiary occupations have been adopted by the West African immigrants in their isolated settlements. It was

74. West African migration could be dated back to the Fung Kingdom; as a result of the British penetration into Northern Nigeria, Mohamed Bello Maiiuno and his followers migrated from Sokoto and founded the settlement of hainro in 1901, on the Western bank of the Blue Nile, which encouraged further migration since then. For further reading, see: Hassoun, I.A., "Western Migration and settlement in the Gezira," Sudan Notes and Records, Vol. 22: 1952, pp.77-107.

75. From a survey of labour conditions, it was found that in the Gezira Main of an average of 132,000 labourers over the whole period of cotton cultivation, over 77,000 were West Africans. At the peak period, out of 208,000 employed, 57,000 were West Africans. They held 48/...
said that what a West African earns as a casual labourer is far more than the net return of the indigenous tenant.76

In the 1950/51 season, commonly referred to as the bumper period, the yields of the tenancy (a unit of 10 acres of cotton) and the sale prices were at their highest. The tenants' payable profits averaged approximately £80077 which compares favourably with the average profit of £27578 in 1956/57. It was a time of great satisfaction to tenants to demonstrate the real benefits of landlordship and the demand for labour has since then been increased. This period coincided with the birth of the Social Development Department as a result of the increased demand for services and the short-lived co-operative societies which were mainly for consumer purposes. The introduction of the intensification-diversification programme brought into being new co-operative societies which were oriented towards the mechanisation of wheat and groundnut production and the marketing of these crops79. With all the socio-economic implications of the

75. (contd.) of tenancies; provide 25% of the labour force in the field; 90% of the labour force employed in ginning factories and 70% of canal maintenance labour. See: Davis, H.R.J., "West African in the Economic Geography of the Sudan," Geography. Vol. 49: 1964. pp.222-34.
76. For further detailed study, see: "El Bashakra Settlement," Department of Architecture, University of Khartoum: 1963.
77. The Sudan Gezira Board submits an annual report to the Sudan Government under the Gezira Ordinance of 1920. See also: "The Gezira Scheme from Within," 1963, p.2.
79. The number of groundnut credit and marketing societies reached 53 in the 1965/66 season, but dropped to 27 in 1967/68. But the mechanical harvesting co-operatives/...
bumper period a vivid picture of development could be seen
in the remarkable transformation in the range and sophisti-
cation of the business transacted in the old market centres,
the newly developed ones and in the appearance of a con-
siderable number of shops in various settlements.

"What changes do in fact strike the eye on looking
round, starting at the simplest material level in the vil-
lage? Crude as the general standards of building, home eco-
nomies and hygiene still are, the comparison must first be
with what they have grown out of, not what they have
yet reached," 80; such were the comments made by Miss Cul-
wick. The economic process and the change in the mode of
life have no doubt created social problems; however, to see
the scheme in its true perspective and to appreciate the
extent of the problems created by this large-scale agri-
cultural development one must not lose sight of the past.
The concession companies were primarily responsible to
their shareholders but their prime duty was to grow cotton
for profit and they had no obligation to provide solutions
for the problems arising in a developing society in terms

79. (cont’d.) for wheat have increased from 10 in 1965
to 46 in the 1967/68 season. Lack of warehousing,
non-availability of market information, etc., were
among the factors that have been affecting the pro-
gress of these societies. It is worth mentioning
that in 1969 the fourth co-operative conference held
in Khartoum discussed the need for co-operative re-
search and Education Institute to be carried out in
the Gezira in 1970 for the good training of the Gezira
tenant farmer and the creation of efficient, well in-
formed co-operative managers.

80. Culwick, G.M., "Social Change in the Gezira Scheme,"
of the required range of social development services for
which there was an obvious need. The irrigation scheme
added considerably to the problem of social health. The
mosquito control and malaria prevention services had been
widely extended in the past by the central government and
other voluntary organisations yet bilharzia which was un-
known before had now become a serious menace, the control
of which has proved to be difficult and costly. A large
and expensive programme has been in progress since national-
isation for improved water supplies to settlements by
the installation of deep-bore wells and anti-bilharzia
water filters alongside canals. Difficulty in obtaining
wood for domestic use and building purposes as a result of
the removal of trees for cultivation purposes, and as a cot-
ton disease control measure, called for adequate research
to provide an alternative solution. In collaboration with
the Forestry Department the Sudan Gezira Board started a
programme in 1951 to plant eucalyptus forests within the
irrigated area, excluded from the rotation, in an attempt
to meet the local demand. At the same time, horticultural
nurseries were established in view of the deficient diet of
the inhabitants.

It is quite noticeable, when compared to localities
outside the irrigated area, that constructive, official
efforts have since then been carried out to improve the
standard of living. The increase in cash resources is
clearly reflected in improved housing, better home equipment,
great improvement in diet, clothing, health, education and
consequently a whole chain of occupations, trades and other services has naturally been developing to meet peoples' demands. It could be argued that the standard of living has obviously changed more than the style of living. However, it is to be expected that there are certainly differences of response to changing economic conditions and new development opportunities.

Politically, the Gesira Tenant Union as a result of the emerging tenant middle class element with a considerable voice in local affairs, the recent constitutional changes enforced by the expansion of press, radio and adult education campaigns have led to a considerable general awareness of the individuals who rightfully believe that they contribute substantially to the national welfare. This has accelerated further demand for social services and the Social Development Department of the scheme and the local authorities are alive to these needs, although they are finding it rather difficult to meet them in view of their financial commitments and long term obligations as regards expansion. Generally, the Social Development Department of the scheme is responsible

81. When devolution was first introduced in 1940 there was what was called Native Administration and devolution thus meant the training of the local people to run their agricultural affairs through what was called the village 'Khat'. Later Omodie councils. In 1952 it was found desirable to re-adjust the boundaries of Omodie to conform to the boundaries of the scheme's agricultural group units. The Gesira Tenants' Union dates back to 1947 and was called the 'tenant representative body', the constitution of which was passed by the Council of Ministers in 1954 with the principal aim of representing the Gesira tenants and the safeguarding of their interests.
for the preparation of the annual social development pro-
gramme and budgetary estimates, some of which are proposed
by the tenants and local authorities. The budget is first
presented to the Gezira local committee which is an advis-
ory body set up by the Act and presided over by the Chair-
man of the Blue Nile Province Authority, who is an ex-officio
Director of the Board, and is composed of ten to twenty re-
presentatives of the tenants, seven of local government coun-
cils, four from the Ministries of Education, Health, Animal
Resources and Irrigation, two from Departments of Forestry
and Agriculture, two representatives of the Board and two
appointed by the Chairman to represent other interests in
the scheme area. The budget with the recommendation of
the Gezira local committee is then presented to the Sudan
Gezira Board committee for final approval and the execution
is generally undertaken by the Social Development Department
in collaboration with the local government authorities.

This system, although limited, appears reasonable enough
under the present circumstances where no planning mechanism
is entrusted with the preparation and implementation of a
comprehensive plan for the future allocation and quantitative
evaluation of these demands.

The actual distribution of wealth in the Gezira scheme
and the financial position and commitments of tenants are
not yet quite known. In the economic literature per

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82. The results of the Tenant Farming Survey which was
carried out by the Department of Rural Economy, Uni-
versity of Khartoum in 1963-66 with the aid of govern-
ment and a grant from the Ford Foundation has not yet/...
capita income \textsuperscript{83} is extensively used as an index or criterion of development since it represents the average potential of the people to purchase commodities and services, which are the components of level of living \textsuperscript{84}. According to McLaughlin "... in 1956 the Gezira contained 7.1% of the nation's population. The average per capita income was approximately £1.71. This was the second highest of any of the Sudan's economic regions: the only higher being the 'Three Towns' urban complex (Khartoum, Khartoum North and Omdurman), with £6.110. This must be again compared with the national average figure of £1.28 per capita in 1956." \textsuperscript{85} This of course does not disclose much of the development potential and the socio-economic structure of the scheme at present. However, there are still several problems for short- or long-term investigation in this large agricultural enterprise, but the dilemma remains in the possible conflict of both collectivism and individualism in the field of production and it is difficult to foretell into what pattern the Gezira scheme will finally settle.

\textsuperscript{82} (contd.) been released by Mr. D.J. Shaw, former lecturer, Faculty of Economics and presently on the staff of the World Food Programme, who was entrusted with the final presentation of the report.


\textsuperscript{84} For criticism of per capita income measure, see: Frankel, S.H., "Economic Impact of Underdeveloped Societies," in Essays in International Investment and Social Change, Blackwell, Oxford; 1953.

2.6.2.2 Technical and Physical Factors:

Considering the crop rotational system which is due to the rational watering regime and the soil fertility researches it was felt necessary for supervisory purposes to group the season’s crop in large units of 20 feddans referred to as ‘numbers’. The tenant generally cultivates four 10 feddan plots which may or may not lie alongside one another in adjacent numbers. This system of rotation takes him on to other tenants’ land and brings other tenants on to his. Moreover not only his cotton moves within these four plots but also his grain and vegetable crops alternate between his land and that of his neighbor in an eight-course rotation. This, however, illustrates that the entire tenant is not farming a compact holding of, say, 40 or 15 feddans but a number of productive units which may be fairly widely separated.

With all the technical advantages of such a rotational system there is great controversy as regards the psychological implications and the emotional attachment of the tenant to the land by virtue of ownership. Also, it was argued that such a system of land tenure created a situation in which the scheme failed to produce "... a set of sturdy peasant farmers with a thorough understanding of good farming practice and balanced husbandry." These matters would have to be substantiated by adequate research and evaluated in terms of the optimum size of holdings, the

benefits and returns from smaller production units, their physical location and possible future adjustment for more efficient production in the light of the policy of intensification and diversification.

It should be noted that the recent modifications of the cropping system have thrown an additional burden on the tenant and his labour resources and added considerably to the complexity of the existing structure of agricultural management. It is fortunate that the Sudan Gezira Board has not lost sight of the long-term implications of the changes of production pattern within the scheme which in recent years have increased the pressure towards partial mechanisation of production.

It is noteworthy that the flat terrain coupled with standardised field layouts in the Gezira plain, and the increasing importance of timing agricultural operations make it an almost ideal area for the operation of modern agricultural machinery. Conversely, however, observations of the world market show that the prices of agricultural goods tend to decrease and the prices of manufactured goods, machinery and equipment tend to increase. Consequently foreign trade possibilities for underdeveloped countries generally become more and more difficult due to the unfavourable terms of trade. At present the economic life of the scheme is still heavily dependent on frequent and substantial changes in external market prices of cotton, especially now that synthetic fibres are becoming more and
more popular.

Some physical and climatic characteristics in the Gezira plain have necessitated the introduction of machinery for some agricultural operations. Since the inception of the irrigation scheme the clay soils of the Gezira were known to be too hard to cultivate by hand or animal plough for most of the year. More experimental and development work has been carried out to find a suitable implement for basic operations of cotton like tillage of land and ridging up so as to facilitate crop alignment and irrigation and also to reduce the risk of waterlogging during the early stages of growth. Local flooding due to intensive rainfall, has been a feature in the scheme specially in the Gezira Plain because of the topographic disadvantages in certain cultivated areas and poor drainage systems which affected a considerable number of settlements. This, however, necessitated the introduction of a number of trailer mounted pumping sets which were allocated, prior to the rainy season, to those areas known from experience to be liable to flooding and waterlogging.

There are basic operations over the whole scheme in preparing the land for cotton cultivation which are undertaken by the Gezira Board's mechanical engineering department. These are laid down by the Agricultural Department,

87. "In 1957/58 30% to 40% of the world production of extra long staple cotton came from Sudan. 50% from Egypt, 7% from Peru, 4% to 5% from U.S.A." The Gezira from Within, op.cit. p.27.
88. For further reading on the history of mechanisation/...
covering the operations of dry ridging, deep blade work, ditch digging and flood water removal, which is carried out by a mixed fleet of 140 wheeled and 45 crawler tractors. The seasonal operations entrusted to tenants, i.e., weed control through split ridging prior to planting and re-making the ridges after the rainy season, have led to the emergence of a large number of small private contractors who operate from village bases and own between them some 700-800 tractors. This, however, has been encouraged because of the important seasonal nature of the work which should be completed in a limited period, usually three weeks for each activity. Other technical operations proved indispensable for maintaining a high standard of cotton production, i.e., pest and disease control by aerial spraying techniques which took over the ground spraying operations in 1960, run by contractors whose task is to provide the aircraft and operating staff, leaving the supply of chemicals and direction of the whole operation in the hands of the Board. Very recently an attempt was made to introduce a multi-purpose agricultural machinery co-operative in one agricultural block (selemi) to improve yields through timeliness of operations and reduce costs of production. Moreover, in view of the rapidly expanding wheat crop and the short period of wheat harvest mechanical harvesting was brought into existence in 1964 and up till 1969 there were 46 combined harvesters co-operatives, having day-to-day

servicing and seasonal overhauls in the hands of distributors and board staff. Many other operations, currently done by local or casual labour, were recommended for mechanisation by the Research Corporation, e.g. pulling out of cotton seed, spreading of fertilisers, planting, threshing of corn and groundnuts and mechanical and chemical weed eradication.\(^9\)

These recent recommendations to raise the standard of cotton production can only be implemented efficiently through the introduction of mechanisation. This attitude, however, has been encouraged by the shortage of casual labour and the declining contribution of the tenants' family and the gradual changes in outlook whereby many tenants appear to be increasingly prepared to pay for machines to carry out the arduous tasks. Nevertheless, reluctance to undertake particular field operations or shortage of seasonal labour, etc., are often the cause of inappropriate utilisation of human resources which is a general social characteristic of most underdeveloped countries. This, however, is an indirect result of the high rate of illiteracy as a result of deficient educational facilities. Conversely, the future role of agricultural mechanisation in the Giza scheme, in view of its present formative stage and its conflicting objectives in relation to the national welfare.

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\(^9\) Several other operations have been or are currently being mechanised, e.g., the cleaning out and maintenance of semi-permanent irrigation channels, (Abu XX) using heavy crawler tractors.
must be carefully specified and cautiously guided, otherwise the solutions of the problems may become more difficult since the wrong decisions could cause irrecoverable loss of resources and consequently further conflict, should agriculture become merely a business as opposed to a way of life.

Agriculture is, and will continue to be, the principal use of land over most of the rural acreage in the Gezira plain. Therefore, the irrigation scheme is essential to the nation’s economic progress and certainly offers favourable conditions for the development of processing industries. The authorities would be well advised to give priority to those industries which use agricultural and animal products for their raw materials, e.g., textile industries, flour milling, oil crushing, dairy products and perhaps some leatherwork as well as the utilisation of cotton stalks, which offer possibilities for the manufacture of sacks, paper, fuel and other building materials which remain to be investigated.

At present, there are only ten ginning factories, owned by the Sudan Gezira Board, located in two main centres, namely Hassa-Heisa and Meringan, which work for six months.

90. There is also proposed a ginning factory at Massid in Northern Gezira. However, the process of ginning is the separation of lint from the seeds and the packing and pressing of the lint into bales of average weight 420 lbs., wrapped in sacking and tied with metal bands. The seeds are then cleaned, packed and dispatched to Port Sudan and the buyers in Khartoum. There are now 960 gins in all factories, working 24 hours a day during the season, employing approximately 8,000 men.
Industrial area. As far as dairy products are concerned, there are no more than experimental attempts carried out since 1951 at Bad El-Bahein. However, the social development department is extending help and advice to encourage tenants to take interest in this sector which is equally important to introduce new economic and social forces into the operations which will facilitate increases in total welfare. Most of the above mentioned industrial activities are carried out in isolated places or small settlements, except for commercial, religious and administrative role in the plain.

Subsequent developments of the scheme have encouraged the growth of a substantial network of narrow gauge railway which operates from January to July collecting cotton.

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91 Commonly referred to as the Gezira Light Railway. Its history is concomitant with the history of the Gezira scheme. It was first built in 1919 for transporting building materials for houses in the field; however, not until 1926 did it begin to function as a substantial means of transport for cotton, with its headquarters at Wed Li-Shafie, about 10 miles west of Barakat.

from the various local collecting stations where the picked cotton is brought either by private-owned lorries or on canals to be taken to the ginning factories. This network has the potential to be an effective means of transport within the scheme all the year round, apart from its present secondary seasonal function of transporting cotton seeds, fertilizers, insecticides, building materials and fodder, etc., which mainly concern cotton production. Also Sudan's main railway line running alongside the Western bank of the Blue Nile on the Eastern side of the scheme is heavily used for transporting cotton and other crops to the capital city and from there to Port Sudan for export.

Earthen roads alongside canals are dominant features of the landscape. During the rainy season when the majority are quite unusable for motor vehicles, raised earthen roads alongside the main canals provide limited accessibility to certain areas. The recently completed highway running alongside the Eastern bank of the Blue Nile, joining Khartoum, the capital, with El Obeid, the provincial centre, is speeding up communication and will possibly have an impact on the growth and function of some of the settlements in the scheme, in particular those through which it passes.

92. These raised earthen roads, although very limited, are designed mainly for the official use during the rainy season. The Sudan Gezira Board employees, just over 10,000 persons, of whom 1,300 are classified officials, and use approximately 200 motor vehicles for the various administrative purposes.
Generally, problems pertaining to the low level of industrialization in under-developed countries may not only be explained by the scarcity of capital, lack of skilled labor, but also by the resultant inadequacy of the basic infrastructure in terms of transportation systems and communication facilities. Conversely, insufficiency, or mis-management, of major industrial inputs such as energy and water hampers the development of this sector. Moreover, the slow growth of a social sense of responsibility, the introverted attitude of the individuals who may be able to invest in this sector manifest itself in such fields of expenditure as luxury items, cars, etc., which of course does not induce development. These shortcomings coupled with insufficiency of demand as a result of low-level of income and education set further limitations upon the development of non-agricultural activities. This requires considerable attention and effort should the contribution of the industrial sector in manufactured consumer goods be encouraged as opposed to external imports of such basic items.

2.7 The concept of design

It is quite noticeable in most of the literature related to this national asset that scholars have generally used the term 'Gezira' as a common denominator, i.e., 'the Gezira', 'the Gezira scheme', 'the Gezira irrigated area', 'the Gezira canalization scheme', 'the Gezira and Managil
Extension’, etc., but nothing so lucid as ‘the Gezira region’. This, however, may illustrate the definitional problem of the true region in itself.

Planners, ecologists, geographers, politicians, demographers and other social scientists, in the course of their investigation and for the purpose of their analysis developed several criteria to define a region and seem to have agreed on one single aspect, that it only refers to geographical area or space. Considering that ‘... the physical space, if it is interpreted separately from the cultural values attached to it, has no meaning for social interaction’ it is clear that natural and physical characteristics of space can hardly be divorced from the functional relationships of the social, cultural and economic activities of the people within the space. However, for definitional purposes it should be noted that there should always be a factor which should be strong enough to distinguish a particular space within the totality of space and there should always be a dimension to consider in relation to space, since the dimensions of space or region are liable to change.

Homogeneous\(^4\) or formal regions, functional\(^5\) regions,

94. A homogeneous region is defined by Sorry, C., as “an area whose physical conditions are homogeneous.” The geographical factors which are considered in this definition may vary from the natural physical characteristics of the land, the climatic conditions to the general aspect of the landscape. See /.../ (and ref. 93).
and political regions are among the various definitions to illustrate the different considerations as related to the natural characteristics, demographic features, economic and social interactions and administrative organisations of a particular society occurring within. Considering the process of planning which would involve the combined consideration and co-ordination of these criteria it may be argued that, individually, these definitions are not of complete satisfaction in view of their limited specialised nature which may not be adequate for practical planning purposes. However in terms of size and scale as related to development purposes, Mr. Feitz, E., offers some detailed definitions of the character, scope and functions of the development region that it ... covers the area in which the effects of a certain development process are felt and, within certain goals, can best be achieved and their implementation best planned. This, although rather broad, emphasizes the flexible attitude towards the general issue of


95. In general, a 'functional region' consists of one central area, the node and around it a number of small areas whose economic and social life is related to the centre, although they may be internally independent. See: Faulkner, J.F., "A Survey of Recent Techniques for Regional Economic Analysis," in Regional Economic Planning, ed. Inard, J., and Cumberlend C.E.C.U., 1961. P.397.