Commercial cotton growing in the Sudan between 1860 and 1925: a study in historical geography

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COMMERCIAL COTTON GROWING IN THE SUDAN BETWEEN 1860 AND 1925

A STUDY IN HISTORICAL GEOGRAPHY

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ABSTRACT

Commercial cotton production was introduced into the Sudan on two distinct and separate occasions, by the Turks in the 1860's and by the British in the 1900's. The earlier venture, however, was a total failure while the second was a success. This thesis examines the factors underlying failure and success using the records left by travellers, administrators and agriculturalists to discuss and evaluate man's changing attitude to the agricultural resources of the Sudan between the years 1860 and 1925. The thesis, a contribution to the historical geography of an African underdeveloped country in the colonial period, stresses the importance in development schemes of two factors, first, the need for careful, soundly conceived and sympathetic pilot studies prior to the main scheme, drawing as much as possible on indigenous farming practice, and second, the need for a clear view of the ultimate aims of large scale developments as an essential preliminary to the isolation of salient issues and the implementation of a consistent policy. In retrospect it can be seen that the Gezira Scheme proper has been a great success and this study focusses upon the vital antecedents that made it a success.

PREFACE

Wild cotton is indigenous to the Sudan and has been gathered from earliest times. Nevertheless, the careful cultivation of cotton for commercial purposes is of relatively recent introduction, and may be viewed as the end product of two separate and distinct attempts to stimulate production. This thesis is concerned with these ventures. The first, made during the Turkish rule between 1821-1882, was a total failure while that of the British, between 1900-1925, has been an unqualified success. We have here a contrast, a contrast between success and failure, although in each case indigenous physical and cultural factors were relatively constant and there was in each period an active external demand stimulated by expanding markets. The fundamental cause of success or failure lay in the attitude of the governing powers to the practical problems of cotton production as well as in the differences in their concepts of what government implied. When discussing causation, two factors are stressed as being important; firstly, the need for a thorough preliminary exploration by means of pilot schemes and for a planned system of land-use based on scientific experiment and practical experience, and protected by an agreement which would engender close contact and mutual trust between administrators and peasants. Secondly, that social principles must also be formulated to ensure an equitable distribution of the benefits of the scheme and to avoid any sort of expropriation of land that might alienate the peasant. Furthermore, it will be emphasised that an adequate and sustained supply of irrigation water is essential to the success or failure of such a venture within the climatic regime found within the Sudan.

However, it must be emphasised that the thesis is not an attempt to discuss all issues involved in large irrigation projects (see R.J. Harrison Church, "Observations on Large Scale Irrigation Development in Africa" UN, ECA-FAO Joint Agriculture Division, Agricultural Economics Bulletin for Africa, No. 4 (Addis Ababa, Nov. 1963).), rather it is concerned with understanding the reasons for failure in one context and success in another, and to show how the choice of issues depended in each case on the initial aims these ventures intended to accomplish.

This thesis is presented not as a study in economic history; it is a study in historical geography. Historical geography has yet to be developed as a study throughout most of the African continent. What follows, i.e. the thesis, is offered as a contribution to the historical geography of two colonial episodes in the Sudan; a study of the way in which travellers, administrators and engineers, gradually paved the way for 'modern' agricultural development in the sense of a carefully planned project dependent on parallel studies by specialist disciplines. This, and it must also be stressed, is not a study in agricultural development in the usual sense of the word. Rather, it is an appraisal of the historical geography of two similar agricultural development schemes undertaken for similar purposes; an attempt to assemble and document between two cases the process of trial and error through which the land of the Sudan was evaluated by successive rulers with an interest in development. This theme raises problems concerning approaches and source materials.

Approaches and Source Materials:

The thesis is divided into two parts: Part One gives details of the historical and physical background to cotton growing in the Sudan as well as a discussion on the problems of agricultural development in general and in the Sudan. Part Two is concerned with the historical geography of the development of commercial cotton growing during the period from 1860-1925.

Since the Sudan has a long history in cotton growing it is considered that historical background can shed useful light on the processes of change from the traditional farming pattern without necessarily providing solutions for the various problems involved. A thorough understanding of the traditional background is a necessary preliminary to agricultural development. Physical factors, on the other hand, provide both opportunities and obstacles to agricultural progress since terrain, climate, water supplies and soils often help determine the scale and layout of agricultural projects. Moreover, an examination of the regional economy of the Gezira and the traditional farming system before the scheme sheds light on the needs and opportunities which encouraged or permitted the emergence of such development schemes, and illuminates the difficulties of evolving ways to remove the peasant from the confining surroundings of traditional subsistence cultivation to learn new skills and techniques of farming in a controlled form of land-use pattern. Furthermore, a broad assessment of factors basic to agricultural development seems important, but it must be pointed out that problems considered here necessarily represent only a small fraction of the range of agricultural development problems, since many of these are beyond the experience of the historical cases considered in Sudanese environment.

With regards to the problems of reconstruction, they vary according to each period. With studies of this nature, the nineteenth century poses certain difficulties:

(1) During this period, the Sudan never enjoyed autonomy; administrative continuity was always at the mercy of viceroys in Cairo and 'personal initiative' played a large role in getting things done.

(2) Statistical infomation is on the whole meagre and unreliable. For example, figures for export cotton, either through Suakin or the Nile routes, are almost lacking, and those available show great contradictions, and are irregular in incidence according to the individuals. Moreover, the various and variable weights, measures and currencies, used by the various sources make it exceedingly difficult to derive from them reliable statistical information.

(3) In the field of agriculture, there is lack of information about exact acreages and yields except for one or two years, and there is great variation in the figures quoted for land-tax revenues. A list of arable land and areas actually cultivated compiled by the government in 1872-3, for instance, gives grossly exaggerated figures that make the delimitation of such areas and their exact location quite difficult.

(4) Documentation for the Turkish period in the Sudan is very poor, and there is even less information concerning agriculture and trade in the Mahdist period (1883-98), and whatever information is available is frequently not of much use to the geographer.

With British rule came western fiscal procedures which make investigation much easier. There are acts regulating almost all aspects of economic life and, moreover, the business nature of the schemes and the inclusion of private enterprise in them from the start, helped a great deal in the proper documentation of this period (1900-1925). However, although some valuable files and documents of the Sudan Plantations Syndicate were lost when their head office in London was bombed during the last war, there are still considerable numbers of files preserved in the Sudan and the School of Oriental Studies, Durham. The official reports of the government departments concerned, and the relevant sections of the annual reports on the financial, economic and administrative conditions of the Sudan during this period submitted first by the High Commissioner in Egypt and later by the Governors-general of the Sudan to the Foreign Office, comprise important sources of documents.

Accordingly, four categories of source materials have been used in this study, all of which consist of written records:

(1) Primary Documentary Sources: these include records of Parliament, such as British Parliamentary Papers and Blue Books, official correspondence and reports of bodies like the Sudan Plantations Syndicate, the British Cotton Growing Association, the Board of Trade and the Turkish viceregal council in Cairo, together with individual reports and personal papers concerning the economic and agricultural conditions in the country from 1860-1925.

(2) Travellers' Accounts: these comprise the descriptive works of travellers who visited the Sudan during the nineteenth century and commented on the various aspects of life there during the time of their visit.

(3) General History and Geography Books, which often form useful synthesis of material are no longer always accessible.

(4) Accounts and Articles: particularly those dealing with all aspects of cotton growing in the Sudan and elsewhere and published in Empire Cotton Growing Review, and other related journals listed in the bibliography.

The reliability of these sources varies considerably. The documentary sources for the period 1900-1925 are more concise and reflect the scientific spirit of the period, while those of the nineteenth century tend to exaggerate and generally show a casual or overoptimistic approach in the evaluation of the resources of the country. The travellers' accounts, on the other hand, pose certain problems. Firstly, these accounts are seldom impartial, and writers range from avowedly pro-Turkish, like von Puckler-Muskau, to those who vilify anything that bears the imprint of Turks, like M. Cadalvene, with others of varying degrees of partiality in between. Secondly, the importance of such accounts depends on the part of the country visited, the period of visit, and the aim of the writer. The parts of the country visited by many travellers are seldom different, and since many of these visits occurred within a short span, information tends to be repetitive. Many books concentrate on aspects such as archaeology and social matters. Thirdly, individual reports, accounts and also history books for the period 1885-1898 are often prejudiced and many can be regarded as 'war propaganda' designed to encourage British Government to undertake military action to 'free' the Sudan from the Dervish rule. Indeed, it is in the economic field, taxation and general agricultural conditions in the country that writers differ widely in their assessments, and these factors entail a very cautious approach in any objective assessment of the writings of these travellers.

Thus, while Part Two of the thesis is based on materials mainly obtained from primary sources, Part One of it, because of its nature, derives most of its material from printed secondary sources, and as such necessarily incorporates a lot of post-1925 information, most of which was the result of research carried out under the British rule.

The only book that deals with the pre-1925 period of cotton growing in the Sudan is Arthur Gaitskell's Gezira: A Story of Development in the Sudan (London, 1959), and as the name suggests, the bulk of the book is devoted to the Gezira Scheme proper (1925-50). Only a small section of the volume is devoted to the problems which constitute the theme of this thesis. The discussion which follows is not directly concerned with the Gezira Scheme; it concentrates on the pilot schemes of the Gezira Project.

On the other hand, it must be noted, there has been no systematic study of economic conditions in the Sudan in the nineteenth century apart from the author's unpublished M.A. thesis listed in the bibliography, and the work of the present thesis should be regarded as complementary to this earlier work.

The approach in this study is essentially chronological since it is believed that this method can offer a better way of comparing the various approaches adopted by the Turkish and British governments in their attempts to develop the agricultural possibilities of the Sudan. However, a rigid adherence to a chronological sequence of events has been subordinated to the main theme of this study, namely, the systematic appraisal of the factors influencing the historical geography of the development of commercial cotton growing in the Sudan between 1860-1925.

Maps, unless the source is shown, have been compiled by the author from information obtained from the sources given below each map. Such maps are initialled thus H.A.A.

ACKNOWLEDGEMENT

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CONVERSION TABLES

TABLE A. EGYPTIAN MONEY AND ITS EQUIVALENT IN ENGLISH CURRENCY (UNTIL 1925)

UNITS	Egyptian Currency				English Currency		
	£E.	P.T.	Para	mms.	£.	s.	d.
One Piastre (P.T)	1/100	1	40	10	0	0	2½
One Para	-	1/40	1		Negligible		
100 P.T.	£E.1	100		1,000	1	0	6
1 Dollar		20			0	4	2
½ Dollar		10			0	2	1
5 P.T.		5			0	1	0½
1 Turkish Dollar		36			0	4	0
½ Turkish Dollar		18			0	2	0
1 Egyptian Dollar		40			0	4	0
½ Egyptian Dollar		20			0	2	0
1 Egyptian Shilling		10			0	1	0

Units:

Paras	=	Replaced by milliemes in the monetary reform of 1885
Milliemes (mms)	=	
Piastres (P.T.)	=	10 mms.
Pound (£E.)	=	1,000 mms.

Rates of Exchange

£1 Sterling	=	97.5 P.T.	=	975 mms.
1 Shilling	=	48.75 mms.		
1 Penny	=	4.0625 mms.		
£E1.000	=	1,000 mms		

Weights and Measures

The values of weights and measures differ according to locality and type of the commodity or items to be weighed or measured.

(i) Ardeb (admitted in English with plural 's'): a measure of capacity used for grains and seeds.

One Ardeb = 560 rotles in the Gezira.

Elsewhere in the Sudan:

1 ardeb of dura weighs 336 rotles

1 ardeb of dukhn weighs 360 rotles

1 ardeb of Serame weighs 264 rotles

(ii) Rotle (admitted into English with plural 's')

113 rotles = 112 lb.

100 rotles = 99.05lb. = 44.94 kg.

(iii) Kantar (admitted into English with plural 's')

1 kantar of unginned Cotton	= 315 rotles
	= 312.01 lb.
1 kantar of ginned Cotton	= 100 lb.
1 ordinary kantar	= 100 lb.
1 Alexandria kantar	= 308.153 lb.

(iv) One Ton of Water = 224 gallons

= 1 M^3 approx.

WEIGHTS AND MEASURES

TABLE B SUDANESE WEIGHTS AND MEASURES AND THEIR EQUIVALENT IN BRITISH AND METRIC SYSTEMS

Unit	British Sytem		Metric System	
Kantar (W)(Alexandria)	308.153	lb.	139.776	kg.
Ardeb (C)	5.445	bushels	1.98 198	hl. litres
Diraa (L)	22.83	inches	58	cms.
Dirhem (W)	48.15	gn.	3.12	grames
Feddan (A)	1.038	acres	0.42008	ha.
Kantar (W)	99.05	lb.	44.93	kg.
Keila (C)	3.63	gallons	16.5	litres
Midd (C)	3.63	quarts	4.125	1
Oke (W)	2.75	lb.	1.248	kg.
Rotle (W)	0.99	lb.	449	grames
Ud (L)	2.537	yards	2.32	metres

C = Capacity   hl = hectolitre
W = Weight   ha = hectare
L = Length
A = Area

1 hectolitre = 2,74969 bushels
1 bushel = 0.352383 hl
1 lb = 0.4535923 kg.
1 kg. = 2.204623 lb.

ABBREVIATIONS

Agr.	Agriculture
Ass.	Association
B.C.G.A.	British Cotton Growing Association
Bull.	Bulletin
Congr.	Congress
E.C.G.A.	Empire Cotton Growing Association
E.C.G.R.	Empire Cotton Growing Review (Changed to Cotton Growing Review from 19)
E.J. Exp.Agr.	Empire Journal of Experimental Agriculture
Ent.	Entomology or Entomological
Ed.	Editor or Edition
F.O.	Foreign Office
G.B.	Gezira Board
G.J.	Geographical Journal
G.R.	Geographical Review
Geogr.	Geographical
Geolog.	Geological
Inter.	International
J.	Journal
J. Soil Sci.	Journal of Soil Science
L.B.	Letter Book
Labs.	Laboratories
M.S.	Maiya Seniya, the Egyptian vali's Cabinet Secretariat
Mag.	Magazine
O.U.P.	Oxford University Press
P.R.O.	Public Record Office
P.P.	Parliamentary Papers
Proc.	Proceedings
R.T.D.	Recuoil de Tous les documents officiels du Gouvernement Egyptien
R. or Roy.	Royal
Res.	Research
Rec.	Record or Recorder

S.N.R.	Sudan Notes and Records
S.P.S.	Sudan Plantations Syndicate
Sc.	Science
Soc.	Society
S.G.	Sudan Government
Text.	Textile
Trans.	Transactions
Trop.	Tropical

P A R T   O N E

HISTORICAL AND PHYSICAL BACKGROUND
TO COTTON GROWING IN THE SUDAN

CHAPTER ONE

COTTON GROWING IN THE SUDAN: THE HISTORICAL AND PHYSICAL PERSPECTIVE

The genus Gossypium is divided into two basic groups: species which bear long, fluffy and spinnable lint, i.e. linted cottons, and those which occur as wild shrubs and bear a short fuzz of seed hairs, i.e. lintless cottons.[1] The linted species constitute what are known as true cottons, and are in general cultivated, or in some cases secondarily wild, and it is the convoluted hairs this species produce that form the cotton lint of commerce today. Thus, here and throughout the thesis, the term 'cotton', unless otherwise indicated, will be used to denote the linted species of Gossypium.

It has been argued that cotton was developed in domestication to meet man's need for a textile raw material adapted to growth and use in the tropics.[2] The centres of origin are thought to be the Indus valley in the Indian peninsula, and from there it is believed to have spread via the Indian Ocean trade routes eastwards towards Arabia and East African coast. Evidently its spread in Africa in the last few centuries has been governed by the same interdependence between man and his crop plants that first brought it into existence. Races of cotton that were brought in early and abandoned in favour of later, more profitable, introductions still persist as insignificant occupants of house yards and clearings in West Africa.[3] Those that suit him best have been spread over wide areas, and under the selective forces, natural and human, that operate in these new areas, they have evolved distinct, locally adapted forms. This development has indeed proceeded so fast that the Egyptian cottons, for example, which are the most advanced, may justifiably be described as native in Africa, though the species to which they belong was, as we shall see later, introduced from America in recent times. The Nile valley, however, is believed to have been the first place in Africa where cotton was used in textile works, and from here this particular type of cotton (G. arboreum race soudanense) is presumed to have spread across the savanna zone to West Africa. The Kingdom of Meroe, which flourished along the Nile valley in Northern Sudan, is this particular place.

I. HISTORY OF COTTON GROWING IN THE SUDAN

Only during the present century has cotton been successfully produced on a commercial scale in the Sudan, but wild cottons have undoubtedly been known in the country since the classical period, while semi-cultivated types have probably been grown at least since the Meroitic period (c 500 B.C. to c A.D. 500), if not earlier, first by some cultivators to satisfy small domestic needs, and later to become an important item in the Kingdom's trade.(4) There is, however, little information about such cottons and their source of origin, and this information is derived from archaeological finds in a Meroitic cemetery, and also from references by classical writers such as Herodotus and Pliny. From these sources as well as historical evidence of cottons grown in India, Arabia and Africa, the possible source of origin will be tentatively discussed at the end of this section.

In 1910, various cotton fabrics of similar appearances were found at Meroë and Karanog (Fig. 2F) in tombs belonging to the Greco-Roman period.(5) Indeed there is some evidence that the cotton plant was known in what some writers of the period used to designate as "Upper Egypt", i.e. Sudan at a much earlier date, according to De Candolle.(6) This is based on the latter's review of the information respecting some cotton seeds which a certain Rosellini declared he himself found in a case among the ancient Theban tombs (of the New Empire 1580 - 1090 B.C.), and which were later identified by an Italian botanist, called Parlatore, as being obtained from the cotton tree G. Arboreum, Linn. However, these seeds, claimed by Rosellini to have been deposited in Florence Museum, could not be found there in 1908. Thus, because of the absence of archaeological finds of cotton during this period, the lack of any reference to cotton by the classical writers Herodotus, Dioscorides and Theophrastus, who wrote about Egypt, and in the face of negative evidence in general with regard to the cultivation of cotton in Egypt until long after this time, it is possible that the seeds, if authentic, were from a rare, exotic plant deposited in the tomb by reason of the high estimation in which they were held.(7)

The first writer to mention the use of cotton for textiles seems to be Herodotus (450 B.C).(8) Although, in reference to India, he makes special remark that the natives of that country possessed a kind of plant which produced wool in place of fruit, which wool was of a finer and better quality than that of sheep, and from which he says the Indians made their clothing, he does not mention cotton plant as in cultivation in Egypt when he wrote. The reference, in an earlier chapter, to two corselets ".... embroidered with gold and tree wool", sent by King Amasis of Egypt to a Greek ruler about 569 B.C., is nevertheless an indication that the fibre was known in Egypt, and was probably woven in the country from imported raw cotton or yarn. However, according to Sir John Marshall, "The Babylonian and Greek names for cotton (Sindhue and Sindon respectively) have always pointed to the Indus valley as the home of cotton growing,"[9] and Baynes draws the conclusion from the evidence available that "cottons were known rather as a curiosity than a common article of dress in Egypt in the first century of the Christian era",[10] which seems to be about the only safe deduction that can be made unless some positive archaeological evidence is found.

The first good description of the cotton plant is given by Theophratus (c. 350 B.C), thus giving a fair indication of the types of cotton plants grown in India and the Persian Gulf.[11] "This", he writes "has a leaf like the vine, but small, and bears no fruit, but the vessel in which the wool is contained is as large as a spring apple and closed, and when it is ripe, it unfolds and puts forth the wool of which they weave their fabrics."[12] In a further passage, he speaks of the island of Tylos (Bahrein) in the Persian Gulf (Fig. 2D), having an abundant supply of "wool-bearing trees", the product of which was woven into textiles of both small and great value. Moreover, Strabo also referred to the cultivation and manufacture of cotton at the head of the Persian Gulf, but makes no reference to Egypt.[13] Four hundred years after Theophratus Pliny wrote that cotton (carbasa) was, in Tylos, called Gossypines, "... but the trees of Arabia, from which they make their garments, are called Cynna, with a leaf like a palm."[14] Further on in the same chapter, in his description of Ethiopia, Pliny makes a distinct reference to cotton growing within the limits of what is now the Sudán. He writes, "The upper part of Egypt towards Arabia, produces a shrub which some call Gossypion, or more generally Xylon, and the fabrics made of it Xylina. It is a small or low-growing plant, and produces a fruit resembling the bearded nut from the interior of which is taken a wool for weaving. Nothing is comparable to it for whiteness or softness. Garments made from it are worn for preference by the Egyptian priests."[15]

The plant referred to here was, judging by the small size of the boll and the whiteness of the lint, perhaps identical with the perennial plant found in Sennar until very recently, or with one of the other kinds which are recorded from many parts of tropical Africa. However, the information given by Pliny does not allow us to determine to which of these kinds his plant belonged, although the small size of the bolls would indicate the first-named, i.e. Sennar cotton. This species was described by Sir George Watt from a specimen sent to him by L. Balls, and is referred to at first as "Sennar tree cotton" by Watt, and as "one of the tree cottons of Sennar" by Balls.[16] Judging from the large seeds and coarse and rusty fuzz, Watt says that "This proves to be a distinct race, but one which seems to fall most readily under the present variety", that is, G. Arboreum. The species mentioned by Balls above and by Broun as "Sudan Country Cotton", Watt places under the name of Gossypium nanking var. Soudanense, Watt.[17] Prosper Alpinus, who states definitely that the cotton used in Egypt was imported from abroad, also speaks of the existence of a tree cotton there, which was grown only in gardens, and which, from his drawing, was found to be G. arboreum.[18]

Another interesting reference to a later date to cotton in the Sudan is also found in the inscription of the King of Axum, Ezana (c. 350 A.D.). In a successful raid against the Ethiopians (Sudanese), he sacked and destroyed, among other things, "... their granaries and cotton trees and cast them into the river Seda (Nile)."[19] Without doubt the reference here is to Meroe. Moreover, in the Medieval period there is yet another reference to the capture of a large quantity of cotton at Ibrim, in lower Nubia, by a certain brother of Saladin in 1172.[20]

From these last two references, Griffiths concludes that "One must not lose of the possibility that the Red Sea trade, much developed in Roman times, might have introduced cotton from India to the Meroites; but the evidence is now strongly in favour of a Sudanese origin of the cotton used in Egypt in early times."[21] G. Crowfoot also adds, "On the whole it looks as if one might think that the Meroe cotton was grown in this country, and then woven there of course!"[22] Arkell, on the other hand, thinks of the possibility of the cotton, of which the fabrics found at the Meroitic tomb were made, being introduced from India, together with the idea of artificial reservoirs, which became so important in this region at this time for storing rainwater.[23] Reisner, however, is inclined to think that weaving might have been done by Egyptian workers. There is evidence of the cultivation of cotton in the countries having a trade communication with Egypt, such as Sicily, Syria and Sudan, from which it may be assumed that the Egyptian looms were supplied.[24] Thus, one can deduce that Egypt knew weaving long before the plant was cultivated there in the fifteenth century, and possibly could supply workers as suggested by Reisner.

Moreover, the Sudan is also believed to be the original home of the long-staple cotton now grown in Egypt. A Frenchman called Jumel is said to have discovered in 1820 a perennial cotton plant in the garden of Mahu Bey who had been a Turkish governor of Sennar and Dongola and who brought back some cotton seed with him to Cairo.[25] (see also Chapter Four.) Jumel's success, as we shall see later and in Chapter Four, led to the introduction of many other types of cotton for trial in Egypt and nearly all failed except Sea Island which was grown on a small scale for a long time. Being a race of G. barbadense closely related to Jumel's cotton, extensive hybridisation took place, and it was out of the resulting hybrid swarm that the modern annual, high quality Egyptian cottons were selected.[26]

Jumel's cotton was identified as G. vitifolium Counillus, which is a type of G. barbadense.[27] Indeed, there are, as we shall see later, three types of G. barbadense, the important ones being those known formerly as G. vitifolium and G. peruvianum; the third is the kidney cotton, G. barbadense var brasiliense. All three intercourse freely where they meet, but the distinction between the vitifolium and peruvianum has been maintained by a difference in their ecological preferences: the former is the cotton of the forest region, while the latter is that of the orchard bush country. Thus, the vitifolium was known in West Africa where the natives cultivated it as a perennial within the forest limits of Ghana and Nigeria.[28] Speke and Grant found the same species growing at the source of the Nile near the ruins of a deserted village in 1862, and it is believed that this species found its way into America after its discovery from West and Central Africa, but others contend, more correctly, that it was originally "a native of Central and South America to the Amazon Basin, as also of Lesser Antilles, recently distributed under cultivation to the Southern States of the U.S.A., the West Indies and Africa; occasionally met with in Egypt, India, Celebes. Madagascar, Mauritius, etc." (Fig.1)[29]

Thus, to sum up, there were two forms of G. vitifolium: one a native of South America which only occurs in Africa in the form of the recently introduced "Sea Island" or "Long-stapled American", both of which, as stated above, belong to G. barbadense, which is regarded as a development from the South American form of G. vitifolium. The second form, termed "Jumel Cotton" is considered to be the African representative of G. vitifolium and with which the developed American form crossed so easily that it has substantiated its close affinity, and contribution, to the evolution of the highly specialised Egyptian varieties of today.[30] Thus, the evidence in favour of Jumel's African origin seems particularly strong, and from the Nile headwaters in Uganda it was probably introduced into Egypt through the Sudan,[31] where it had been established long before the Turkish conquest in 1820, and from which, and perhaps another stock, the Sudanese wove their clothing.

However, the circumstances under which cotton reached Africa in general are almost unknown, but there is good evidence, as mentioned above, that it was not known in Egypt before about the fifth century B.C. About 500 B.C. - 300 A.D., cotton had become established in the Sudan where cotton trade is said to have been the source of Meroitic wealth. From the Sudan, it is believed to have spread across the open Savanna zone between the Sahara and the forests of Central and West Africa, thus providing new material for weaving crafts among the indigenous folks that persist in many parts to this day. Cottons were also introduced along the coast of East Africa, and spread south as far as Delagoa Bay and across South Africa to Angola.[32] The coastal trade route between Western India, the Persian Gulf, the Red Sea, and the East African coast had been in regular use for so long that it can scarcely be doubted that cotton from India and Persia have been introduced many times and at various intervals into Africa (Fig. 2). However, since the cottons of India and Tylos (Bahrein) were perennials in the fourth century B.C., it may be accepted that the first African types, on which the Meroitic wealth was dependent, were also perennial. There is no reason to doubt that G. herbaceum and G. arboreum (see below) were both introduced at an early date since their perennial representatives in Africa are of what must be regarded as primitive types.[33] But the similarity of the G. arboreum cottons of Madagascar and East African coast to those of Western India (race indicum) indeed leaves no doubt that they were brought from India, probably more recently than the introduction of the soudanense cottons into the Sudan.[34]

The foregoing records supply some evidence for the existence of cotton plant in the Sudan, and some parts of Africa, long before it was known in Egypt. But in view of the confused early history of domesticated cottons in the Sudan, it is essential to summarise briefly the forms and characteristics of Sudanese wild cottons present until very recent times in some places, and which are still found today in some isolated localities.[35]

II WILD SPECIES OF GOSSYPIUM IN THE SUDAN (Fig. 2F)

The wild lintless species of Gossypium are perennial xerophytic shrubs occurring naturally in the arid regions of the tropics and sub-tropics. They are not cottons in the true sense, since none of them have seed hairs which can be spun. They are geographically widely scattered, but the individual species are naturally restricted in distribution, the commonest habitat being the beds and banks of seasonal streams, although some drought-resistant species do well on dry hillsides, or over arid stony or sandy stretches of land. Being essentially plants of open associations they were found to suffer severely from heavy competition under overhead shade as well as in the seedling stage.[38] Thus, a knowledge of the distribution and relationship of the wild species of Gossypium is important both for the interpretation of the evolution of the cultivated cottons, and more so because many of them possess characters of potential economic value. The best known wild species in this respect are those of the New World, among which group G. thurberi and G. armourianum are known to be resistant to certain cotton diseases, such as pink and Egyptian bollworms and leaf curl, and the former carries a factor capable of enhancing the strength of the lint of commercial cottons.[37] Among the wild species of the Old World, G. annomalum is almost immune to blackarm disease, and G. somalense is resistant to pink and Egyptian bollworms.

Wild species have been discovered in all continents of the world which extend into subtropical region, but usually they have more or less distinct distribution which rarely overlaps. But the two species of the Sudan: G. annomalum and G. somalense occupy the same territory over a large part of their range although they differ botanically. The examination of annomalum plants from over wide areas has shown remarkably little variation, except for such minor ones as boll shape and degree of hairiness of the leaves.[38]

Of the two species, G. annomalum seems to be the best known in the Sudan, judging by the various local names given to it. G. somalense has no local names, and until it was found growing to the west of Omdurman in the Sudan, and at Fada in former French Equitorial Africa (Chad now) in 1945, this species was thought to be confined to the former British and Italian Somaliland as far south as Tana river (Fig. 3). However, specimen from the Sudan grown under experimental conditions have proved to be remarkably uniform in character, except for slight variations in height and habit of growth, while the Somali specimen, under similar treatment, showed considerable variations.[38] The Sudanese type, moreover, is a small perennial shrub about 1½ metres high, and is well adapted to wind dispersal, and thus differs in important respects from the only other type of Somalense so far grown experimentally in Kenya, the latter displaying reddish flowers, small bracts and leaves, and no wind dispersal of bolls.[39]

G. annomalum is the only wild special of Gossypium with a continent-wide range (Fig. 2). It is also exceptional in having a discontinuous distribution, but examination of herbarium material reveals no evidence of the establishment of distinct varieties or geographical races. While in the Sudan region it appears the only wild representative of the genus, it appears in the south-west coast and in Somaliland to overlap G. Somalense (Fig. 2).[40]

With regards to the distribution in the Sudan of the two species, annomalum and somalense, they cover, as Fig. 2 shows, a broad belt across the country between the 5 in. and 20 in. isohytes. The northern, more arid, fringe of this belt runs from hill top to hill top across the northern part of Khartoum, Kordofan and Darfur provinces. Southwards, with increasing rainfall, these species are to be found on qoz land (Fig. 3B), and still further south on mature sand plains which lie in a belt across southern Kordofan and Darfur extending into Equatorial province, and this has been attributed to the effect of grass fires.[41] The four typical sites where these species were found are: Gebel Merkhayat and Gebel Katul and Fertangul for G. annomalum, and Gebel Abu Asal, also Merkhayat and Katul for G. somalense (Fig. 2).

However, although the characters of some wild species and their distribution could be of historic and economic importance, the fact remains that some of the best known commercial types, such as the Egyptian cottons, have evolved from wild and semi-cultivated species by both natural and artificial processes. The result of this cross-breeding has been the appearance of the wide range of varieties into which cotton crops of the world are classified. The classification may either be scientific or economic, and thus we find classifications according to staple length, genetical and botanical characteristics and each of these poses its own problems, especially the former. Now, we can turn to this aspect of cotton.

III CLASSIFICATION OF COTTON ACCORDING TO STAPLE-LENGTH

The history of the cotton trade contains many records of substituting one variety for another in response to the changing conditions both of supply and demand. Thus, at the beginning of the nineteenth century, the new American cotton was rapidly driving out the older varieties from the West Indies, Central America and Brazil, as well as from the Levant and India - varieties which had formerly supplied the bulk of raw material for the rising Lancashire cotton industry. During the American Civil War (1862-64), however, the American crop suffered an eclipse, as a result of which Egyptian cotton acquired a footing in Lancashire, as we shall see in Chapter Four, which proved to be permanent. Since the beginning of the present century, the major part of the Sea Island supply from the Atlantic States of the U.S.A. was lost, and its place has been taken by the Egyptian Sakellarides (Sakel).[42]

Substitution indeed is primarily a question of price, or rather of obtaining the best value for the money, and as the spinning value of any cotton depends mainly on its staple length, a classification according to staple length is adopted by many authorities.[43] However, since the disappearance of the American Sea Island cotton, and the change in the Egyptian crop through the advent of Sakel, all the long-staples, including the Egyptian and Sea Islands, were grouped together under the grade "Fine", and others under "Medium", and "Short" staple cottons. But this classification has had to be modified because the Egyptian crop, for example, is now sharply divided between Sakel and Uppers, each with different markets. At the same time, owing to the deterioration of the American crop, quite substantial part of it is now very little better than some of the Indian crop. On the other hand, the development of longer-stapled varieties in India has raised a material portion of that crop sufficiently to make it comparable with the American. With all these in consideration, Todd adopted the following method (Table 1).

Thus, to draw the line between the different staple groups, Todd has chosen "Above $1^{3}/8$ in." as the definition for the best group so as to include only Sea Island and the best Egyptian varieties. The second group, $1^{1}/8$ - $1^{3}/8$ in., consists largely of Egyptian Uppers, with other varieties which definitely compete with it, while the third group, $^{7}/8$ - $1^{1}/8$ in.

TABLE 1 CLASSIFICATION OF THE WORLD'S COTTON CROPS (STAPLE-LENGTH)

Group and Staple Length			Variety
I	-	Above $1^3/8$ inches	Sea Island, Egyptian Sakel, Pima
II	-	$1^1/8$ inches to $1^3/8$ inches	Egyptian Uppers, Brazilian, Peruvian, Staple American
III	-	$^7/8$ inches to $1^1/8$ inches	American, Indian I/S
IV	-	Under $^7/8$ inches	American, Indian

Source: J.A. Todd, op. cit., p. 48

is still the largest, but it now includes a much larger number of different crops, many of which have to be divided between this group and the one above or below it. Finally, the fourth group, under $^7/8$ in., now includes part of the American crop as well as the bulk of the Indian crop and most of the other Asiatic varieties.

However, in making classification by staple, it should be remembered that the official description of the staple length does not always correspond with ordinary trade evaluation, particularly in the case of the official standard for the American crop which is more exacting in measurement of staple length than the trade descriptions in Liverpool. Thus, staple Upland cotton which in America would be described as at least $1^1/8$ in., would probably pass muster in Liverpool as at least $1^3/8$ in.(44)

IV DISTRIBUTION OF COTTON SPECIES IN THE WORLD (WITH SPECIAL REFERENCE TO AFRICA (Fig. 2)

Thus, there are many varieties of cotton in the world, these being developed to suit local conditions; each variety has its characters which distinguish it from the others, and this has led to the development of more or less distinct markets for each. In this respect, generally speaking, one can distinguish about six categories,(45) some of which are so closely related to each other that they can be grouped together under one species, thus making the categories still less, and here an attempt is made to describe briefly the characters, indigenous places, and distribution of the main species with special reference to Africa, before discussing in more detail the varieties grown in the Sudan before 1925.

Four species contribute to the world's cotton crops: G. herbaceum and G. arboreum, which are diploid and of Asiatic origin, and G. hirsutum and G. barbadense, which are tetraploid and indigenous in the New World (Fig. 2). All these have long been established in Africa, but they are not native to the continent, the Asiatic species having been in use here long before the European exploration of Africa, and those of America being among the early introductions of crop plants from the New World.[46] However, each of these species occur in two or three races, some of which are distinct enough to be classified as a separate category by some people, and this necessitates a discussion on these species and their related races (Fig.2A).

(i) GOSSYPIUM HERBACEUM (Fig. 2A)

This species is Asiastic and is more or less indigenous to India, China and Asia Minor, and is probably derived from India. It is fuzzy seeded, the seeds being large and coated with grey fuzz and harsh greyish white wool, the seeds usually bear two coats of hairs, long lint hairs and short fuzz hairs, and in rare types bearing lints only.[47] In Africa, it is represented by three forms, the annual and most typical form being formerly cultivated along the shores of the Mediterranean, including northern Egypt, and very rarely found south of the Sahara. The perennial form, var. acerifolium, is widely distributed in the Sudan - West African region, and specimens have been collected in Abyssinia and the Sudan, Kharga and Siwa Oases in Egypt, and Giarabub in Libya, and Jidda in Arabia, but it is most common in West Africa.[48]

G. herbaceum was introduced into northern Africa from the Levant and Arabia in the wake of the Muslim conquests, and the annual form is believed to have come from Syria and Turkey, and cultivated in the Nile Delta by the middle of the sixteenth century or perhaps much earlier.[49] The perennial form is believed to have come from Western Arabia, and the probable route by which it spread into the savanna regions of West Africa is indicated by its presence in the desert oases of Egypt and Libya. However, it did not establish itself as a crop in Egypt or the Sudan, presumably because the Meroitic cotton, G. arboreum var. soudanense (or the Sennar Cotton tree) was already established there and satisfied the local need.

(ii) GOSSYPIUM ARBOREUM (Fig. 2B)

This species, as its name suggests, is a tree cotton that grows to as much as 20 feet in height with trunks of 3 inches in diameter. It is indigenous to India and the borders of the Indian Ocean, and yields a fibre of short staples; seeds are usually coated with two types of hairs, short fuzz hairs and long lint hairs, occasionally with lint hairs only. It is represented in Africa by two races, the most important one being var. soudanense, which abounds in the Sudan - West African region (Fig. 2). However, specimens have been collected from wide areas stretching from Egypt to the Nile - Congo watershed, from the borders of the Sahara to Lagos in Nigeria and Tamale in Ghana, and from Somaliland to the Sudan, the commonest habitat being the open savanna country rather than forest regions.[50] This species provided until very recently the bulk of Sudanese spinning cotton, and, as stated above, it occurs in the Sudan in wild state.

The other race is most common in East Africa, and is found in Madagascar, where it was extensively cultivated, and in Tanganyika (Tanzania) coast, and along the Zambesi, Shire and Lake Nyasa. It is sufficiently closely related to the Indian cottons, and as a result is allocated to the race indicum. Annual forms, however, are of recent introduction, and, although they are grown commercially (as Budi cottons), they are only of local interest.[51]

(iii) GOSSYPIUM HIRSUTUM (Fig. 2C)

This is so named because of the hairy characters of the plant, the seeds bearing a copious coat of lint hairs and usually a thick coat of fuzz hairs also, and is believed to have been originally native to Mexico. It is found in Central America from Guatemala northwards and the cotton belt of the U.S.A., and has been introduced and acclimatised in almost all cotton growing areas of the world as the Uplands, and as such they form the most important commercial cottons of the rain-fed regions of Africa. When first introduced from the Cotton Belt of the U.S.A., they were of better quality American varieties, such as Sunflower, Allen, Rattler, and Floradora, but because of a lack of precaution to maintain their purity in initial tests, and the resulting mixing and hybridisation together with local environmental selection, all evidence of relationship to the American progenitors was obliterated.[52] In the Sudan and former British colonies, the resulting mixture indeed has given rise to a number of highly variable and locally adapted stocks which have yielded, under sèlection, the best commercial varieties now in cultivation, the most renowned being Allen in Nigeria, Pump Scheme Strain in the Sudan, Buganda Local and the N.17 derivative of Nyasaland Upland in Uganda, Lake Province Local in Tanganyika, and Nyasaland Upland in Nyasaland.

This species exist in Africa in two forms, the most important being G. hirsutum var. punctatum, and is similar to those found on the coasts and inlands of the Gulf of Mexico and the Bahamas. It is believed that it was first introduced to the Gambia - Senegal coast by the British and the Spaniards, and by the French to the Reunion which might have given rise to the punctatums of Madagascar and Tanganyika (Figrs. 1 and 2A). This is now well-established throughout the savanna belt from Senegal to the Red Sea, and gradually has displaced G. herbaceum in native cultivation, and in most African countries are grown as annuals. However, hybridisation with punctatum was common in West Africa, and during the first years when Upland was introduced, seed mixing between Uplands and punctatum was unavoidable, and this rapidly caused serious deterioration in the quality of the Upland crop.[53] This necessitated careful control over seed supply, and this is why punctatum is banished from the commercial Upland areas. However, the results of natural selection have been the provision of types resistant to blackarm and jassid, from which the breeders have been successful in furthering these natural adaptive trends. The isolation of resistant strains has provided such successful crop varieties as BAR SP.84 in the Sudan, 26C in Nigeria and U4 in South Africa.[54] In the Sudan, punctatum is as common as G. orboreum var. sudanese, but only in perennials form. The notorious "Hindi" weed, which in the past has been a source of considerable trouble in Egypt's, and to some extent in the Sudan's, cotton fields, is also a form of punctatum.

The other form, G. punctatum var. marie-galante, or the Carribean Cotton tree", is still confined to the New World, and is distinguished by its tree-like habits as opposed to the bushy habit of punctatum. Careful studies showed that it does not occur in India, former British East Africa, the Sudan and Nigeria, and its presence in Ghana, where it is believed to have been recently introduced from former Ivory Coast, has been attributed to the Basle missionaries who brought Negroes from Jamaica and Antigua in 1843 and settled in Ghana.(55) It is now widely distributed here, from the dry Accra plain to the long grass savanna country of the northern territories, and exist either as bushy thickets, or large and overgrown shrubs or small trees.

(iv) GOSSYPIUM BARBADENSE (Fig. 2D)

This is the well-known silky and long-stapled variety, the seeds of which are free, bearing a copious and even coat of lint; beneath the lint they may bear a full coat of fuzz, or a tuft of fuzz at one or both ends, or fuzz may be absent altogether. They are indigenous to tropical South America, and are believed to have been introduced to the U.S.A. from Barbados, and to have been spread recently throughout the Antilles whence it was introduced to South Carolina and Georgia, where annual, fine-linted types were selected and gave rise to Sea Island cotton. The Egyptian cotton of commerce is grown from annual varieties descended from hybrid stocks of Sea Island X perennial barbadense parentage. It has been introduced into Africa, India, the East Indies and Polynesia, where it is to be found sporadically in or near gardens, and occasionally in the bush, and only cultivated in Nigeria.(56) It has been introduced almost all round the African coast, and is widely spread in the forest regions and orchard bush country of West Africa.

There are, as already stated above, three main types of G. barbadense, all of which intercourse freely: G. vitifolium, G. peruvianum and the kidney cotton var. barsiliense. The last two are common in Brazil and the West Indies, and might have been introduced into Africa by the Portugese, but G. vitifolium, which resembles the cotton of western South America, might have found its way into Spanish hands. Its introduction into West Africa was done by the early European traders.(57)

The main importance of the barbadense cottons of West Africa lies in their contribution to the ancestry of those of Egypt.[58] The development of the Egyptian cottons from vitifolium X Sea Island hybrids is considered among the great agricultural achievements of modern times as well as a milestone in the development of modern irrigation works there and in the Sudan as we shall see in the succeeding chapters. The establishment as a commercial crop of the perennial plant known as Jumel's vitifolium, made perennial irrigation necessary. At first, as we shall see in Chapter Four, this was in a modest scale, and consisted of erecting sagias and deepening of canals to maintain the flow of water during the critical low Nile (see Chapters Two and Five), and to raise it to the level of the cotton fields.[59] The wealth brought by the sale of cotton provided capital for building barrages and a high canal system, and thus began the transformation of Egypt from the precarious flood to the secure perennial irrigation of modern time. This drastic change was followed by more revolutionary changes in plant breeding, for the perennial cottons were replaced by annual varieties of the former, and this made possible great expansion in irrigation facilities and consequently in crop production. The market contined to expand and to absorb the increased production at prices which made possible even greater capital investment so that not only has Egypt been equipped with that vital system of perennial irrigation, but its benefits have been extended to the heart of the Sudan, the Gezira, and even more ambitious projects for the control of the Nile were put forward, most of which are, however, still under consideration, as we shall see in Chapter Five. All these developments are interdependent: they were started by the establishment of cotton crop in Egypt, and financed by the money it brought to the country, yet, one should remember, this was made possible by a revolution in the Egyptian agriculture, followed by a vast extension of the world market for fine cottons.

The Egyptian cotton is primarily the cotton of heavy cropping on irrigated land; indeed it has failed whenever it has been tried under rain-fed conditions, but given regular watering, high soil fertility, and comparative freedom from major pests and diseases, it has no competitors, and this reflects the conditions under which it evolved. In other respects, its ancestry is evident: it is highly susceptible to blackarm, leaf-curl and jassid, as are the two parent races: G. vitifolium and Sea Island. The annual habit and much of the quality of the lint, came from Sea Island, but something of its lint character came from vitifolium. Taxonomically, Egyptian cotton belongs to a New World species, but although the introduction of G. barbadense into Africa is such a recent event, the race is, by all evolutionary criterion, native in the Nile valley.

However, from the general Egyptian type has been evolved a variety of long and short-stapled cottons to meet different trade demands. Long staple varieties of Egyptian origin are not widely distributed: for example, Karnak is grown, under that name, in Algeria and Peru. Sakel also maintains its original name in the Sudan, though this is now used to cover both the Sakel and Lambert group of strains despite some genetic differences between the two.[60] The many versions of Pima type, now grown commercially in the U.S.A., Peru, Morocco and Israel, all also originated in selections made from long-staple Egyptian cotton taken from Egypt to the U.S.A. around the turn of this century.[61] By contrast, the Ashmouni has never been commercially grown outside Egypt because of its low price; yet it has a ready market in Lancashire because of its ability to give a good nap-free carded yarn, an attribute due to its fibre maturity and relative coarseness. But due to political difficulties of recent years, it has been replaced by the lower grades of the Sudan Lambert and the Acala 1517 as grown in el Paso district of Texas.

The Sudan at present produces two distinct types of cotton: the long-stapled high quality Egyptian type (G. barbadense) by irrigation, and the medium staple American Upland type (G. hirsutum) by rain. The old "Sennar Cotton tree" (G. arboreum var. soudanense), formerly common, is a wild perennial native cotton of Asiatic group. However, before confining itself to the production of these two types, the Sudan experimented with a large variety of cotton imported from Egypt, the U.S.A. and Africa.

V COTTON VARIETIES GROWN IN THE SUDAN BEFORE 1925

From about 1900 a number of varieties of cotton were introduced into the Sudan from abroad, especially from Egypt, and during the experimental period from 1904-23, about twelve different kinds of cotton had been tried in the Baraka Delta, Zeidab and the Gezira, ranging from Egyptian long staples to American Upland varieties. Among the former were noted: Afifi, Nubari, Assili, Makhsous, Sakellerides (Sakel), Ashmouni, Joannovitch, and Abhasi, and among the latter were Allen's Improved, Griffen, Sunflower, Simpkins, Webber, and American Upland originally obtained from Nyasaland.

By 1910, as we shall see in Chapter Seven, Tokar (Baraka) Delta was raising the bulk of the cotton crop, grown solely from Afifi seed obtained fresh each year from Egypt. But by 1911-12 some varieties, both American and Egyptian, were tried for experimentation as the following table shows (Table 2).[62]

TABLE 2 VARIETIES OF COTTON GROWN IN TOKA DELTA UNDER EXPERIMENTAL CONDITIONS 1911-12

Variety	Length of staple (mm.)	Average Price Pence/lb.	Average Yield: lb/Feddan Moderately Irrigated	Lightly Irrigated
Afifi	33.0 - 40.6	9	906	593
Abbasi	38.1	10	530	355
Nubari	3811	10	-	-
Simpkins	30.5 - 33.0	8	1476-1610	-
Allen's Improved	25.4 - 30.5	5.07	1260	712
King's American	27.9 - 33.0	8	1240	980
Sunflower Improved	27.9 - 33.0	5.19	980	-
Cooks	22.9 - 27.9	5.07	-	955
Griffen's Improved	25.4 - 33.0	5.19	-	683

Source: Bulletin of Imperial Institute, (1913), p. 194

From this table one can gather the importance of irrigation for both American and Egyptian varieties, and in the very variable volume of the Baraka river, and consequently in the extent of inundation, the advantage of the well-watered parts of the Delta can easily be discérned. Similarly, this was the case in the Gash Delta where, under very similar physical conditions, Egyptian varieties of Afifi and Abbasi were being grown together with a small quantity of American cotton from seed brought into the area from Eriteria.[63]

Further east along the Nile at Zeidab, in Berber Province, Nubari and Afifi also constituted the major portion of the cotton crop with some other Egyptian and American varieties, as Table 3 below shows, the American consisting of Allen's Improved and Griffen.[64]

TABLE 3 VARIETIES OF COTTON GROWN AT ZEIDAB, 1911-12

Variety	Length of Staple (mm)	Price: pence/lb.
Afifi	35.6 - 43.2	13.0 - 13.5
Abbasi	33.0 - 43.2	9.0 - 9.5
Nubari	30.5 - 43.2	13.0 - 13.5
Voltos	35.6 - 40.6	14.75- 15.0

TABLE 3 continued

Variety	Length of Staple (mm)	Price: pence/lb
Makhsous	38.1 - 45.7	10.5
Sakollerides	35.6 - 40.6	11.5 - 12
Gallini	40.6 - 50.8	10
American	22.9 - 27.9	5.05 - 5.25

Source: Same as Table 2

However, from 1920 Webber, an American type, was introduced at Zeidab, and by 1922-23 it replaced all other varieties, including the Egyptian, and thus established itself as the main crop, as we shall see in Chapter Seven.[65] Meanwhile, the Gezira grew the Afifi and Nubari varieties of Egyptian cotton, Assili being added in 1913 by the request of Lord Kitchener.[66] However, by 1917 the growing of the American varieties, Allen's, Griffen, Sunflower and Nyasaland, was stopped because of their low returns, and when the Research Farm was established in 1918 in the Gezira, earlier Egyptian cotton varieties were discarded, and work was concentrated on selection work from the Sakel stock, and also on American cotton using seed of a large number of new varieties imported from the U.S.A.[67]

However, the decline of Sakel in Egypt made the Sudan depend on her own resources for the production of planting seed, which it used to import fresh, and the maintenance of lint quality (Chapter Five). This was made possible by the research division which maintained, and still does, a large breeding programme for developing strains more suited to Sudan conditions. Thus, to obtain a standard variety for use in long-term agronomic experiments in the Research Farm, a strain called Massey's Selected Domains Sakel was selected in 1922 from Sakel seed imported from Egypt for the purpose. From these experiments all the varieties of Sakel now grown in the Sudan have been selected.

From the foregoing account, the influence of Egyptian cotton on the development of cotton growing in the Sudan can easily be discerned. Although from a financial point of view this development was mainly a British enterprise, it was Egypt that furnished a vast agronomic research experience from which the Sudan drew lavishly during the experimental stage.

This, as we have seen, ranged from provision of fresh seed to the supply of skilled growers to start the new schemes and teach the Sudanese methods of proper growing of cotton (see Chapters Five and Seven). Moreover, Egypt provided the basic varieties to experiment on, the result of which has been the production of cotton types well-suited to the conditions in the Sudan. For these reasons and also to show the rapidity with which varieties appeared and disappeared to suit the forever changing supply and demand in cotton trade, it does not seem irrelevant to include here a short description of each of the various varieties introduced into the Sudan from Egypt during 1900-25. However, we must not in this respect forget, or underestimate, the vast experience accumulated from constant research conducted by the various experimental stations in some of the former British Tropical colonies and other countries, and from which the plant breeders in the Sudan gratefully drew, until the time when they formed their own school of cotton breeding.

(i) Gallini:

This was introduced into Alexandria market about 1860, and was considered as being very close to, if not actually an acclimatised form of, Sea Island, and indeed was known in Liverpool market as "Egyptian Sea Island".[68] The lint was apparently strong, silky and fine, but it seems to have yielded feeble return in ginning, and this together with its late maturity, sensitivity to temperature variations and temporary shortage of water, made it uneconomic for growing.

(ii) Afifi or Mit Afifi:

This was discovered by a Greek merchant in 1882 near a village of the same name. It produced large yield of fibre from seed cotton which reached 35-36% in ginning, with a staple of 25-28mm. The fibre was not only longer, but finer, stronger and softer to touch than Ashmouni, in which field Afifi was first found. Thus, the advent of this type was thought to have done more to establish the reputation of the Egyptian staple than any one previously grown, for it may be said that Afifi determined the existence of a brown colour as a desirable characteristic of Egyptian cotton. As a result it became in such demand that 77% in 1906 and 62% in 1910 of Egyptian cotton crop consisted of Afifi.[69] However, it began to give way to other browns, mainly its offshoots Nubari and Assili from

1910 onwards, and in 1915 it was obliged to surrender its first place to the finer, earlier white cotton, Sakellarides, which by this date had established itself upon the European and American markets for a specific use, and in which position, up to the present, it has had no rival. The main reasons for Afifi's deterioration were due to its late maturity, and the introduction of pink seed worm from India in 1909-10 which necessitated the establishment of an early maturing cotton, which the Sakel was, and thus the days of predominance of brown cottons in Egyptian cropwere ended.

(iii) Abbasi:

This was a selection from Afifi made in about 1893, slowly came into great demand about 1897, and obtained very high prices, which accordingly increased its production. The particular characteristics which made Abbasi so popular were that the lint was pure white and very brilliant, and the staple longer (about 28-30 mm) and finer than, but not as strong as, that of Afifi, the cotton being particularly suitable for mercerizing. However, the chief defects were that the later prickings were usually so much inferior to the earlier ones that they obtained a much lower price. As a result, the production was not so heavy nor so constant as that of Afifi, and the usual ginning turn-out varied from 32-34% of lint to seed cotton.(70)

(iv) Joannovitch:

This was usually regarded as a selection made from growths of Gallini and propogated by a M. Joannovitch since about 1894. The lint was described as longer, finer and stronger than any of the other kinds grown in Egypt at the time of its introduction. The lint was white, but spinners are said to have found more waste in spinning, thus introducing a considerable element of fluctuation in the price; moreover, it seems to have required special conditions of soil and environment in general, and had to be picked as soon as the bolls were opened, as the fibre was shed very rapidly after ripening.(71)

(v) Nubari:

A cotton bearing the name of Nubari first appeared about 1905, having originated in a field of Afifi cotton, and propogated by a man called Nubar. The lint resembled that of Afifi, but was generally of distinct superior quality, and the plant seems to have a more vigorous growth and exacting in its soil condition requirements. As a result it was only suited to certain places, and eventually had to give way, like the other brown cottons, to the Sakel white variety.(72)

(vi) Sakellarides (Sakel):

Although Sakel cotton is a white variety, and somewhat of the Sea Island in fineness and silkiness of its fibre, it was a selection from a field of brown Afifi made in 1906-7 by a Greek whose name it bears. However, although condemned by English spinners in its early days as a cotton which would only meet with a very limited demand, and as one which could not displace the brown cottons, Sakel has, nevertheless, been so successful in that direction as to threaten the entire disappearance of lower Egyptian brown kinds.(73) Sakel has in fact shown itself to be a most desirable cotton from the manufacturer's as well as the cultivator's point of view. Field tests have indeed shown that the plant matures earlier than any other cotton then grown in Egypt, and moreover it was a kind which was not unsuited to cultivation on land where a slight impregnation of salt was markedly deleterious to other kinds of cottons. For these reasons, cultivators preferred Sakel to Nubari, Afifi and other kinds already mentioned above. Moreover its suitability for employment in the manufacture of motor tyres gave it a great demand in the U.S.A., and in the course of time, Sakel could prove iself as a durable and unbeatable commodity in the world of cotton trade.

(vii) Assili:

In the year 1906-7, another type of Afifi, this time called Assili, was selected in a field of the former, and developed by a Mr. Berla. Indeed greater care was bestowed upon the propagation of Assili, the seed of which became available, and was disposed of to the cultivator at high prices. The variety was said to be distinguishable from Afifi by the large size of the bolls and the superior lustre of the fibre, but it had an immense advantage from the ginner's point of view in the abnormally high figure of ginning out-turn, which was said to average 110 lb. of lint to the kantar of seed cotton (315 lb.) or about 35%, with some samples even yielding as much as 36.6%.(75) However, curiously enough, despite this high ginning out-turn, Assili did not meet with a big demand by the cultivator, who found that in order to make up 315 lb. of seed cotton, a much larger bulk of the crop was necessary than of other kinds of cotton, and for this reason the diminished seed weight had to be made up in lint.

(viii) Voltos:

Being a selection from Abbasi, Voltos was a white cotton of exactly the same type, but less contaminated by admixture with other varieties than the former had later become. However, this variety never obtained much importance, and even its seed had become unobtainable by 1917, although it only made its appearance in about 1910.

(ix) Ashmouni:

It is generally accepted that Ashmouni cotton was the first recognised and specially identified off-shoot to probably take place of Jumel. The characters which appear to have given this cotton a superiority over the older kinds, seem to have been those of productivity, regularity of staple, and a fine creamy brown colour of lint. The variety originated in the early 1860's at the town of Ashmoun, and in a short time it spread throughout Egypt, completely taking the place of all other varieties except Sea Island, which continued to be grown on a small scale in 1870.[76] The mean staple length was 25 mm., and it seems to have practically held sway in Egypt until the appearance of Afifi in 1882 as none of the several cottons evolved before this date appear to have established themselves sufficiently in popular favour to largely displace Ashmouni. With the appearance of Afifi, Ashmouni was pushed out of Lower Egypt, but in the hotter Upper Egypt, it held its own as the most remunerative crop until very recent times.

(x) Makhsous:

Nothing much is known about the origin of this cotton, apart from the fact that it boomed when introduced into the Sudan round about 1906-7. This hybrid, which was somewhat extensively planted on its reputation for productivity, was abandoned by 1915 after exhibiting all the irregularity and lack of uniformity which characterised uncontrolled hybridisation - thus giving an example of the futility of haphazard choice of natural hybrids occurring in the field.[77]

This is the story of the various Egyptian cottons introduced into the Sudan, and the evolution of the varieties that were propogated to meet the changing demand of the spinners and manufacturers in England and elsewhere, to whose specifications the propagators had to comply. The plant breeder in his turn had to be very strict on seed control as a protective measure against disease-infected seeds and exotic plants and to maintain purity of strain. Such restrictions, however, were untenable to the old spinners of the Sudan; the cotton they knew was obtained from semi-cultivated perennial shrubs, grown from seed stored for this purpose, and thus their simple needs were satisfied. From such cotton the Sudanese women spun the renowned damour cloth, which, for centuries, had been the dress of people from all walks of life.

VI SPINNING AND WEAVING IN THE SUDAN:

Until very recent times, the Sudan was one of the few places in the world where cotton was still spun on a hand spindle, and indeed the origin of this industry can be dated back to the Meroitic period, as has already been mentioned. What is not known is whether this industry descended to the Sudanese people straight from that time onward or was it interrupted by the destruction of the Meroitic Kingdom at the hand of the Axumites in 350 A.D., and later re-established itself under a different regime after a lapse of time. However, the only thing definite is that this industry was already well-established when the first Europeans visited the Fung Kingdom of Sennar during the late seventeenth and early eighteenth centuries. Thus, Poncet in 1699 and Krump in 1707 mention damour manufacturing in Sennar; in 1770 Bruce visited Halfaya, near Khartoum North, and recorded that the manufacturing of cotton homespun, damour, was the chief source of livelihood there, and that this cloth was extensively used as a currency.(78) Krump in 1707 described what he called tub thamour (misspelling of tob damour, tob being the length of the fabric used by women and men as a garment) as a currency and a dress in Sennar: "Men and women wore it, folding it in two, and winding it round their waists",(79) and it was a readily accepted currency all over the Sudan, indeed until the end of the nineteenth century. There was considerable trade in damour between Sennar and the various caravan trade centres of the Sudan, and according to Burckhardt, who visited the Sudan in 1813-14, the cotton manufactories of Sennar and those of Bagirme, to the west of Darfur, furnished "the greater part of northeast Africa with articles of dress."(80)

However, there is no consensus of opinions as to where from this craft was introduced. Arkell, for example, suggests that the spinning and weaving of cotton into cotton cloth seems to have reached Darfur from North Africa via West Africa, and not via the Nile. This conclusion he reached by comparing the names given to the material and its measurement in both West Africa and Darfur as mentioned by two Arab travellers, and which Arkell found to be very similar.[81] Although Darfur had connections with the Nile valley from early times, one is left with little doubt as to the true source from which cotton weaving was first introduced into the Nile valley, a possibility which even Arkell does not rule out completely. We have already seen that the Meroites were the earliest people in Africa known to have used cotton, that the common Asiatic cotton of the Sudan today, G. arboreum var. soudanense, is believed to be the modern representative of their stock, and that there is a great possibility of this cotton plant being introduced into the Sudan from India via the Red Sea. It will be of interest, in this connection, to note that the loom used in the Sudan until very recently was found to be identical to Hindu loom, and that it is also found in Oman and Arabia, parts of Syria and Egypt. In Africa it is also found among the Galas of Ethiopia and related tribes, and is thought to have probably been imported into Africa, and the Nile valley from India via Arabia.[82]

The spinning of the long fibres of flax and wool is known to be more ancient than cotton spinning which, on account of its short staple length, requires a higher degree of technical skill. There can be little doubt that the discovery and improvement of cotton was made by a technically advanced people already well acquainted in making linen and woollen fabrics. The earliest civilisation to spin and weave cotton was that of the Indus valley, and for many centuries cotton plant seems to have been known outside this area only in travellers' tales. The fragments of cotton fabrics found at Mohenjo-Daro (Fig. 2) have been dated at approximately 3,000 B.C.[83] Although Mohenjo-Daro had contact with Babylonia, the textiles of the latter and those of Egypt were still of wool and linen when Herodotus wrote in 44 B.C. The north-eastward spread is believed to have occurred even later, cotton having been developed as a crop in China between the seventh and thirteenth centuries.[84]

The spread of cotton from the Indus valley had been effected, as already mentioned above, by coastal trade routes that linked the peninsula with the Perian Gulf, the Red Sea and eastern coast of Africa. The Red Sea was an important trade avenue, and first ancient Egyptians, and later

Greeks and Romans, plied its coast for exotic articles, and in fact the Romans are considered the heroes of the second chapter of European expansion in the Red Sea. But, unlike the Greeks, the Red Sea in the Roman eyes had no great commercial importance, and the further eastern trade was a matter of vital moment. Finding the old land trade-routes blocked by the Parthians, the Romans sacked Aden, discovered the monsoons, developed the trade routes in Upper Egypt from the Nile to the Red Sea, and as a result the Indian trade assumed enormous dimensions.(85) However, the most valuable addition to our knowledge made by the Roman writers is the light thrown upon the local intermediate commerce which arose, or continued, in complement to the great Indo-Egyptian trade. The author of Periplus indicates that over and above the merchants who trafficked directly between Egypt and India, there were others who trafficked between Egypt and the Red Sea ports on the one side, and between the latter and India on the other. Among imports from India cotton and fine muslins figured high in the trade of Adulis (Fig. 2F), where also Egyptian textiles, both made up and in piece, were in regular demand.(86) This trade was fostered by the Axumites, and there is no doubt that cotton weaving was passed to the Meroites from this direction. Spinning and weaving, on the other hand, does not seem to have had such an important place in southern Africa than in the north, although De Barros (c.1560) said of the ruler of Zimbabwe (S. Rhodesia) that "the greatest ornaments of his house are cotton cloths made in the country with greater labour".(87) However, Zimbabwe being a source is a remote possibility, since cotton was also introduced to this part of Africa from India probably at the same time as to, or later than, Axum.

In this manner, it may be supposed that the early civilisation of north-western India, which added to man's cultivated plants the bread, wheats, peas and other legumes, mustard and rape, also gave the world the original diploid cottons.(88)

In the Sudan the craft of spinning was a woman's job whereby some hard cash could be obtained so as to supplement other sources of income. Doubtless the first fabrics spun were for the exclusive use of the rich ruling clan and might have remained a luxury for the common people for quite some time but by the sixteenth century cotton clothing seems to have been universally adopted. Damour became the cheapest form of dress until early in this century, as part of increasing governmental control over cotton production, the storing of cotton on the seed was forbidden to eliminate the risk of diseases. Nevertheless, cotton had distinct advantages over such fibres as wool and flax, and in addition to cheapness, damour was surprisingly warm and suitable for winter wear. In addition processing was simple and the cotton went into the material straight from the boll, the only intermediary process being spinning. However, different qualities of damour were used by men and women, and the best distinction for the two was between warp and woof. Thus, the warp thread for women's damour had to be spun very fine and strong, and as a result this needed great skill and dexterity and consequently fetched higher prices, while that for men's damour, though hand-spun and fine, was slightly thicker and stronger than that used for women's.[89]

Spinning and weaving were typical household industries, and as such seem to have been handed over from generation to generation until the industry quietly died out as a result of competition from cheap European and Indian cotton goods and government restrictions over seed. While spinning was a woman's task, weaving remained a man's job, each weaver working for himself. Men in fact wove to order and not for the market, and women brought their own spinning, warp and woof, and paid a fixed price to have it woven into damour. Every woman or girl spun for her own use or for sale, and in every village there were a number of weavers who worked the yarn into a variety of materials, and indeed some villages came to be well-known for the cloth they produced. From Darfur, for example, came nice cotton stuffs dyed with locally grown indigo; they were in different lengths, but 10-yard pieces were the most common.[90] However, of all the cotton piece goods made in the Sudan during the nineteenth century, those from Dongola were considered in Egypt to be the most solid, although there was a steady local demand for the cloth woven in Matemma and dyed deep red. (Fig. 35). Berber province was famous for the finest spun-yarns during the Turkish and Mahdist period (1821-98), and here stripes of imported coloured silk were frequently interwoven in the cloth, which was used principally for turbans, as well as coverings of various sorts and shawls. The Gezira was also known, during this period, for common cotton stuffs, which were brought to the markets of Khartoum and Omdurman in large quantities, and were made principally to satisfy the commoners' need. Dongola was also famous for the manufacture of sail-cloth, and materials from Kordofan were noted more for their durability than for their beauty.

All these clothes were made from cotton grown for this purpose around all important trade centres, such as Dongola, Damer, Shendi, Sennar, etc., and it will be appropriate to end this section by discussing the various methods of cultivation practised until about 1910.

VII METHODS OF CULTIVATION OF COTTON IN THE SUDAN (Fig.3)

Methods of cultivation differed from one place to another according to the physical conditions of the area in which cotton was grown, but here it must be remembered that cotton growing was not a seasonal practice as it is today, and that once planted, the plant was left to grow and attain tree dimensions. However, the most important factors were the availability of water, contours of the land and, of course, its suitability to cotton growing, and this is why different practices were used. For example, in the Dongola reach of the Nile as well as in the riverine areas north of Khartoum, cultivable land was limited, before the introduction of pumps, to a narrow strip along the river, which was irrigated by saqia and shaduf. Since the area irrigated by these devices was very limited, all such land was necessarily devoted to food crops and date palms, and plants such as cotton, except during part of the Turkish period, (as we shall see in Chapter Four), were grown on lands not devoted to food crops, and in some ways these methods were peculiar as, for example in Dongola province. Holes, which might be 3 feet long, were dug in the sand down to the level of the river alluvium and were filled with silt dug out from a nearby well (Fig. 3B). Seedlings were established in the saucer-like top of these holes by hand watering. In due course their roots penetrated to the level which water seeps through the alluvium from the river, and as the branches grew sand collected round and among them until a series of hummocks were formed from which the ends of the branches protruded. Thereafter, no further attention was required. The trees, mulched by blown desert sand, and kept free from weeds by the aridity of the surface, flourished for ten years or longer without any interference with the peasant's farming activities. However, the resulting bolls were small and the fibre short and weak in staple, but it seems to have served some purpose in the native domestic economy.[91] Indeed, it is not unlikely that this method of cultivation was used in Meroitic times.

With increasing rainfall to the south, however, cotton cultivation depended on rainfall, and the most important area has always been the Gezira

Plain between the Blue and White Niles. But here rainfall was a limiting factor, the average at Wad Medani being 14 inches, while cotton requires at least 20 inches of rainfall. It could, therefore, only be grown in natural depressions called ugud, into which water naturally drained, or in small quantities near earth banks, or terus, constructed on slightly sloping lands where the rainwater could concentrate and be directed to specially chosen areas, or on land naturally flooded by rivers, as we shall see in Chapter Six. But the areas of such places were definitely limited and although irrigation was required for any successful raising of cotton, native cotton was grown in the Gezira by these methods to supply the native spinners with cotton from which damour was woven. Thus, the Gezira people were able, after satisfying their domestic needs, to pay the annual tribute of 100,000 rolls of cotton cloth levied by the Mahdist Government.[92] Native cotton, however, hardly commanded any market outside the Sudan, and with the local demand easily met, it was of almost no value as a means by which the growers could obtain a steady cash. In fact, there had been practically no cash rain crop in the Gezira except dura, and the whole tradition of the people, as we shall see in Chapter Three, was to keep large reserves of grain against years of bad rain which tided them over to the next rainy season.

In the Gash Delta, however, water has always been available for crops, by the annual inundation caused by the Gash river. But until flood control measures were taken during this century, the Delta remained almost uncultivated in the proper sense of the word. In 1814, Burckhardt described it as very fertile, but not properly tilled, and that cultivation was done in the most desultory and casual way.[93] In 1870, Langham described it as ".... not much cultivated .... with an alluvial soil left sprinkled with thorn bushes left untouched amid the growing crop.",[94] while in 1871 only one-fourth of the Delta was cultivated according to Munzinger.[95] Here cotton, together with other crops, was grown by the shiote system. Shiote is the name given to the water channel cut by the cultivator at an angle from the Gash main stream to bring water to his land, and also to the area irrigated by this method (Fig. 3B). Thus, Shiotes served three purposes. First, water in such a channel could be regulated and the land watered by the channel could be kept comparatively clean of weeds which would have overgrown the area if water was not regulated. Secondly, in case the Gash water continued its flow for a period of say, 100 days, the consequence was that the cultivator, by cutting his shiote (channel) through the flow zone, called balag, and so out to the rain land could sow earlier and thus harvest earlier. Thirdly, the cultivator, by this device, saved himself the immense labour of clearing the dense vegetation after the Gash had ceased to flow, and thus could lead the silt-laden water into the rain land region where grasses were shallower and, therefore, easy to clean - involving four to six men one day to clear one feddan. This cleaning was necessary because the heavy silt carried by the Gash, as we shall see in Chapter Two, blocked the shiotes (channels) unless cleared every year before each flood, otherwise he could not secure plentiful water.

The area of the Shiote (land) varied from 50 - 100 feddans, although in years of heavy continuous floods, the area could be extended, especially in the lower reaches of the river, to several times that amount. Sowing was done by a long, pointed stick, called seluka after cleaning the land (see Chapter Seven). However, cleaning was the most expensive operation, since one feddan of shiote in the natural flow zone of the Gash river took 25 men one day to clean it, while clearing the channels was done in two ways: either by unpaid labourers, in which case the owner had to let them have half the area flooded by the channel, or by paid labourers, in which case a contract, according to the price ruling at the time and the type of channel which was to be cleaned, was paid by the owner, who cultivated all the flooded area by himself.[96]

These methods formed the primitive precursor to the imaginative irrigation works undertaken between 1906-1925, but before discussing these, it is desirable at this stage to establish the physical background which necessarily formed a framework within which the early experiments took place.

GENERAL PHYSICAL BACKGROUND

I. RELIEF AND GEOLOGY: SUDAN AND THE GEZIRA (Figrs. 4,5,6 &7)

The Sudan, as Figure 4 shows, does not exhibit great diversity in relief, and broadly speaking, the country is a vast plain stretching from the great desert in the north to the borders of the Equatorial forests in the south. This low and regular relief is broken only by a few small hills and mountain ranges, such as Gebel Marra (3,150 m.), the Nuba Mountains (1,407 m.), and the Red Sea Hills (1,565 m.) (Fig. 4). Of the whole area of the country (c. one million sq. miles, or 2.5 million sq. Km.) less than 2% lies lower than 300 m., about 75% between 300 - 500 m., and a further 50%

below 1,200 m, which means that "there are only inconsiderable areas that are so high as to enjoy a markedly different climate from other parts of the country at the same latitude."[97] However, since relief is in part a product of geological evolution, a brief summary of the geological history of northern Sudan will be given.

The platform which underlies the superficial deposits is composed of folded crystalline rocks of the Basement complex, which forms over two-thirds of the rock exposures of the Sudan (Fig. 5).[98] During the Mesozoic Era, the northern part of the country was invaded by the sea and as a result extensive sedimentary deposits were laid down, mainly consisting of sandstones, some limestones and mudstones. Of this series, called Nubian Series of Jurassic and Cretaceous ages, large tracts were swept clear by sub-aerial denudation, to be followed during Miocene-Pliocene by uplift in the east accompanied by faulting, which respectively produced the Red Sea Hills, the Abyssinian Highlands and the Red Sea trough. To the west this uplift was accompanied by downwarping, resulting in a hollow running north-south which now forms the Nile valley. The depressions produced were filled by unconsolidated sands, clayey sands and some gravels, called Umm Rawaba Series of late Tertiary age. This period also witnessed volcanic activities in widely separated areas in the country (Fig. 5). During the Quaternary, movement consisted of smoothening of the volcanic relief by erosion, and the deposition of extensive sand and clay deposits, which today mask the solid geology beneath. Recent deposits include raised coral reefs along the Red Sea Coast, the Nile valley alluvium, and the silty outwash banks of the Baraka and Gash rivers, most of which constitute the superficial deposits: the central clay plain, the stabilised qoz lands and recent deposits of the Nile. (Fig. 5).

The geology of the Gezira is similarly simple as Fig. 6 shows. The rocks overlying the folded and metamorphosed Basement Complex are in general sub-horizontal or gently dipping and few faults have been recorded. The Basement Complex occur in the southern margin of the Gezira, being well exposed at Gebel Moya and Gebel Saqadi, and in the western margin along the White Nile at Gebel Bereima and Gebel Arashkol (Fig. 6). The Nubian Sandstones rest unconformably on the Basement Complex. The superficial deposits consist of unconsolidated clays, silt, sand and gravel, and here thickness varies considerably. Generally, where the deposits are thin, they consist mainly of clay as in the north, while in the extreme south the deposits are predominantly formed of clays overlying Nubian Sandstones. Recent deposits consist of sand dunes and sheets in the southwest and the Nile silts (Fig. 5).[99]

As simple as the geology is the relief of the Gezira as Fig. 7 shows. The basic features of this plain are the two broad, flat basins of the White and Blue Nile, separated by a low watershed, which varies in height from 10-40 m. (32.8 - 131.2 ft.) above the level of the clay plain adjacent to the Blue Nile, except where isolated gebel outcrop through the soil mantle. These gebels, some of which rise to as much as 500 m. (1,640-42 ft.) above the plain, are characteristic of the area of the high central ground between the two rivers, and seldom occur in the flat clay plain adjacent to them. Apart from the gebels, the Gezira looks monotonously flat, but in fact it slopes very gently from south-east to north and west (Fig. 7). A small area west of Sennar has an altitude of 420 m. (1,377.95 ft) and over, and the rest of the plain, an area of some five millions feddans, lies between 420 and 380 metre contours (1,377 - 1,286.7 ft). Thus, from Sennar to Khartoum, a distance of 170 miles (273.6 Km), the land slopes uniformly from 420 to 380 m, and the Blue Nile cuts its way northwards along this slope, while from Kosti to Khartoum, a distance of 190 miles (305.8 Km) the land level drops less than 10m (32.8ft) and the watershed between the two rivers extends from south of Khartoum via Manaqil. The northern part of it, however, is not high enough to be a barrier to canalisation, and in fact there is a small ridge or elevation running almost parallel to the Blue Nile along which the Main Gezira Canal is aligned. (Fig. 47).

Another important feature is the marked difference in gradient between the Blue and White Niles which is reflected by the levels of the clay plain adjacent to the two rivers. Thus, the gradient of the White Nile between Kalakal and Kosti is between 1.25 - 1.50 cm. per Kilometre, depending, of course, upon the season, while that of the Blue Nile between Sennar and Roseires is of the order 12 cm. per Kilometre. Moreover, the Blue Nile meanders to a greater degree than the White Nile, and as a result its steeper gradient has degraded considerably below the level of the clayplain. However, there are two distinct bank levels, the lower being represented by the aggraded bank of recent alluvium, and the upper one represented by the present level of the clay plain. Behind the recent banks there are usually the seasonally-flooded shallow depressions called mayas, and behind the higher banks the clay plain tends to slope gradually towards the drainage running parallel to the river (Fig. 14). It is in that portion of the plain that most of the ground is considered suitable for lift irrigation by pumps.

Another feature of the Blue Nile and Dinder rivers is the kerrib, which is the area of gully erosion between the clay plain and the river, and varying in width from 3 Km (1.9 miles) on the former to 1 Km. (0.6 miles) on the latter. The kerrib has been brought about by the degrading of the rivers, which is indicated by the height of the clay plain above the low water level at 19 m. (62.34 ft) at Wad Medani and increasing to 33 m. (108.27 ft.) at Roseires, while it averages 5m. (16.40 ft) throughout the White Nile region.[100]

In the Rahad and Diner area, the land is superficially uniform, flat plain, almost featureless apart from occasional isolated low-lying knolls, and in certain areas, closed and often seasonally-flooded depressions. However there is a general slope from south to north as well as from east to west, and between the Blue Nile and Rahad rivers the plain dips more or less evenly south-north from 417 m. to 405 m. (1368.11 - 1328.74 ft).[101] To the north and east of the Rahad is the gently undulating plain of the Butana with a rather lower rainfall and better drainage than the Gazira, but it lies too high for irrigation from the Nile and too dry for regular rain-fed cultivation except round and south of Gadaref. Towards the north, rainfall gets more erratic, and successful crop raising can only be realised where a sure source of water can be obtained as in the Gash Delta or from Atbara river.

II RELIEF OF THE GASH AND BARAKA DELTAS

The Gash Delta stretches for about 100 Km (62.1 miles) in a northwesterly direction from Kassala, and the area, in its widest sense, is assessed at 700,000 feddans, of which about 400,000 feddans could lend itself to irrigation, depending on the volume of the river. The Gash debouches on to an inland delta, and is completely spent 60 to 90 miles (96.6 - 144.8 Km) north of Kassala. In 1884, the river divided at Kassala into two branches, the Eastern and Western Gash, but the latter became silted up after the earlier irrigation works had been started between 1905 and 1920, resulting in the drying up of the wells along its course (Fig. 8).[102]

Geophysical tests have clearly indicated the presence north of Kassala of a deep depression running from south to north, which has been filled by sand and silt brought down by the Gash river from the Eritrean Highlands.[103] Now the Delta lies slightly above the surface of the surrounding ground, and looks completely level, but in fact it rises rather sharply on the eastern side of the Eastern Gash so that no important area is flooded on this side. It also rises slightly from the western bank, then falls off continuously to the northeast, and as a result there is a well defined natural flood boundary marked by a vigorous crop of tamarisk trees, or grass, beyond which growth is much poorer.

The Baraka Delta indeed differs from that of the Gash in that its slope is steeper, with a drop of 1.5 m. per kilometre at the southern end, and its waters are often much more heavily charged with silt (see Chapter Two). As a result, scouring and deposition go at a more rapid rate, and as long as the river remains uncontrolled, it will tend to search out and follow the line of least resistance, and discharges its waters over the lowest convenient tract of the country where obstructions are few and flow is easy. Thus, in the course of some years, it would have raised the general level of the temporary favoured tract, when it will seek new fields, again adopting the lowest convenient area, and thus continuously changing its course.[104] Another important feature in this Delta is the action of wind scour, which is most marked on land which in successive years has failed to receive a watering. In such cases the whole landscape undergoes a change. The surface of the land is scoured by this action with deep furrows and dunes of sand and fine powdery silt collects whenever any obstruction is met with. These dunes are easily washed away, and when, after a period of years, the land becomes flooded, fresh deposits of silt, which vary from 5 cm. to 1 m. in depth, are laid down, and the land, in the course of a single year, regains its fertility. These conditions, combined with the severity of the summer gales, are to a large extent responsible for the complete changes which take place in the general physical features of the country in the course of a few years.

These are the salient features of the geology and relief which are in a great part the products of the climatic conditions. Moreover, the crop production pattern is generally influenced by climatic factors, particularly rainfall and temperatures, and this makes the study of these factors essential.

III CLIMATIC FACTORS

Of all the climatic factors influencing agriculture in the tropics rainfall is the most important factor, as it generally has the biggest effect in determining the potential of any area, the crop which it is practicable to grow, the farming system which can be followed, and the nature, timing and sequence of farming operations.[105] The extent to which the rainfall in any area can provide soil moisture available to crops depends not only on the total annual rainfall, but also upon its seasonal distribution, its variability within and between seasons, its intensity and rate of infilteration into the soil and on the balance between rainfall and evapo-transpiration from the crop and the soil.[106] Whenever the rainfall is deficient during the whole or part of the period of growth of the crops to be cultivated, irrigation is required for agriculture. It is for these reasons that more stress will be laid on rainfall of the areas under consideration, but before going into this, it is desirable to discuss briefly the general climatic conditions within the country.

(i) General Climatic Conditions in the Sudan (Figs. 9. 10 & 11)

The Sudan lies within the tropics. Conditions vary from semi-equatorial climate, with short dry season, in the extreme south, through a belt of summer rainfall of varying duration and intensity, to complete desert conditions in the north. The change, however, is very gradual, and divisions between one climate type and another are by no means sharp, this being due to the absence of any mountain barrier to obstruct the flow of airstream between north and south (Fig. 9).. This gradual change in the incidence of rainfall is also accompanied by an equal gradual increase in annual temperature range.[107]

The variation in the duration of the rainy season and the characteristics both of the rainy and dry seasons, can be explained by studying the distribution of the high and low pressure belts and wind movements in the northern hemisphere (Fig. 9). Thus, during the winter, cool northerly winds blow from the high pressure centres in the northern landmass, and are usually dry except when they blow across the Red Sea, where some orographic rain is experienced along the coastal plain. During this time the Inter Tropical Convergence Zone (ITCZ) lies further south outside the Sudan as Fig. 9 shows. With the northward movement of the sun, temperature increases, and the ITCZ moves northwards across the Sudan, thus bringing unstable air from the South Atlantic Ocean behind it, and by July the ITCZ has reached its northern limit, which is by no means fixed (Fig. 9). Southwesterly winds now prevail all over the country, though with its passages northwards, the surface of ITCZ become more inclined, and the southwesterly current more shallow. Showers, though less frequent, are heavy because the southwesterly current and the more pronounced shear between the surface and upper currents are alike less favourable to convection.(108)

During the northward passage of the ITCZ, most places in the central and northern Sudan experience some variability in weather due to humid winds being succeeded by drier and hotter northerly and northwesterly winds. The most common and worst of them all is the dust-storms (haboobs), the cause of which being the proximity of two differing winds and the very strong surface heating.(109) In the north, the rainy season lasts for one to three months, by September rainfall begins to decrease, temperature begins to rise, humidity falls to about 10% and the dry season sets in to last for 8 - 9 months. Behind the retreating ITCZ comes north and northeast winds heralding the onset of winter.

However, rainfall is irregular in incidence and amount; one or two or three inches may fall from a thunderstorm in as many hours, but not concentrated in a small area. As a result, many places may not experience any rain for some time, even during the rainy season. "In the north, where the mean annual rainfall may be 10 inches (230 mm.), or even less, the annual total may fluctuate greatly, and in some years the entire fall may be concentrated in very few occasions."(110) The general character of individual storms and showers is much the same throughout the country. The wide variations in seasonal totals are almost entirely due to variations in the number of storms occurring, and not to any significant differences in the average amounts of rain yielded by individual storms.(111) Thus, three quarters of the country receive more than 60% of the annual rainfall during the period July - September, central and western Sudan at least 75% and the extreme northern areas all the annual rainfall. The number of rain days (A rain day is defined on two criteria: as a day upon which rainfall is equal to, or greater than, 1 mm. in one case, and equal to, or greater than, 10 mm. in the other) in the year in which 10 mm. (0.39 ins.) of rain are recorded varies from 50 days in the extreme south to 13 days at Elobied (385 mm. or 15.16 inches), 6 at Khartoum (161 mm. or 6.34 inches), and only one day at Atbara (74 mm. or 2.91 inches). Accordingly, variability is much higher in the drier areas, for example, at Abu Hamed where it is 80% and only 6% at Yamhio in the extreme south (Fig. 10). Evaporation rate is also very high and as Fig. 9 shows at most times of the year the potential evapotranspiration is much greater than the actual precipitation, and in the northern parts of the country, the daily evaporation rate throughout the summer stands at 20 mm or more (0.79 inches).[112]

(ii) Rainfall in the Gezira

Daily rainfall records for the Gezira have been taken since 1906 from nine stations (Khartoum, Kamlin, Hasaheissa, Wad Medani, Rufaa, Sennar, Managil, Dueim and Gekina), the longest run of data being available only for the three oldest stations: Tayiba, Barakat, and the Gezira. The general pattern and the sequence of rainfall are similar to those of the Sudan as a whole.[113] Thus, increase of rainfall towards the south and east and decrease towards the west and north is clear from the trend of Isohytes (Fig. 12). Kosti, for example, has an annual rainfall just under 400 mm. (15.75 inches) while Singa on the Blue Nile receives 500 mm (19.69 inches). Khartoum, in the extreme north, has only two months exceeding 50 mm (1.97 inches) each, while Wad Medani, in the centre, has three months, and Sennar, in the extreme southeast, four months. Wad Medani, with a mean annual rainfall of 404.2 mm. (15.91 inches) recorded as high as 435.7 mm (17.13 inches) and as low as 239.8 mm (9.41 inches).

Thus, the annual rainfall varies greatly from one season to another, and in the average, the five stations in or near the present irrigated area (Kamlin, Hasaheissa, Wad Medani, Rufaa and Sennar) experienced, over 28 years (1906-33) an annual rainfall that ranged from 184 mm (7.24 inches) to 500 mm (19.69 inches) in 1929, with a mean 302 mm (11.89 inches) and a standard deviation of the season's rainfall of 71 mm. (2.80 inches). Although most of the rain falls in heavy storms, which gives the impression of being purely local and irregular, the variation from centre to centre are not sufficient to mask the general character of the season as a whole. Thus, the standard deviation of the annual rainfall is 101 mm (3.98 inches) for one station as compared with 71 mm (2.80 inches) for the average of the nine stations.[114]

TABLE 4 GEZIRA RAINFALL IN mm.

MEAN FOR NINE STATIONS (1906-33)

April	May	June	July	August	September	October	Total
2	9	26	92	118	47	8	302
(0.08 in)	(0.35 in)	(1.02 in)	(3.62 in)	(4.65 in)	(1.85 in)	(0.31 in)	(11.89 in)

	Mean	St. Deviation for one stn.	Increase per Degree: Latitude	Increase per Degree: Longitude
Early Rain (before 1 July)	36(1.42in)	28(1.10in)	- 22	22
Middle Rain (July-August)	210(8.27in)	85(3.35in)	- 58	50
Late Rain (After Aug. 31)	55(2.17in)	40(1.57in)	- 26	16
	302(11.89in)	101(3.98in)	- 106	90

Source: E.M. Crowther (1936), op. cit., p.111

The average distribution of rainfall throughout the year is given in Table 4 above for seven months, and for a convenient grouping into Early, Middle and Late rainfall. It will be seen that about two-thirds of the annual rainfall occurs in July and August, appreciable amounts often fall in June and September, and they may be occasional light showers in April and May, or in October or November. In other words, in rather more than half the seasons recorded, rains have occurred in May and October, but the falls have been light, while in sixteen seasons out of twenty, rain has been recorded in June, and in some years the amount has indeed been considerable.[115] The Early rainfall and the Late rainfall are more variable relative to their means than the main or Middle rainfall.

The change in rainfall amount with position is also relatively greater for Early and Late rainfalls than for Middle or total rainfall.

Khartoum, for example, has 11 mm. (0.43 inches) Early and 160 mm. (6.30 inches) total rainfalls, while at Sennar the Early rainfall is 82 mm. (3.23 inches) and the total 456 mm. (17.95 inches). Table 1 in App. 1 also shows how closely the 28-year means for Early and total rainfalls agree with values calculated from the regression of rainfall on latitude and longitude. It will be noticed from the regression coefficients that the relative rates of increase towards the southeast are greater for Early and Late rainfalls than for mid-season rainfall. The standard deviations of the means of five or nine stations (Appendix 'b' and 'c') shows the magnitude of seasonal variations of the area as a whole.(116) Relative to their mean values, Early and Late rainfalls are much more variable than mid-season or total rainfall. In round figures, the standard deviation in the present irrigated area may be taken as 30 (1.18 inches), 90 (3.54 inches), 50 (1.97 inches) and 100 mm. (3.94 inches) per annum for Early, Middle, Late and total rainfalls respectively.(117) Finally, in an analysis of variance of rainfall for five or nine centres over 28 years the means effects of stations and of years may be eliminated, and the interaction between years and stations used to give a standard deviation per station which measures the variability of rainfall between the stations in a single year (Table 5).

TABLE 5 VARIABILITY AND MEAN ANNUAL RAINFALL AT CERTAIN STATIONS in mm.

	Khartoum	Medani	Kosti	Sennar	Singa	Roseires
Mean Annual Rainfall (mm)	160 (6.30 in)	370 (14.57 in)	417 (16.42 in)	469 (18.46 in)	592 (23.31 in)	803 (31.61 in)
Variability (%)	34	22	18	16	13	13

Source: A. Gibb & Partners, op. cit., p. 48

Variability of rainfall, as Table 5 and Fig. 12 inset map show, increases from south to north, and in fact long drought periods occur at frequent intervals of years during August, September and October. The high degree of variability of rainfall to allow for the long drought periods, and the intensity of storms are all factors which frequently mitigate the effective contribution of rainfall to the production of crops. Furthermore, a slight reduction has to be made from the mean rainfall to allow light rains of 5 mm. (0.20 in.) depth or less per day which are not regarded as effective from the agricultural point of view. Such light rains are frequently evaporated before they reach the root zone of the plant.

TABLE 6 DEDUCTIONS TO BE APPLIED TO THE MEAN ANNUAL RAINFALL AT CERTAIN STATIONS TO OBTAIN THE PROBABLE LOW EFFECTIVE RAINFALL

	Percentage of Mean Annual Rainfall (R/F)	
Station	Mean Annual Rainfall Probability	Mean Annual Non-effective R/F
Kosti	18	12
Malakal	18	12
Medani	22	12
Singa	13	12
Roseires	13	12

Source: A. Gibbs and Partners, op. cit, p. 49 R/F : Rainfall

The percentage of the mean annual rainfall which falls in daily amounts of 5 mm. (0.20 in.) or less has been calculated on an average basis because its monthly variation is considered insufficient to justify any analysis. Moreover, the water storage capacity of the soil should be to even out monthly variations from the annual mean in respect of both variability and non-effective rainfall.[118] Thus, without irrigation, considerable hazard is to be associated with the large-scale production of anything other than drought-resistant crops, such as certain types of sorghums.

Another hazard to plant growth imposed by the nature of the soil, as we shall see in Chapter Two, is evaporation. Under the intense heat, much of the water from the rain is easily evaporated from the impervious clay surface (Fig. 5). There are two temperature maxima: one is May and June before the rainy season, and the other in September and October after the rainy season (Fig. 12). Mean annual air temperature is about 84^{o}F (29^{o}C), with extremes of 115^{o}F (46.3^{o}C), and 102^{o}F (39^{o}C), and the daily maximum is 98^{o}F (72.2^{o}C) and the mean daily minimum is 70^{o}F (56.7^{o}C).

Thus, a point of considerable importance to the agriculturalist is that evaporation is at its highest when the river is at its lowest; consequently the demand for water set up by crops and the cost of irrigation are at a maximum during the same period. This fact will largely determine the nature, and scope of agricultural effort, for the crop must be so chosen that its period of greatest water requirement coincides with the time when the cost of irrigation is as near minimum as possible. Evaporation is lowest in the summer months and reaches a peak of over 20 mm. (0.79 in.) per day in April, and the average for Khartoum is 16.5 mm. (0.63 in.) per day, Qurashi 13.5 mm. (0.51 in.), Medani 15.1 mm (0.59 in.), Wad Shair 15.3 (0.59 in.), El Medina 12.8 (0.87 in.) and Sennar 13.7 mm (0.91 in.).[119]

(iii) Climate of the Gash and Bakara Deltas

In the Gash Delta the climate, as in Central Sudan, is conditioned by two main airstreams: the dry northerlies in winter, and the moist southerlies in summer which give rise to a climate of continental type prevalent in the rest of the Sudan. Winter weather, however, differs slightly from the weather further west, but its greater humidity which is shown up by quite heavy dews from December to March.[120] High summer in April, May and June is intensely hot, and during this season the Gash Delta is particularly prone to violent duststorms, which are connected with frontal conditions, and carry thick and fine dust. But, during the rainy season and the Gash flood time in July, August and September, the weather is far cooler, although the rains are followed by a hot spell, rather shorter than in the central plains, until the north wind sets in.

The rain is sparse over the whole Delta, and decreases sharply from south to north as shown by Table 7. The thirty year average for Aroma is 197 mm (7.76 in.) and the 5-year average for Kassala 317 mm (12.48 in.). About 30% of this rain falls in August, and nearly 30% in July, and almost all the remainder falls in June and September (Fig. 13). Normally, the rain falls in violent storms of short duration, and, owing to its intensity, produces considerable run-off. Thus, in the southern parts of the Delta, natives often hold up the run-off by building low banks, and the water so impounded percolates into the soil sufficiently to produce crops of millet, while in the neighbourhood of Aroma and to the north this is only possible in particularly favoured spots or in years of exceptionally heavy rainfall.

TABLE 7 10-YEAR AVERAGES OF RAINFALL IN THE GASH DELTA

Stations from South-North	Rainfall in MM.
Kassala	269 (10.59 in.)
Mekali	185 (7.28 in.)
Aroma	188 (7.40 in.)
Degein	186 (7.32 in.)
Metateib	161 (6.38 in.)
Hadaliya	142 (5.59 in.)

Source: C.H. Richards, op. cit., p. 6

In the Baraka Delta, however, the annual rainfall is 100 mm (3.94 in.) and, unlike the Gash Delta, it occurs in the form of light showers from November to January, but during the winter months, December - March, the climate is similar to that of the rest of the Sudan.

The strong southerly gales, Haboobs, commence in April and extend throughout the summer until October, during which period the temperature rises to 120°F. and violent duststorms are of daily occurrence, the intensity of which renders work and travelling almost impossible, and cotton can only be sown during the fortnight of calm in the beginning of September. Towards the end of October, the southerly gales are replaced by a hot easterly wind known locally as Hababai, which prevails until December,[121] when the cool northerly wind blows in across the Red Sea, and is accompanied by heavy dews at night. The Hababai, too, is a violent sand-laden wind, but is less fierce and less constant than the Haboob. However, both winds change the face of the Delta by piling up dunes and by erosion as already mentioned above. The Hababai will gouge out, for example, a quarter of a mile square (unit of demarcation) and a more of growing cotton and up to 4 feet (1.22 m) depth of earth with it, while the Haboob scours the earth to a far greater depth, although fortunately no damage is done to crops because nothing is grown during the Haboob season.[122]

Rainfall is heavier in the Gash Delta than in the Baraka (Fig. 13), and averages (i.e. in the Gash Delta) 331 mm (13.03 in.) per annum, and ranges from 226 mm (8.90 in.) to 464 mm (18.27 in.). It comes at the same time as the flood, and when both cease in October, the land receives practically no more water till the following July, with the important result that the crop, which is sown after the flood, never has a direct watering after its early growth. In this respect, the Gash Delta differs from the Baraka Delta, where there is winter rainfall to mitigate the rigours of the long dry spell, and thus, in Tokar the rainfall, though light, contributes very largely to the success of the cotton crop. Arriving two months after the period of inundation, the rains form an important contribution in supplying moisture direct to the young plant, and with the heavy dew, assist in preventing excessive evaporation. Moreover, because of its proximity to the Red Sea, the humidity throughout the growing season is much higher and winter temperatures more equable than in the Gash Delta (Fig. 13).

The most serious problem, however, is the action of the wind on the young cotton crop and, as already mentioned, the strength of these winds is so great as to be capable of scouring the soil to a depth below the roots of the plant. Should the young cotton survive this, further troubles occur depending mainly on the size of the flood. Thus, if the land has been insufficiently watered, the cultivator eagerly waits for the early rains to save his crop. If, on the other hand, his land has been generously flooded, he has still to wait for the locusts, driven towards the Delta by the hot easterly Hababai, which is itself destructive to the young cotton, especially in lightly flooded districts. However, the damage which the locusts cause seems to depend on the condition of the desert vegetation around Tokar at the time of their coming. If rainfall has been good in the surrounding areas, the damage done is confined to grass and millet, while if they come off a glaring parched desert, they devour anything that is fresh and green.[123]

From this discussion of relief, geology and climate, we will proceed to discuss very briefly the vegetation of the areas under consideration, and also of possible climatic changes, if any, during the last 200 years, so as to give a more or less clear picture of the ecological setting into which cotton was introduced.

IV VEGETATION

Broadly speaking, the Sudan houses five main latitudinal vegetation zones, although Harrison and Jackson list seven principal categories,[125] and the following discussion on the vegetation of the areas under consideration is based upon the former classification.

The Gezira, in general, bears coarse grass and herbs, and more or less scattered patches of Acacia mellifera, A. orofta, Zizyphus spinachristi, Tundub, and such shrubs as Boscia senegatensic, Grewia sapp., and Cadaba farinosa Forsk. (Fig. 15.) In the land between the Blue Nile and Dinder and Rahad rivers, the dark, heavy brown clay bears thorn vegetation of Capparis decidua, Ballanites aegyptiaca, Heacia orofta, H. Mellifera, A. Seyal, A. senegal, and B. senegalensis, with an undergrowth of such grasses as C. nevatus. On the grassland areas are found scattered trees and bushes, while in the river flats sunt is dominant with an undergrowth of various grasses.[126]

To the east and north of the Rahad river extends the Butana, where the annual rainfall ranges from about 100 mm. (3.94 in.) in the north to about 400 mm. (15.75 in.) in the south along Sennar - Gadaref railway line. Generally speaking, rainfall is erratic except in the south, where considerable growth of grasses remain standing throughout the year. In this area of deep soils, run-off becomes less important and woody plants are generally absent, and, instead, mixed grasses and herbs provide an even and continuous cover. Mile after mile of grass is the feature except along drainage lines or semi-permanent pools where some Acacia arabica or Ballanites aegyptiaca are found. However, the grass sward often is not continuous, but grows in patterns which, seen from above, resemble ripples on a sandy beach.[127]

Further east in the Gash Delta and the river itself, are large forests of Tamarisk articulata, Zizyphur spinachristi, and Acacia sapp., while in the flood plain are abundant tall trees of Calatropic procera with Indigó fera oblongifolia and C. rotundfolia, and the leafless caparis decidua as dominant shrubs. The herbacious flora over the flooded cotton growing area contains principally Cyprus rotundus, parpalidium desertorum, sorghum sapp, and various malvaceous weeds. The Baraka Délta carries similar vegetation.

Along the main Nile north of Khartoum, vegetation is scanty away from the river. D. Cynosuroides Stapf. is abundant, and along the river occur frequent trees of A. arabica, the red barked A. seyal, and the light barked A. Albida, while inland the vegetation consists, in favoured localities, of shrubby A. flara.[128]

These are the salient features of the climate and vegetation, which is correlated with it, of the Sudan today, and at this point it would be appropriate to see if there has been any climatic change since, say, the beginning of the nineteenth century which might have necessitated a different agricultural approach for the British at the beginning of the twentieth century than for the Turks in the 1860's. This is important for the discussion of the thesis since it is assumed that no climatic change has occurred between these two periods.

Indeed, there is no evidence, so far, that the climate of the Sudan has changed during the last 200 years, and the change in vegetation cover is solely due to man's interference and not to any climatic change. The account of many travellerswho visited different parts of the country during the late eighteenth and nineteenth centuries depict a similar picture to that of today. Thus in 1772, James Bruce described the treeless area between Gadaref and Gallabat except for some ebony trees between Gadaref and Beila and along the Dinder river. But from the Dinder to Sennar there was "…. no wood and not even a tree", and people cooked their food by cow-dung and dura stalks.[129] It is very probable that all trees in the neighbourhood of Sennar had been denuded during the Fung period (1504-1820), for agriculture and for firewood for the town. However, between a place 12 miles NNW of Sennar and to the east of the White Nile, Bruce describes the country as full of trees and favourite stations for camel, and just north of Sennar, there was plenty of Acacia nubica, while thick forests of A. arabica lined the Blue Nile bank to the neighbourhood of Kamlin, at which place there were no trees away from the river. Muskau, in 1840, witnessed similar forests of bushes and trees along the Blue Nile.[130]

Lepsius

Years later, in 1853, Lepsis saw thick forests near Abu Haraz, on the Rahad River, including tamarinds, which have now disappeared leaving kerrib land.[131] In 1899, Garstin, recorded much scrub near Shendi as a result of depopulation during the Mahdiya, but he describes thick forests of Acacia nilotica along the Rahad river near Abu Haraz, and along the Blue Nile to the south, and also south of Dueim along the White Nile.[132] C. Dupuis also describes the Gezira plain beyond Kamlin as "a flat expanse without a tree to break the monotony", and it seems that all forests mentioned by Bruce had been cleared, and those available were confined to the eastern bank of the Blue Nile.

Thus, the denudation of forests on a larger scale seems to have started during the Egyptian period (1821-1883), due largely to the increase in cultivated area and boat-building which was probably followed by a parallel increase in population in the northern and central Sudan. The encouragement of western immigrants to settle in the empty lands between the Blue Nile and the Atbara denuded the forests and began to change the face of southern Butana.[133] The Gash and Baraka Deltas were largely cleared for cultivation of cotton and dura. The description of the Gash Delta given by J.L. Burckhardt (1814), L. Rokeby (1872), and Junker (1875) are similar to the present conditions there, except that cultivation is more regular and controlled and planned.[134] During the above dates, <u>dura</u>, and later cotton, were grown in cleared patches among tamarisks and other shrubs already mentioned. In the Baraka Delta, according to tradition, the Delta was fairly well wooded, not so long ago, mainly with <u>acacias</u>, and these trees broke the force of the wind. But about 1860 Mumtaz Pasha, a Turkish officer, (see Chapter Four), cleared the trees away in order to grow cotton, and from that date, the violence of the wind is said to have steadily increased, but there is no evidence of this.[135] Yet, the fact remains that, with a regime like that of the Gash and Baraka rivers, as we shall see in the next chapter, a neglect of a few years could completely change the face of the delta, as it happened in the Gash Delta during the Mahdiya, when thorny jungles, tamarisks, and grass encroached upon formerly cultivated areas, due to neglect, until 1910.[136]

The climatic conditions, rainfall incidence and distribution, were in every aspect similar to those of today. In 1823, Ruppel recorded summer rains falling usually a few times in the year as far north as latitude 20° which were enough to produce low bushes in favourable localities, while description of the climate of the Gezira is identical to that of today.[137] Pallme's account of the climatic conditions in Kordofan in the 1830's, and that of Prout in 1875, is in everyway similar to those of modern times, and even the way of life of the nomadic people in Kordofan and the Gezira, both along the Blue and White Niles, is strikingly similar to the one they led until irrigation development took place from 1911 onwards.[138]

From these accounts, it is clear that there were changes in the vegetation cover in the areas under consideration, and that the changes were solely due to man's activities as a cultivator, herder and boat-builder, and not to any climatic change.

However, in discussing vegetation, the major problem which must be considered is the cost of clearing trees, particularly Ballanites aegyptiacas, and other related types and shrubs. Unfortunately, no reliable figures of clearance costs are available, but the fact remains that the costs of clearing normal stands of Acacias or Ballanites woodlands, wherever they existed, had added considerably to the cost of developing the area concerned. Acacia scrub clearance, on the other hand, would vary greatly depending on the density of the scrub. In the Gezira, there are perennial weeds which, because of the damage they cause to cotton, need mentioning. These have deep roots, and thus use up nitrogen and impoverish the soil during the whole of the fallow period, and some of them, which are difficult to kill, keep on growing after cotton is sown and compete with it. For example seid (Cyperus rotundus) and nageel (Cynodon dactylon Pers.) do this.

However, except in Zeidab, where the initial cost of scrub and trees clearing and also levelling was expensive, little heavy clearing was done in the Gezira, where vegetation, except in low-lying areas and towards the more rainy south, consisted of thin acacia scrub and some tufted grasses like Ankuj and Moleita, the above-mentioned weeds having in fact increased after irrigation was applied to the land. Thus, the initial cost of clearance was comparatively small, and whatever trees cut down were used as fuel for pumps at Tayiba and Barakat.

The uncertainty of rainfall in many parts of the northern Sudan is a hazard to production of crops like cotton, and for this reason large scale commercial cotton growing has always been closely associated with irrigation from the Nile or the seasonal rivers, such as the Gash and Baraka. Thus, the waters of the Nile and the soil derived from the silt it carries, have been the most important physical assets of the country, and in the Chapter which follows it is proposed to examine in more detail the hydrology of the Nile and soils of the areas under consideration in an attempt to establish, together with Chapter One, the physical background to the production of commercial cotton. This discussion, however, will necessarily focus upon certain key areas, and will incorporate retrospectively data and information derived ultimately from the more sophisticated post-1925 research and experiments.

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CHAPTER TWO

THE PHYSICAL BACKGROUND TO COTTON GROWING: HYDROLOGY AND SOILS

The physical factors other than climate that are of particular importance when considering the basis of cotton growing in the Sudan are the availability and supply of water and the nature of the irrigable soils.

I. HYDROLOGICAL FACTORS

In the Sudan the critical values for rainfall probability has been used to determine the necessity for irrigation, and for this purpose N.W. Allen chose the values of 100 mm. and 500 mm.(1) According to him an annual rainfall value of less than 100 mm. is not enough for raising any crop, and, therefore, irrigation becomes a necessity for crop production, while an annual rainfall value of 500 mm. is sufficient for rain cultivation, irrigation only being necessary during drought periods. Thus, according to this system, the percentage probability of receiving more than 100 mm. is 50% in the southern two-thirds of the country, and decreases northwards from about 16°N reaching less than 1% in the extreme north, thus indicating the necessity for irrigation north of latitude 16°N. The percentage probability of receiving more than 500 mm. of the annual rainfall is at least 100% for almost the southern half of the country (Fig.16).

The importance of irrigation for the economic development of the Sudan can hardly be questioned if the restricted rainy season is taken into account. This factor has, from the earliest times, led to a concentration of population along the Nile and its tributaries. Thus, despite the availability of plentiful agricultural land, the risk and uncertainty of production associated with unreliable rainfall has not led, until very recently, to the development of agricultural production centres away from the Nile (except in those areas which can be irrigated from the Nile and the Gash and Baraka Deltas). Only in these areas has a demand for land existed for some time, where some degree of assured, regular irrigation by flood or artificial irrigation has given the land a premium. Moreover, the soil productivity and economic prosperity, not only of the Sudan but also of Egypt, are mainly dependent on irrigation by the Nile. Therefore, the seasonal variation in the supply of water and the amount available for irrigation each year have necessitated a detailed study of the hydrology and regime of this river and its tributaries.(2)

The Nile is a distinctive river not only because of the variations in the volume it carries but also because its importance varies according to the system of irrigation practised. For basin irrigation, for example, the height of the flood is important because this system requires a flood of a certain height to maintain flow of water into the basins, while for perennial irrigation which is mainly practised when the Nile is at low discharge, it is the quantity of water which matters. Thus, for the former system August and September are important because this is the high flood period. For the latter system, the period from March to June, when the river is at its lowest, are important because, if the natural flow is not supplemented by water already stored behind a dam, the natural river flow would fail to meet the requirement of perennial irrigation during this period.

The regime of the Nile is complicated when examined in detail: for example, the total discharge in a year of very high flood may be more than three times the discharge in the lowest known year. The water supply comes from three main tributaries: the Blue Nile, the Atbara and Sobat rivers from Abyssinia, and the White Nile from the lakes plateau of East Africa (Fig.4). The character of these rivers are shown in Fig. 17. The Atbara and the Blue Nile are rivers of torrential nature with rapid fluctuations during the flood period but during the low period, the Atbara is reduced to a series of pools, and the discharge of the Blue Nile becomes about one-fifth of what it was at the peak of the flood. It is the Blue Nile, however, which determines the shape of the main Nile curve. On the other hand, the head streams of the White Nile are also subject to fluctuations, but the White Nile itself is a much more regular river, its discharge at its lowest being on the average rather less than half its flood discharge (Table 8).(3)

From the point of view of irrigation in Egypt, the White Nile is more important than the Blue Nile, and it is to conservation work on this river that Egypt has always looked for the development of its cultivable land. The White Nile begins to rise in May, but the rapid rise of the Blue Nile, by ponding water in the White Nile valley above Khartoum, prevents this rise from affecting the discharge of the main Nile until later (Fig. 17).[4]

TABLE 8. MAXIMUM AND MINIMUM DISCHARGE OF THE MAIN NILE (8th OF SEPTEMBER AND 10th OF MAY RESPECTIVELY)

Tributary	Maximum Discharge		Minimum Discharge	
	Million M^3/Day	% of total	Million M^3/Day	% of total
White Nile	70	10	37.5	83
Blue Nile	485	68	7.5	17
Atbara River	157	22	nil	-
Total	712	100	45	100

Source: H.E. Hurst, (1957), op. cit., p. 242

II. HYDROLOGY OF THE NILE AND TRIBUTARIES (Fig. 17)

It is the quantity of water available for irrigation that ultimately determines the size and scope of agricultural undertakings - the availability of suitable land being granted at this stage - and it is the quantity available, not only for developing a certain area but also for the countries through which the river flows, that always involves political arguments about the allocations of water to each country - a characteristic feature of the Nile which is also complicated by the large variation in quantities carried from year to year and in the seasonal flood.

Thus, during the low Nile period from January to June, the mean total discharge below Khartoum is 13.8 milliard cubic metres of which the White Nile contributes 10 milliard cubic metres, and the remainder, 3.8, by the Blue Nile, the Atbara being almost dry during the period (Table 9).

From the beginning of July the river rises rapidly reaching the peak about the end of August, then falls almost as fast until the end of October (Fig. 17). From July - December, the mean total discharge just below Khartoum varies between 73.5 to 75 milliard cubic metres, of which 23 milliard comes from the White Nile and 52 milliard from the Blue Nile,

TABLE 9 TOTAL AND SEASONAL FLOW OF MAIN NILE AND TRIBUTARIES IN MILLIARD CUBIC METRES (M^3)

Rivers	Total Flow	Seasonal Flow	
		July-December	January-June
White Nile	27.0	17.0	10.0
Blue Nile	50.5	45.0	5.5
Atbara river	12.0	11.5	0.5
Main Nile (below Albara)	89.5	73.5 - 75	16.5
Main Nile at Aswan	84.0	69.0	15.0

1 milliard = 1,000,000,000 Cubic metre = 35.3 cubic feet

Source: H.E. Hurst (1957) op. cit., p. 249

and the remainder from the Atbara river. The last two rivers are heavily laden with silt in July, August and September, while the White Nile is relatively free from silt, that amount present in it being mainly brought by the Sobat river.(5)

The Blue Nile average discharge at Roseires is estimated at 60.25 milliard cubic metres, of which only 3.83 milliard M^3 comes from Lake Tana, and 46.4 milliard from the tributaries that join the Blue Nile between Lake Tana and the Sudanese boundary (Fig. 4). A further source of supply below Roseires comes from the Rahad and Dinder rivers, which contribute 1.0 and 3.0 milliard M^3 respectively. An interesting feature of the Blue Nile is that 80% of its total annual flow occurs in the period from mid-July to mid-October, and 90% from July to September (Table 2, App. 2).(6)

The White Nile, on the other hand, gets its flow mainly from the lakes plateau through Bahrel Gebel and from Abyssinia by the Sobat river. The average discharge of Lake Victoria at Ripon Falls is 65.2 million M^3 per day (or 20.6 milliard M^3), but after Lake Kioga, the average discharge is reduced to 49.4 million M^3 per day (or 19.7 milliard), the loss being due to evapotranspiration from this lake (see App. 3 for the annual balance sheets from all sources). Immediately below Lake Albert, the river carries 24 milliard M^3, the increase being due to rain directly falling on the lake and contribution by Semliki river. From Lake Albert to Mongolla in the Sudan, the normal flow of Bahrel Gebel, as it is now called, is estimated at 27 milliard M^3, the increase being supplied by the various torrential streams joining the river in this reach. However, half of the amount entering the Sudd Region, about 13 milliard M^3, is lost be evapotranspiration and over-spilling, but as a result of the natural regulation effected by the Sudd, the flow from Bahrel Gebel into the White Nile via Lake No is more or less uniformly distributed throughout the year (Figrs. 4 & 17).(7) The Sobat flood comes during Jûly to December, its total annual contribution to the White Nile at Malakal being 13 milliard M^3. However, a loss of 4 milliard M^3 is experienced in the Machar Swamps and the flat terrain through which it flows, where, by overspilling and scattering of water, the flood of the Sobat is delayed.

From the junction with the Sobat, the behaviour of the White Nile is governed by the combined behaviour of the Bahrel Gebel and Sobat rivers. Unlike the Blue Nile, the White Nile gets its peak of the flood in October - November and, as a result, it forms a natural flood relief for the Blue Nile. The total annual flow of the White Nile at Malakal, estimated at 27 milliard M^3, is uniformly distributed among the months of the year (Fig. 17), and this qualifies it to be an ideal source of irrigation. But actually it is not, because, first, it being broad and a sluggish river, the possibility of diversion is remote; secondly, the Blue Nile can command the lands in the vicinity of the White Nile from Sennar and Roseires; and thirdly, because of heavier rainfall, waterlogged and swampy conditions towards the south, the need for irrigation, until extensive drainage works are undertaken, remain small. Thus, it appears that north of Malakal the White Nile, due to its pattern of flow, offers good prospects for utilising the available land with full intensification from the water point of view.

Between Malakal and Khartoum, the White Nile loses 4 milliard M^3 by evaporation, but the large volume of water added by the Blue Nile and Atbara rivers increase the discharge at Wadi Halfa to 89.5 milliard M^3.

However, due to the desert conditions and pervious sandstones through which the Nile flows in this reach, the amount is reduced to 84 milliard M^3 at Aswan. Of this mean annual discharge at Aswan, 84% comes from Abyssinia (68% from the Blue Nile and 16% by the Atbara) and only 16% from the White Nile.[(8)]

Thus, the behaviour of the main Nile is governed mainly by that of the Blue Nile during the flood period. During the low water stage, the shape of the flow is broadened out and the low flow of the Blue Nile is replenished by the staple behaviour of the White Nile. The flood season of the main Nile from mid-August to mid-November (corresponding to mid-July to mid-October at Roseires) contributes 55% of the total annual flow as compared to 80% in the Blue Nile.

The great river system of the Nile runs through the Sudan, but it does not drain it. No sizeable river rises in the Sudan and enters the Nile, except Bahr el Ghazal which, though receiving runoff from an extensive area, adds practically no water to the Nile. Various seasonal streams enter the Nile, but hardly any of them carry enough water to make it worthwhile to measure it. In the southern plains there are extensive areas of permanent swamp, fed by spill from the Nile, and between evaporation and spill the Sudan is certainly the scene of the loss of immense quantities of water from the Nile. These huge losses in the face of the increasing demand for irrigation water both in Egypt and the Sudan poses various problems because the basic problem of irrigation in the Sudan is water shortage during part of the year, caused by large seasonal variation in the levels of the Nile.

III. IRRIGATION PROBLEMS IN THE SUDAN

The bulk of this seasonal variation arises from the Blue Nile, the White Nile at Khartoum being relatively constant. The Blue Nile has an average range of about 8 metres between low and high level, while its discharge varies from 10 to 500 million M^3 per day (Table 10). In the flood time the river fills a channel about 400 metres wide and 10 metres deep, while at low stage it is usually less than 200 metres wide and 2 metres deep, and winds about in the floor of its channel among sand banks or, near Roseires, pebble banks.

TABLE 10 DAILY DISCHARGE OF RIVERS.
MONTHLY MEANS 10^6 M^3

River	Year	J	F	M	A	M	J	J	A	S	O	N	D
Main Nile at Halfa	227	98	83	67	63	72	93	156	556	690	476	234	126
White Nile at Khartoum	71	80	60	48	45	47	54	50	51	99	121	104	93
Blue Nile at Khartoum	145	29	19	13	8	15	43	189	505	491	263	103	51

Source: Hurst & Phillips, op. cit., Vol. V (1938), p.1

These great variations in the levels of the river, as well as in the quantity it carries, from one season to another, undoubtedly impose some problems for irrigation. The ideal site conditions for any water-lifting device, such as pumps are: (a) Deep water close to the bank at all stages of the river; (b) Permanency - subject neither to erosion nor to silting in front of the inlet; (c) A bank face of steep slope so as to involve the shortest possible length of suction and discharge piping: (d) Immediately behind the bank, ground as high as the higher parts of the irrigable area to avoid canalisation in high banking, and (e) Location immediately adjoining the irrigated area.(9)

Conditions (a) and (b) are indeed essential for the convenient operation of the pump, while the other conditions mainly affect the capital cost of the scheme per feddan of cultivable area. However, there are few places where these conditions are met. In the Blue Nile region, the main limitation to irrigation by pumps is the topography immediately inland of the river bank, which lacks condition (d) above, thus entailing rising mains, high embankments and other structures, as at Tayiba and Barakat (see Chapter Seven).(10) The only site, however, where these conditions were greatly satisfied was at Hag Abdalla. But because of the high variations in level already mentioned, the pumps erected along the Blue Nile had to work at a very high lift of a maximum of 20 mètres during the season of low river, while at high flood this is reduced to 10 metres and less. For saqias, the high lift and instability of the river banks, except in favourable places like Kamlin, were too great for the oxen to draw, thus putting more limitations on the already limited irrigation capacity of this cumbersome native contrivance (see Chapter Three).

The White Nile, on the other hand, is a sluggish and almost currentless river, with very gentle gradient of about one metre in every kilometre. The land on both sides is flat and slopes towards the river, and the channel is wide, and the variation between low and high stages of the river is only 4 metres. Thus, there is no high lift here, as in the Blue Nile, although during the low stage the river recedes back, leaving wide tracts of exposed banks, thus necessitating shifting of the pump site. This contravenes with condition (b) above, and the fact that the land slopes towards the river does not fulfil condition (d) either. Only when a reservoir is created to lessen this variation, whereby the level is made more constant, can the White Nile offer advantageous conditions for pump sites, and this was achieved by building a dam at Gebel Aulia in 1937. However, the rarity of saqias along the White Nile south of Khartoum is mainly because the riverine tribes, before the building of the above dam, were pastoral and cultivated only incidently (see Chapter Three).

In northern Sudan along the main Nile, the main engineering difficulties are first, to find reasonably suitable pump sites and then to ensure their permanency, and secondly, the irregularity of cultivable land, sometimes wide and occasionally narrow. Both of these difficulties tend to increase the capital cost of development per feddan. A further difficulty is the high lift required in many cases during the low river season. All this undoubtedly emphasises the importance of the economic aspects of the schemes in the area. The cash value of the crops produced has to be fairly high to give an adequate return on capital invested and meet the cost of transport, and leave a fair profit for the cultivator himself.

Apart from the physical factors posing irrigation problems, the chemical qualities of any river are as important as its quantity for irrigation purposes, for if it contains too much soluble salts, and in particular too much alkali, the water becomes unsuitable for irrigation. Fortunately, apart from the relatively large content of suspended matter during the flood period, the Blue Nile water compares favourably with other irrigation waters, and has proved to be of good quality for the irrigation of the alkaline clay soils of the Gezira (Table 4 and App. 4).

TABLE 11 CHEMICAL QUALITY OF THE BLUE AND WHITE NILES, AND THE FORMER (A) COMPARED IN SOLUBLE MATTER WITH OTHER IRRIGATION WATERS (B)

PROPERTY	BLUE NILE (A)	WHITE NILE	Soluble Matter in Solution (B)	
			River or Place	%
Solids in Suspension	Vary from 4 ppm in Feb. to 2000 ppm in August	Vary from 26 ppm in Sept. to 167 ppm in August	Blue Nile California Arizona New Mexico	.01 .06-.07 .10 .25
Solids in Solution	Generally between 100 and 150 ppm	Generally between 150 and 200 ppm	New South Wales	.05
Calcium-Sodium ratios	High - generally 3-4	Low: especially in March when it is about 0.4		

p.p.m = parts per million. Sources: A. Gibb and Partners, op. cit., p.62
E.J. Russel & Martin-Leake, op. cit, pp. 8-9

The Blue Nile water was found to contain only about 0.01% of the dissolved solids in the period August-December - a figure which is not unduly high, though one would prefer it to be lower.(11) Each watering of 450 M^3 adds 0.9 cwt. of salt to the *feddan* during the season (of cotton growing). Moreover, the water is distinctly alkaline, its pH value being 8.7, but not sufficiently high to cause alarm, and it also possesses a valuable property of a high ratio of calcium to sodium salts. The waters of the White Nile also have a low suspended matter and salt content, but the ratio of calcium to sodium is less favourable for irrigation purposes compared with the Blue Nile (Fig. 18A). The concentration and amount of suspended matter in the Nile is shown in Figrs. 18A and 18B, and this totals annually to 100,000,000 tons containing 30,000,000 tons of fine sand, 40,000,000 sand and 30,000,000 clay.(12) Appendix 4 gives detailed analysis of the Blue and White Niles waters together with matter in solution in the Nile from source to Cairo. The soils from the irrigation point of view will be discussed later in this chapter.

Although the country depends on the Nile for its most ambitious schemes, there are still some small, but valuable, streams, such as the Gash and Baraka, which provide a system of irrigation far more simple than along the Nile (see Chapter One). Although with much less complicated regimes and much lesser volumes than the Nile, cotton was introduced into, and indeed was successfully being raised in, their rich deltas long before it was started along the main Nile, where politicians and engineers were haggling and wrangling over the allocations of the Nile waters between Egypt and the Sudan, when preparations for the Gezira Scheme were under way. For their past history in the development of cotton growing in the Sudan (see Chapter Four), and their present importance as producers of fine cotton, it is worthwhile to conclude this section on hydrology by discussing their hydrology.

IV. BARAKA AND GASH RIVERS: HYDROLOGY

In contrast to the Nile, although they are called rivers, the Baraka and Gash are in fact torrential streams that come tumbling down from the Eritrean Highlands during the rainy season, and dry up for the rest of the year. Nevertheless, their agricultural value has always been great.

(i). The Baraka River:

The catchment area of the Baraka lies in the Eritrean Highlands and with tributaries, the main being Anseba, it drains an area of approximately 35,000 sq. Km. In the Sudan, it is joined by Khor Langeb. Downstream of this junction, the Baraka consists of a broad shallow river, which narrows down to an average width of 100 metres and, when in spate, flows in a single clearly defined channel until the rocky gorge of Sheddin (Fig. 64). Downstream of Sheddin, the river broadens and then narrows with a deep straight channel, and at about 10 Km. northeast of the gorge, it splits up into a number of branch channels (Fig. 64).

With decreasing slope towards the sea, the channel becomes gradually silted up and gets shallow and consequently breaks up into a number of small khors. On emerging from these khors, the water flows over the land in broad sheets, depositing its silt as it goes until, at a distance of about 35 Km. northeast of Sheddin, the water becomes comparatively clear. It then scours out deep channels through the sand dunes and, traversing the salt marshes, finds its way to the sea.

Generally speaking, the Baraka is in flood from about July to September, the maximum discharge being more or less between July 15 - August 15, although the possibility of an earlier or late flood is always there. However, although accurate observations of the Baraka in flood had only been taken over three separate years (before 1923), the 1913 flood can, for convenience, be considered as an average year. Here the first flush occurred on July 6, the river continuing to flow intermittently until September 22. During this period, the total quantity of water discharged was 206 million M^3, and, moreover, five important flushes occurred during the period from July 19 to August 22, the maximum being reached on July 19, when a discharge of 860 cumecs was recorded. The maximum discharge was in 1920 when it reached 1120 cumecs, with a surface velocity of 7.2 metres per second, and seven important flushes lasting for 60 days.[13]

However, an important feature of the Baraka is the heavy load of silt it brings down each year (Table 5 App. 5). This silt is of a fine powdery nature which rapidly disintergrates under the action of sun and wind. The results of samples taken in 1920 on Khor Langeb and Baraka show that the quantity of silt in suspension brought down by the former is approximately identical with that carried by the Baraka itself (Fig. 18A). The Nile, during the flood carries a maximum of 2,100 parts per million at Berber, and comparing this by the results above, it will be seen that the silt in suspension in the Baraka is 46 times greater than that of the Nile.[14]

This great load of silt, its nature, the greater variation in the flood level, and the number and duration of spates, and heavy scouring by both wind and the river itself, and the tendency of the latter to change course, have their advantages and disadvantages. The advantages are, first, allowing of the soil to recuperate by this natural fallowing method. Secondly, lessening the problem of excessive growth of weeds under conditions of successive annual flooding, entailing expensive clearing which would raise the cost of cultivation. Thirdly, during the enforced flow, i.e. flood peak, the weeds die out, and by the time the flood swings back, little or no clearing would be required, and fourthly, it gives freedom from pests and diseases.

The disadvantages are, first, the insecurity that any particular area will be flooded in the ensuing year with the result that native tenants are averse to spending money and labour on their holdings in preparation for water which may never come. Secondly, the fact that, with the flood being under no form of control, considerable areas of the Delta are too lightly flooded to give any crop, and as a result this amount of water is wasted, and similarly a certain amount of water is unavoidably lost through passing on to unsuitable land. (Fig. 19).

Thus, compared with the Gezira, the Baraka Delta can, therefore, be regarded as an area where the cost of cultivation is low, the average yield is low, but the area under cultivation is large, and that there is always the gamble to the cultivating leasee of receiving a piece of well-watered land where, at a low cost of production, a good yield of cotton can be obtained.

(ii). <u>The Gash River:</u>

The Gash river, called Mareb in its Upper reaches, has its head-waters in Eritrea, but unlike the Baraka it is perennial there and progressively becoming emphemeral towards the Sudan plains. A little downstream from Gebel Kassala, a major spill channel, <u>Khor</u> Kwenti, takes off on the west side and carries a lot of water during high floods (Fig. 8). Near Gebel Kassala, the Gash is joined by <u>Khor</u> Abu Alaga downstream of which junction the Gash channel tends to get wider and spreads instead of the well-defined course it maintains above this junction. But while the main course of the river has not changed for many years, the bed is most unstable; silting and scouring, though balancing out one another in general and over large stretches, cause constant changes in details as sand banks move from one side to another of the bed and erosion attacks one bank and then another (Fig. 20). The average width of the bed is about 300 metres, and the flood plain, varying in width from one Kilometre to virtually nothing, is intersected by small spill channels.[15]

However, the Gash has a similar regime to that of the Baraka. It is usually in flood from early July to September, the extreme dates recorded being June 10 to October 18. Like the Baraka, its flow is torrential and highly variable, and it may increase from a mere trickle to a high spate of 800 cumecs within a day or even a few hours. Nevertheless the total discharge for the flood season has varied from about 140 million M^3 to about 1,260 million M^3, and on the average over 22 years 0.5% of the flood passed in June, 25% in July, 55.5% in August, 18.7% in September and 0.3% in October.[16] The variability in discharge from one year to another can be discerned from Fig. 68

Moreover, the Gash, like the Baraka, also carries a large quantity of silt, but this load varies enormously, the highest recorded being 9,722 parts per million by weight at Metateib in 1939, while at Hadaliya to the north the highest recorded in the same year was only 1,480 parts per million.[17] Fig. 18 shows the load of silt recorded in 1926 and 1939 at Kassala and Magauda, thus showing similar variations although Magauda, lying to the north of Kassala, shows a higher load in 1939 than in 1926. However, despite these variations, an average figure might be taken as 5,500 parts per million or 0.55%. Indeed the proportion of silt carried by the Gash can be gauged by comparing it with the average figures for some rivers, which are given as percentages: The Nile (just south of the Second Cataract), records 0.15%, the Indus 0.40%, Colorado river 0.90%, Sütlej 0.05% and the Yellow river as high as 38% (not average).[18]

Thus, the intermittent and variable nature of the regimes of these rivers undoubtedly have constituted a major problem in irrigation and river control, but it was only after 1910 that this problem was seriously studied, and although some measure of control has been effected on the Gash, the Baraka is still more or less the master of its own behaviour. However, having gained some knowledge about these rivers, it is appropriate to discuss the soils they irrigate.

V. SOIL CONDITIONS

In the Sudan, as well as everywhere, the soil types are influenced by the climate, the nature of the parent rocks, relief, drainage and vegetation. The climate is tropical continental, with rain increasing from nil in the north to some 1,750 mm. (75 in.) per annum in the south (Fig. 9). As a result there is a transition from absence of true soil through varieties of arid and semi-arid soils characterised by the presence of gypsum, salt and calcium carbonate, to lateritic soils. With regard to parent material, it is mainly derived from the Archaean Basement Complex, wind blown sand

and alluvial clay (probably from the basaltic highlands of Abyssinia). Relief, due to its level or gently sloping nature, has no great influence on soil genesis.

Today, most is known about the soils of areas having potential for agricultural development, such as the Gezira, the Gash and Baraka Deltas, and the riverine areas. The Central Clay Plain (Fig. 5), where today's agricultural schemes and future development prospects exist, is worth considering very briefly before going into a detailed discussion of the soils of the areas concerned.

VI. The Central Clay Plain:

This embraces one of the largest group of soils in the Sudan (Fig. 5). Here heavy clay is dominant although slight variations in the mode of formation and the origin of the clay material lead, in conjunction with variations in climate and vegetation, to local soil differences, mainly in clay content and salt distribution. Thus in the Butana plain, which forms the northern lobe of the clay plain, the breakdown of the local rock both Basement Complex and Basalts (Figrs. 5 & 6), has resulted in a soil which has "a top horizon of friable clay loam, grey brown and a slightly heavier textured darker horizon beginning about one foot below surface".(19) Calcium carbonate concretions occur throughout in small amounts but, unlike that of the Gezira, there is no gypsum and little salt, indicating that the parent alluvium might be of local origin. To the east and south of the Butana, the undulating surface has resulted in soils being better drained and more varied in texture, cracks being wider and deeper, and alkalinity low, with much calcareous materials in the second horizon which persists to a greater depth than in the Gezira. Westwards towards the White Nile, there is an increase in the clay fraction, probably due to reduction in the velocity of the water that carried the sediment till deposition.(20)

The features of these clays, which have an important bearing on their soil characteristics are fine texture, generally over 60% clay (0.002 mm.), alkalinity, high pH (9.0 - 9.5) which is correlated with the abundance of easily decomposed minerals together with relatively poor teaching by surface water; the thickness, demonstrating constant conditions of deposition over a considerable period is more or less uniform. However, the degree of alkalinity varies in response to rainfall and also with the composition of the exchange complex. The more northerly soils are saline with a well-marked change in salt content down the profile. The salt content and distribution are not, however, solely controlled by the rainfall. The Gezira area, and a large area to the east, have a striking difference in salt content under similar rainfall, which may be due to local conditions of climate and nature and origin of the parent material.

VIII THE GEZIRA SOIL

Various hypotheses have been put forward to explain the origin of the Gezira clay plain. Some asserted that it was lacustrine,[21] some acolian,[22] and others that it was of alluvial origin.[23] However, due to lack of evidence of shorelines, beach and salt deposits, the first hypothesis was discarded, and this leave the third hypothesis as the most probable mode of deposition, and indeed all evidence present today, particularly the distribution of freshwater shells, clearly indicate that the Gezira soil was deposited from fine material by seasonal flooding of the Blue Nile, the duration of flood being longer near the river and decreasing towards the west. A tentative dating of this deposition is given by Tothill (1946) as between 50,000 - 10,000 B.C.[24]

However, practically nothing was known about the soil of the Gezira before the scheme except that in years of good rainfall, it produced good crops of dura. Nevertheless, the soil has shown itself to be capable of producing good yields of high quality cotton under favourable conditions, but it has certain qualities and defects which impose definite limits upon the cropping that can be followed. Throughout the Gezira the soil is remarkably uniform clay with rare textural variation except along the White Nile where it exhibits profiles of obvious recent alluvial origin with bands of shells and sharp change of texture. The characteristics of Gezira soil can be summarised as follows: (a) It is very heavy containing 55 to 60% clay, with little variations in depth; 13 to 20% silt, varying irregularly with depth; fine sand 12 to 20%; coarse sand 2 to 10% usually falling off slightly with depth, and stones and gravels rarely more than 2.5%, these usually being calcium carbonate (Table 6 App. 6). Gypsum occurs in considerable quantities in lower layers (Fig. 22).[25] (b) It contains very little organic matter ——, not more than 0.015% of nitrogen, and 0.3 to 0.4% of organic carbon, these values being about one-tenth and one-fifth respectively of those for arable soils in England.[26] Indeed the nitrogen amount is exceedingly low, it being a little more than 300 lb. per feddan in the top 9 inches of soil (228.6 mm). As to organic carbon, these figures taken from 4 foot (1.22m) samples are of interest: Kamlin 0.196; Tayiha 0.332; Medani).234; Hosh 0.421; and Sennar 0.468. In the last case, samples were taken down to a depth of 20 feet (6.10 m), and humus gradually diminishing from 0.5 at the top to 0.08 at the bottom.[27] (c) It contains appreciable quantities of soluble salts, 0.07% for the first foot and more in the lower depths, and it is distinctly alkaline, pH values of 9.4 - 9.5 being not uncommon. The soil is more alkaline, and also saline, above than below, because of the presence of sodium bicarbonate, sodium sulphate and sodium chloride.[28]

The profile is surprisingly regular throughout the plain in the top 6 feet (1.83 m.) which consists of three horizons: a dark brown top horizon down to 2 feet (0.61 m) and a grey second horizon again about 2 feet (0.61 m.) thick resting on a very considerable depth of yellowish brown soil (Fig. 22).[29] These layers are not sharply divided and it is common to find deep tongues of the surface soil penetrating the grey soil as a result of deep cracking which allows the surface soil to be washed down into the lower layers. However, the proportion of the brown, grey and yellowish brown soil vary considerably, which means that the compactness of the profiles varies, and that the occurrence of the salty grey and yellowish brown layers also mean the main root zone is more salty than in profiles which have a deep brown layer, especially towards the south with increasing rainfall in that direction.[30]

The original soil analyses in the Gezira were designed to determine soil fertility, and soil productivity studies, expressed by cotton yields, are very recent. Both Crowther and Gray used basic mean yield, i.e. average yield which would be produced by the whole of blocks of the Gezira (1941).[31] Then Jewitt (1955) comprehensively examined the data available from soil analyses and Crowther's basic mean yield and, quoting the work of Snow (1938), considered that the sodium value gave a reasonable reflection of the soil productivity as far as cotton is concerned.[32] Sodium values have, therefore, since been used in assessing the fertility of new areas for cotton growing, and only areas with sodium values below 35 have been brought under irrigation. This concept was first tried at Dueim on the White Nile and later in the Gezira (Table 12).

TABLE 12 SOIL EVALUATION SYSTEM OF SUDAN ARID CLAY PLAIN
(Data refer to the 0 - 90 cm. Soil Layer)

Class		Sodium Value	Clay %	Salt %
I	Good	0 - 25	> 40	< 0.3
II	Medium	26 - 35	≯ 35	< 0.5
III	Bad	> 35	< 35	> 0.5

Source: Finck and Octman, op. cit., p. 88

However, the reliability of sodium value was set against the estimated yield of Sakel cotton according to the sodium value as calculated by Jewitt and the block basic yield of Sakel from the same table. Toms (1960) after examining 36 blocks (administrative units of the Gezira Scheme) found a coefficient of determination of only 18% and regarded the correlation unsatisfactory, and concluded that sodium values alone cannot be used to form a true estimate of the soil productivity.(33) Moreover, a recent work by Finck and Ochtman (1961) excludes sodium value as a true index to soil fertility.(34) They found that the level of fertility had been greatly overestimated and soils classified as medium produced poor yields, and it was pointed out that theoretically for the Gezira the yield correlation of the sodium value was rather low, only up to 10%. As a result doubts have been expressed as to whether sodium value could be a good criterion for yield estimate on non-sodic soils, and that since sodium content decreases if land becomes cultivated, correction quite often was entailed. Instead they found a close association of cotton yield with clay content in two out of three cases they examined (Table 7 App. 7).(35) But the causal relationship underlying this clay-yield association has not yet been studied (Fig. 21 and Table 13), except that the high clay content was found to cause the low permeability, which, by interfering with root growth and water supply to the plant roots, also causes low fertility.(36)

From this general introduction, we can proceed to discuss in some detail the main characteristic features of the Gezira soil.

TABLE 13 COMPARISON OF YIELD ESTIMATION FROM SODIUM VALUE AND CLAY CONTENT AT DUEIM

Plot	Soil Data		Measured Relative Yield %	Estimated Yield %	
	Clay	Sodium Value		From Sodium Value	From Clay
23	61	128	128	76	110
16	56	60	60	125	92
101	15	39	37	122	43

Source: Finck & Ochtman, op. cit., p. 90

(i). Salt Distribution:

The amount of salt at the surface is relatively low and increases with depth to a maximum and then begins to decrease as Table 14 shows of the mean content for six steps for four groups of holes from northern Gezira. (See also Table 8 App. 8.)

TABLE 14 SALT DISTRIBUTION FROM HOLES IN NORTHERN GEZIRA SHORTLY AFTER IRRIGATION STARTED

Six inch step (mm.)	1 (25.4)	2 (50.8)	3 (76.2)	4 (101.6)	5 (127.0)	6 (152.4)	7 (177.8)	8 (203.2)	9 (228.6)
Salt Content %	0.04	0.11	0.19	0.38	0.45	0.51	0.48	0.46	0.45

Source: T.W. Jewitt (1955), op. cit.,

The different salt content in the clay soil has one direct effect upon the properties of this: when salt content rises in the profile to about 0.25%, flacculation of the clay occurs, and there is a corresponding change in properties at this point in the profile.[37] The results of the first investigations carried out for selecting land for inclusion in the irrigation scheme are shown in Fig. 23, and it clearly shows that the saltier soils occur in areas of lower rainfall to the north and west of the irrigation area, the less salty ones being mainly towards the south on higher ground, and districts of heavier rainfall (Figrs. 7 & 12).

The salts seem to sink an inch or two when the soil is watered and to rise again when the soil dries out, but these changes have been traced not to a displacement of salts, through the soil material, but to swelling and shrinking of the less saline surface soil occasioned by changes in moisture content and to mechanical disturbance and settling which depends on cultivation.[38]

(ii). Soil Permeability:

Experiments have shown that increasing content of exchangeable sodium leads to a deterioration in the physical propetties of soil. Indeed the fact that the Gezira soil is alkaline and that material extracted by water from soil is mostly sodium carbonate, suggests that the low permeability of the soil (Table 15) is due to the amount of sodium which is in chemical

TABLE 15 MOISTURE PER CENT AFTER FLOODING, GEZIRA SOIL

Foot (Metre)	1 (0.30)	2 (0.61)	3 (0.91)	4 (1.22)	5 (1.52)	6 (1.83)
Before Flooding	13.8	17.9	18.8	21.6	22.2	21.3
After 3 days of flooding	35.6	32.2	26.0	23.1	22.1	21.4
After 14 days of flooding	33.5	33.4	32.0	26.2	22.0	21.0

Source: H. Greene (1928), op. cit., p. 5

combination with clay. It appears from Tables 15 and 16 that the object of irrigation should be to maintain a sufficient depth of soil moisture at a moisture content between 30 - 40%. Experiments have indeed shown that although the soil has a high water-holding capacity, indeed greater than that of the Gash, its permeability is low so that at the Gezira Research Farm no considerable part of rain-water or of irrigation water penetrates below a depth of 3 feet (0.91 m.) while the bulk of it is held up in the top 2 feet (0.61 m.) to which region root development is largely restricted (Fig. 22).[40] Under the native system of cultivation of directing rain-water to selected areas by light earth banks, only the top foot receives a

TABLE 16 MOISTURE CONTENT AND SOIL CONDITION

Moisture Content %		Condition of Soil (as percentage of dry weight)
Over	60%	Maximum water-holding capacity
Over	40%	Maximum for healthy growth
About	40%	Moisture equivalent
	36 - 40%	Optimum for plant growth
About	30%	Cotton begins to need water
About	28%	Lento capillary point (C) lower limit of ready available water
	23 - 24%	Cotton suffers severe check: crop ruined at
	18 - 20%	Wilting to cotton seedling in pot
About	14%	Hygroscopic coefficients
	6 - 8%	Soil in equilibrium with air of 25% relative humidity

Source: H. Greene, (1928), op. cit., p. 532

considerable increase in moisture content, and only with continued rain penetration does it extend to 3 feet (0.91 m.) (Fig. 22). The salt content shown in dotted line, shows a sharp line at the limit of rain penetration. Fig. 22 shows the moisture content of a plot 24 hours before and as many after irrigation estimated at 430 tons to the feddan. However, 48 hours later the second foot had gained a little in moisture at the expense of the first foot, whereas the bottom 3 feet (0.91 m.) remained constant throughout the irrigation cycle. Moreover, the rate of drying after that flooding showed that, although loss of water from the surface is very rapid, movement of sub-soil water after cessation of flooding is very low.[41]

(iii). Nitrogen and Organic Matter:

In the arid parts of the Sudan, organic content of soil is low. However, nitrogen content tends to increase with rainfall, but it never attains large values because of the high temperatures and the long dry season. In the Gezira, considerable changes in the amount of nitrogen in the soil have been shown to occur, but the contents of nitrogen always remains low in the order of 0.03% or 300 parts per million in the upper 2 feet (0.61 m) while in a good rotation yields of over 1,200 lb. of seed cotton per feddan were regularly recorded, no manure being applied, although heavy manuring was found to increase yield considerably.[42] Two sets of soil nitrate measurements on 3-course rotation crops at the Research Farm showed the following: the first set, a long continued series taken over 21 years, showed for the first foot samples that there is a distinct tendency for nitrates to be depressed during the rainy season, this tendency being more marked in the more open rotations which is attributed to washing down of nitrates (Fig. 21). The second set of measurements showed accumulations in the second foot and a distribution consistent with downward movement.[43] Potash content is about 0.3% (Table 9a App. 9).

(iv). Clay Content

Unlike the low nitrogen and organic matter content, Gezira soil shows a high clay content. However, the soil is uniform to a depth of at least 4 feet (1.22 m.) and shows only, but to a slight degree, the tendency to an increased content of clay in the second foot as the following ~~figure~~ table shows:

TABLE 17 PERCENTAGE OF CLAY CONTENT WITH DEPTH

Foot (Metres)	1 (0.30)	2 (0.61)	3 (0.91)	4 (1.22)
Clay Content %	55.9	57.0	57.7	58.8

Source: T.H. Jewitt (1955), op. cit., p. 164

Below 5 feet (1.52 m.) the soil changes in character. However, an interesting feature is that the percentage of clay increases in passing southwards till in about latitude 12°N it approximates to the clays of the White Nile. Analysis made by Beam (1911) from 34 holes and by Joseph (1921) and the results are given in Table 10 App. 10.[44]

Generally speaking, the Gezira soil has credited itself for cotton growing provided that its fertility be maintained by sparing crop rotations which incorporate long periods of fallow, usually before or after cotton. This is necessitated by the fact that swelling of the soil when wet has a harmful effect on the soil structure which becomes so swollen that root penetration is largely reduced. However, this soil has its own advantage and disadvantage. Its impermeability is an advantage from the point of view of irrigation because it means that canals do not leak, and consequently expensive cementing is not needed. It also means that no water passes below the depth of the plant root and none is lost. But, on the other hand, this compact clay soil inhibits healthy growth of plant roots - because of poor aeration, which is due to water-logging resulting from rain and heavy watering. That is why ploughing and the natural cracking of the soil are important in this respect.

VIII RIVERINE SOILS

The question of the suitability of the riverine soils for irrigation has been investigated at Zeidab, the oldest irrigated estate on the Nile, and, as expected, they turned out to be very much suited to it. They were found to be fertile, with a good water-holding capacity, and mainly consisted of recent silt deposited from the annual floods of the Abyssinian tributaries of the Nile. The silts are, however, in the process of being deposited; on the river banks, on the river bed and as islands in the river, there are areas of modern silt which are, depending on the level of the flood, being currently added to, and removed by, the Nile, and which, by virtue of their fertility and easiness to work, produce good annual crops. Behind these silt deposits, and in shallow lagoons near bends, finer particles are deposited, thus giving rise to these patches of cracking clay which, depending on their salt content and texture, may be classed, from the point of view of agriculture, as good or bad - those which are good possessing low salt content and good permeability.(45) A representative profile sample from Berber showed the top 6 feet of the soil to contain 42 - 74% of fine sand, 9 - 20% of silt, and 17 - 38% of clay. These alluvial soils are generally calcareous, alkaline and sometimes saline, the latter two features increasing northwards in keeping with increasing aridity in that direction.

Behind the cracking soils and higher than the river flood and seldom inundated are recent soils of variable texture, but relatively fertile, which carries most of the permanent irrigation, and is called saqia-land. Inland from these, there are older soils, often very saline and of heavy texture and crack deeply when dry, more difficult to work and puddle easily, and in many places overlain by wind-blown sands. These constitute basin or karu land, with large concentration of salt near the surface (Table 11 App. 11).(46)

At Zeidab, samples taken from 15 profiles showed the land to be of fair quality (Table 12. App. 12), and in all of them the fraction of fine sand is always considerable and none of them has very considerable quantity of coarse sand or stones or gravels. The salts and pH values are given in Table 12 App. 12, for each separate 6-inch step. The salts show a dramatic rise at the seventh step, and from this it is evident that crops can be grown successfully with very high concentrations of salts within range of their roots. Conversely, the pH values show a sudden fall in the layer where salt concentration becomes high; the example described in Step 6 has low salts and low pH throughout. However some profiles had very high salt content with ashy efflorescence on the surface, and in a sample of such a soil, the surface soil had 2.16% salt and a pH of 6.9.[47] After the sodium value in the soil has been determined, a fertility estimate is made, and this clearly shows that high fertility is associated with low sodium value, but we have already seen that the concept of sodium value is not adequate to determine fertility and cotton yield.

IX. SOILS OF BARAKA AND GASH DELTAS

(i). The Baraka Soils

The Baraka Delta roughly forms an equilateral triangle and has been formed by the silt brought down by the Baraka from Eritrea with a slope of 150 cm. per kilometre at the apex to an order of 100 cm. per kilometre downwards, the soils accordingly vary in texture from sand at the apex, gradually changing to silt of extreme fertility as one progresses towards the east. Some distance from Sheddin (Fig. 64) and onwards, the Baraka annually deposits fresh silt which, under the action of the sun, later disintegrates into a fine powdery dust which is easily picked by the strong summer gales and carried away to build up dunes elsewhere. Further east near the sea, the land is salty and in some cases has saline groundwater near the surface. The soil profiles usually exhibit differences in colour and texture (Table 13 App. 13).[48]

The salty profiles at Tokar usually show high nitrate concentrations, which may in some cases be high enough to be toxic, and are certainly high enough to upset the normal nutrition of cotton plant, and it shows a progressive diminution in the nitrate content with depth (Table 14 App.14).

Moreover, some samples of Tokar soil have been shown to contain high values of phosphates amounting to more than 400 parts per million - P_2O_5. Values of exchangeable calcium obtained ranged from 11 mg. per 100 gram of soil to 44 depending closely on the percentage of clay and that of clay plus silt, especially in places like Tonak where silt figures are unusually high compared with Tokar soil in general.(49)

However, the seaward areas are more salty; yet it is an interesting fact that where such areas are watered, it is often possible to grow cotton when a grain crop would fail. But, generally speaking, the soil is fertile in large parts of the Delta, and the best soils when well-flooded are exceedingly fertile, a good index being that the average yield of cotton for a 10-year period up to 1949/50 was about 460 lb. per feddan, with a range of 350 to 1,100 lb.(50)

(ii) <u>The Gash Soils</u>:

Here, as in Tokar, the soils are derived from the Eritrean highlands, and generally consist of recent deposits, still being formed, of coarse sand, finer sand, sandy loam, clay loam, and clay as one proceeds from the apex to the tail of the Delta. The rich, fertile silt is known locally as <u>lebad</u>, and the heavy clay found at the tail of the Delta is called <u>badobe</u>, which is more difficult to deal with, cracks on drying, and produces as a rule a smaller crop of cotton.

According to Tothill, the Gash Delta is underlain by an old impermeable bed of clay which enables the silt to retain enough moisture after a single flush to produce crops of cotton and grain and also to hold water in underground reservoirs to furnish well-water for the villages, thus largely solving the problem of drinking water during the dry season.(51)

A remarkable feature of the Gash soil is its great depth, which varies between 300-350 feet (91.44 - 106.68 m.) and has, by virtue of its fine particles, the advantage of allowing the plants to absorb easily the food material contained in the soil. Nevertheless, the relative proportion of silt, sand and clay vary widely, but generally this has been found to be as follows: 50% clay and 40% silt, and the remainder consisting mainly of sand. Moreover, there is no marked accumulation of salt at any point in the profile, and calcareous nodules do not occur, and the pH values of samples taken to a depth of 5 feet (1.52 m.) were found to vary from 7.1 to 8.3 (Table 15 App. 15).[52] Furthermore, the nitrogen content of the soil is low and the ratio of calcium to sodium is considerably higher than is found in the Gezira soil, and this in fact is bound up closely with the superior permeability of the Gash soil (Table 18 and Table 1b App. 16).

Moreover, water distribution was tested to a depth of 6 feet both before and after flooding, and giving the soil sufficient time to drain. The result was that the moisture content was raised from approximately 4% to 20 and 30%, and most important the moisture was almost distributed uniformly throughout the profile (Table 16 App. 16). Moreover, loss by direct evaporation is small and root development is probably sufficient to make use of the full depth of the moistened soil.[53]

The Gash profile shows clear evidence of their alluvial formation with sharp changes in mechanical composition and well-marked layering, and

TABLE 18 A COMPARISON OF THE GEZIRA AND GASH SOILS

	Gash Delta	Gezira
Clay (per cent on soil)	40 - 70	50 - 60
Exchangeable sodium (per cent of total exchangeable bases)	About 2	8 - 12
Percent flocculation of clay	80 - 90	About 70
Permeability to water	Good	Bad
Root development	Good	Poor
Linear shrinkage per cent	About 5	About 15
Profile development	Nil	Marked
Water soluble salts per cent	Below 0.1	0.1- 1.0
pH of acqueous extract	About 8	About 9

Source: Green and Snow (1935), op. cit., p. 2

rapid textural change from one profile to another, as Table 15 App. 15 shows. It will be noticed that all the four profiles are coarser at depth than in the upper profile, although some other profiles do not show this. Thus, the balanced nature of clay, silt and fine sand in the Gash soil gives it an important capacity of absorbing water, which does not quickly dry out through cracks as often happens in clays, and the grade of mixtures renders penetration of the plant roots easy as well as lessening the trouble involved in clearing the land from weeds.

This is the physical environment of the cotton growing areas in the Sudan, and it has embraced geology, relief, climate and vegetation in Chapter One, and hydrology and soils in this chapter. Having formed this background, it will be appropriate to discuss generally the physical requirements of the cotton plant and then to consider the suitability of these areas for the production of cotton.

IXI THE PHYSICAL REQUIREMENTS OF COTTON PLANT

The geographic limits for the economically feasible growth of cotton lie between latitude 37-40°N to 30-32°S, corresponding roughly to the mid-summer isotherm of 25°C (c. 77°F). The different species are grown under a wide range of rainfall conditions, although they thrive in the drier rather than the wetter districts and the requirements of moisture supply and soil differ according to the species and the variety, but for commercial production the bolls must open in dry weather. Cotton is grown as a summer crop in the higher latitudes and as a winter crop in lower or subtropical latitudes, while the growing season is determined by rainfall alone in tropical climates.[54]

However, in the U.S.A. Cotton Belt and similar latitudes there must be a frost-free season of at least 200 - 210 days. The minimum rainfall limit is considered to be 20 - 25 inches (508.0 - 635.0 mm.) unless irrigation is practised, but total autumn rainfall in excess of 10 inches is likely to be injurious, and relatively dry, cool conditions at picking time are much preferred. Moreover, planting needs abundant sunshine and a moderate amount of moisture; heavy rain at planting time and during early growth stages is undesirable for this encourages shallow root development. Later, too much rain may cause excessive shedding of leaves, blooms and bolls and squares, and later in the season rains stimulate top growth, delay maturity, interfere with picking and discolour the lint.[55]

Furthermore, soil moisture and rates of transpiration constitute contributing factors, for they determine the amount of shedding which may result in losing up to 60% of the fruit. In Egypt, for example, the average rate of shedding was 40% and in St. Vincent from 10 - 20% of the flowers produced by Sea Island plants in the West Indies eventually matured. However, the ideal distribution of rainfall for cotton is of the thunderstorm type with several days of bright, warm weather between rains.[56] Moreover, temperature and day-length are, according to Eaton, important in influencing the type of branching which occurs on the cotton plant. Cool days and cool nights result in mostly vegetative branches, while cool days and hot nights result in mainly fruiting branches. Thus, under conditions of moisture stress, vegetative growth may decrease by half, and boll sizes may be reduced, but with no appreciable effect on relative fruitness..[57]

With regards to soil, well-drained alluvial flood-plains are the best, such as the alluvial soils of the Tennessee, Mississippi, Arkansas and the Red River valleys, which have furnished excellent cotton lands, but the dark, friable Texas grasslands are considered to constitute the best soils in the world. Also noted for their fertility are the valleys of the Nile, Indus, Yangtze, Rio Grande and Parana. The cotton plant seems to thrive well in pH values ranging between 5.2 - 7, although it can be grown successfully at various degrees of acidity.[58] However, irrigation practices vary greatly with the nature of the soil, the amount and distribution of rainfall, the temperature, and humidity of the atmosphere. In general irrigation is desirable to obtain rapid growth early in the season before heavy fruiting. In Arizona, for example, plants in plots receiving irrigation soon after planting were stimulated into rapid and extensive growth prior to heavy flowering, these plots consistently outyielded plots in which the first irrigation was delayed until the plants reached the wilting point.[59]

Insects, on the other hand, have played a major role in delimiting the present distribution of cotton industry in the U.S.A. and in the breeding of various types of cotton. It was found out that cloudy, rainy weather, and cold winters may tend to hold them back. The bollweevil and pink bollworm are considered to be the most destructive pests, and preventive measures against them include destruction of old cotton plants and infested bolls, planting as early in the season as possible, and the use of early maturing varieties, and protection against bollworm is by disinfecting the seed by various disinfectants. Diseases most serious to cotton include blackarm and leaf curl.[60]

Taking this as a background, we can discuss the suitability and limitations of the cotton growing areas of the Sudan.

XI. SUITABILITY OF THE GEZIRA FOR COTTON GROWING

The climate and irrigation water of the Gezira (from the Blue Nile Table 4 App. 4) seem to be well suited to cotton, and this is fortunate as they are not amenable to control. The mean of dry temperature in winter is sufficiently high to allow for continuous growth of cotton plant, although the minimum temperature in January and February is not far from the limit (55.4 - 57.2°F or 13 - 14°C), usually regarded as safe for the cotton flower. However, in Fig. 24 temperature and relative humidity condition in some other cotton growing areas are compared with those of the Sudan, and it can be seen that the Sudan is hotter (see also Fig. 9). Thus, when it is realised that the optimum temperature for both bacteria and the cotton plant lies about 86°F (65.6°C) the importance of irrigation in maintaining a suitable soil temperature becomes obvious, and this is important in the Gezira where rainfall is not enough for cotton growing. Moreover, the Nile temperatures vary between 65 - 82° F (53.9 - 63.3°C) (soil temperatures vary from 185°F (c.75°C) in the top 2 inches (50.8 mm.) to 98.6°F (72.6°C) 18 inches (457.22 mm) below), and by the time the water has reached its destination it is a few degrees higher. In June, the temperature of irrigation water is 86°F (65.6°C) and 75°F (59.4°C) in November, the result being that in soils under cultivation and irrigation, the optimum temperature is just about realised during the period of most active growth, that is, July - September.[61]

The land in the Gezira is an engineer's dream of irrigation, but it does not appear that the soil is so well-suited. The soil is so heavy that there is virtually no through drainage and this increases salt accumulation, although no deterioration of soil under irrigation has been noticed. However, yield was shown to depend mainly on salt content and alkalinity, amounts of organic matter and nitrogen, and the permeability of soil, but recent work has clearly shown that the clay content is an important yield-determining factor and, together with organic carbon, showed the highest yield correlation.[62] The heavy clay restricts root development, and more than 80% of the root mass is concentrated in the surface layer of 30 cm. The good response of yield to nitrogenous fertilisers indicates that fertilisation and cleaning expenses would be increased. Indeed there is need for land-use capability classification, and soil selection for crops other than cotton and evaluation of soils already investigated.

XII. SUITABILITY OF GASH AND BARAKA DELTAS FOR COTTON

The conditions under which cotton is grown in the Gash Delta are somewhat peculiar, and thus different from those of the Gezira. The crop starts its life with a certain supply of water in the soil and receives no more irrigation during the whole of its growth. The soil is sufficiently open in texture, and as its surface layers dry out, the plant is able to strike its roots into the lower depths which still remain moist. The system of flooding provides a reserve of water in the soil on which the plant is enabled not only to live but also to develop without a check, while the atmosphere is sufficiently dry to prevent rank growth and, at the same time, is not dry enough to be harmful. Moreover, temperatures rarely, if ever, fall sufficiently low, and over a sufficient period, to act as a check. (Monthly means at Kassala are: November 70.7°F (21.5°C); December 62°F (17°C); January 60.1°F (15.6°C) and February 60.8°F (16°C). However, the Gash cotton yields fluctuate abnormally from about 1 - 2 kantars per feddan to 5 and over, the main reason being not enough water supply due to variation in the volume of the flood (see Chapter Seven). But suffice it here to say that, for its good physical conditions and relative freedom from pests and diseases, the Gash Delta is used as a filter for seeds for the Gezira commercial crop.

With regards to the Baraka Delta, reference has already been made in Chapter One to the various problems affecting cotton growing there.

XIII. SUITABILITY OF BERBER DISTRICT FOR COTTON

It was in the Berber District that cotton was first tried on a commercial basis under irrigation, and the first true knowledge of its suitability to Sudan's climate was established. The various schemes for growing cotton, the most important being Zeidab, fall within this tract where the importance of temperature in the choice of crops and times at which they are grown are paramount, and where land-use is determined by water availability and the form of land tenure. The temperature during the winter months constitutes a limiting factor and, therefore, cotton of the American Upland type has been chosen instead of Sakel and other Egyptian varieties which had proved a failure as we shall see in Chapter Seven. Here the winter months of November - March are relatively cool with a mean temperature of 77.0°F (25°C) and occasional minimum temperatures as low as 40.1°F (4.5°C) and the wind is northerly. However, it was due to severe attacks on Sakel by pests encouraged by adverse climatic conditions, that the shift to this large-bolled, quick-maturing, long-staple American was made, the check on the growth of the slow-maturing Sakel by the cold winter temperatures was also a contributing factor.

Generally speaking, there are usually very few days during July,- September, the period of most active growth, when the daily maximum temperature does not exceed the optimum for healthy development. Daily measurement of the increase in height have shown that the maximum amount of growth takes place not in the day time, but between sunset and the early hours of the morning. Should the night temperatures remain high, growth is continuous until dawn when inhibition soon occurs by reason of the increasing intensity of the sun's rays. This 'sun-shine effect' is very marked in the Sudan, and is due to the excessive strain thrown on the transpiratory organs of the plant.[63] However, the cessation of growth is not only caused by lowered temperature; on stiff clay soils, in which penetration is difficult and the movement of water is slow, incomplete development and stunting are often caused by root limitation. The water requirements of a cotton plant are very great, and should the root system prove inadequate owing to the mechanical difficulties imposed by the texture of the soil, the effect is at once observable in the stunted, straggly condition of the aerial portion of the plant.[64]

Thus, while the temperature is undoubtedly the limiting factor during early growth, the water supply becomes of increasing importance as the season advances and the humidity of the atmosphere becomes less. At the onset of the dry winter winds, considerable amount of foliage is always shed to maintain the equilibrium between absorption and transpiration of water. This loss of assimilatory surface must effect the productive power of the plant and both the yield and the quality of the lint suffer in consequence.[65]

Important as these physical factors are, all development must necessarily take account of the prevailing cultural, social and economic conditions, and the discussion must now move to an appraisal of what may broadly be termed 'economic' considerations, which will mainly concentrate on problems of agricultural development.

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CHAPTER THREE

PROBLEMS OF AGRICULTURAL DEVELOPMENT

The history of man is, in large part, the story of his settlement of the land. Sometimes this settlement has expanded suddenly; sometimes the expansion has paused, and there has even been recession, but on the whole throughout historic times more and more land has been taken for human use. However, schemes for original settlement were thought to be likely in what are usually considered as the 'new' countries, such as the Americas and Australia, because they are ordinarily the countries which possess wide areas of undeveloped land. Nevertheless, the 'old' countries often find occasion for such schemes, especially where some important physical, economic or environmental changes make previously unattractive land agriculturally desirable, as in the case of the drainage of the Pontine Marshes in Italy, or the elimination of malaria from the Terai in northern India, or where some new policy of agricultural tenure is initiated, as in the case of the state colonies in Burma.(1) The Gezira, however, has never been an unoccupied waste, but the traditional mode of land-use was primitive and crude, and consisted of cultivating patches of suitably located land with dura, the staple food. Apart from this, the Gezira plain was an area of extensive livestock raising, although in favoured localities a crop of native cotton could be produced. Consequently, the villages were inhabited mainly by persons dependent upon these occupations, i.e. farmers, cattle and sheep herders, hired labour and slaves, as well as landless people who were allowed to cultivate on their own account in the communal land, or who could receive a tenancy from a landlord.(2)

According to local traditions, the Gezira rainlands started to be used regularly about the end of the sixteenth, or the beginning of the seventeenth centuries. At first the inhabitants of the riverine villages along the Blue Nile went inland with their cattle only for grazing purposes, and they lived there in grass huts during the few rainy months that these lands could feed the animals. While they were settled in these seasonal camps, they often constructed banked-up reservoirs or hafirs to store rainwater, and every year they came with the rains in July and stayed as long as there was grazing, and departed when the hafir dried up. Later, these pastoralists dug wells, and thus water became available throughout the year, and this encouraged some people to remain after the end of the grazing period, and to gradually found hamlets, clear and clean the land and start cultivation. Meanwhile, many folk had already established themselves permanently as agriculturalists on the banks of the Blue Nile where they grew crops. With increase in population in the riverine settlements, there was a spread to neighbouring areas where river land was still available, and satellite villages were founded. However, when the riverine lands, which were by no means extensive, were fully occupied, people started moving to the rainlands in greater numbers to grow crops, and so new villages were established. The colonists who settled in these rainland villages did not lose touch with the riverine villages when they came, since very often they continued to grow crops on the river banks, where they maintained their land rights, even when the rainland villages became autonomous. In fact, they remained satellite settlements throughout the Fung period (1506-1821), and continued to be administered from the main riverine villages in more or less the same way as in the Siljan of Europe.(3)

By the end of the eighteenth century, the political situation of the Fung Kingdom became very confused and disturbed. The kings had lost authority over a great part of the country, and the local chiefs were acting independently of Sennar, the capital. Raiders from Darfur made periodic incursions, often reaching as far as Omdurman, and the situation was aggravated by the fact that the local chiefs were fighting, quarelling and raiding each other. Insecurity was so great that the rainland inhabitants abandoned their settlements and retreated to the riverine villages where protection was more certain.(4) In 1820, came the Turkish period followed immediately by rebellion, and it was only when peace was re-established in the 1830's that the people, who had fled their rainland villages, were able to resettle in the homes they had abandoned.(5) The Mahdiya (1885-98), was in no way conducive to settled life because of the punitive expeditions of the Khalifa against the Gezira tribes, forced conscription in the army, and the ruthless raids and looting for grain carried out by the army and government officers against a reluctant people who saw no reason in giving up their very sustenance to a government for which they had no sympathy.(6)

In western Gezira and along the White Nile, tribes like the Hassanya moved to and from the interior to the river banks with the season, grazing their animals and cultivating dura and other crops. But, unlike the Blue Nile, the White Nile occupies a shallow valley, the banks of which were, before Gebel Aulia Dam was built, extensively exposed when the flood subsided, thus allowing river-bank cultivation of much wider areas than along the Blue Nile (Chapter Two). Here, the Hassanya led a more convenient life. During the summer months, when they moved towards the riverine areas, their only occupation was the tending of their herds and flocks which, being performed by the young, left the middle-aged and elder men in a constant state of idleness, their only occupation being to attend the markets of the neighbouring villages to effect the sale of a sheep, goat or a cattle and purchase for their needs.(7) The busy season commenced with the rains, when they broke up their camps and, on the back of bullocks, conveyed their portable dwellings and utensils into the interior, where every family had already cleared a piece of ground for the growth of dura. The land was at their service for clearing and cultivating without charge, and the industrious individuals were thus able to take in a new piece every year.

The fields formed continuous blocks and were usually situated at a distance from the camp; they were not fenced or manured, and thus after a few years of cropping, the field had to be abandoned for a new piece of land. Most of the field-work was done by men, and cultivation was performed with a long-handled hoe by which a hole was made in one direction: first to the boundary of his land, and returning, he repeated the same operation, each row of holes being placed at a short distance from the other. Another man followed with seed, throwing 5 - 6 grains in each hole which he covered by his right foot. With the duties of the farm over, he fenced his pens, and a communal large fence was built by the men to keep cattle there at night so that they did not damage the growing crop plants. Then mulukhya (Corchorum olitorius) and bamia (Hibiscus esculentus) were grown for vegetables, and hoeing, cleaning and weeding began. Since no labourers could be obtained, these tasks were mainly performed by men who did the hard parts, like tufted grasses, while women and children carried out the lighter tasks of cleaning less heavily grass-covered areas. Large farms were, however, communally cleared.(8)

After two and a half to three months, the crop ripened, and grain heads were chopped from the plant and collected into a large stack in order to guard against the ravages of the white ants. When the whole of the crop had thus been collected into several stacks, the threshing floor was prepared with smooth clay or cow-dung, when the men, with large sticks, rhythmically beat the crop to separate the grain from chafe, which was winnowed off by women. Most of this new crop was consigned to the matmura, or the underground storage pit.

During the time that the people were employed in the interior, the lowlands which they inhabited during summer had already become inundated and enriched by the silt deposits of the White Nile. Thus, towards October, previous to the return of the whole community to the river banks from the interior, men commenced to sow their crops as soon as the bank soil had obtained sufficient consistency to allow a man to walk over it without sinking more than ankle-deep. Here dura, some cotton, beans, onions, red pepper and water-melons were sown, the main crop being the safra, or yellow, dura. Sowing was done by the seluka, and cost of cultivation was comparatively higher here than in the interior because of the thicker stands of grasses which necessitated constant weeding - a task requiring more efficient tools and energy.

With the drying-up of grasses and water-pools in the interior, people eventually returned to the riverine lands with all their belongings and the surplus dura was then sold to other tribes, like the Kababish of Kardofan, an ardeb of which cost only 2 shillings under normal conditions in 1863, but higher prices up to £5 per ardeb were by no means uncommon during the famine periods.[9] Milk was sold to local cheese-makers, and thus formed another source of income for these people, who, by combining pastoralism and cultivation, managed to escape the rigours of life that might have ensued by practising only one activity.

Thus, pastoralism and cultivation were not mutually exclusive, but were generally carried out by the same person. Throughout the Gezira, a good herdsman was more likely to achieve success as a rainland farmer than a villager who attempted too sharp a break with pastoralism and neglected to take care of his livestock. The switch-over from a pastoral economy to an agricultural one was, however, achieved gradually. Wealthy herdsmen bought slaves, or hired labour, with income derived from their cattle, and employed them to cultivate crops, and thus by using the income of their livestock to direct such labour to the soil, these herdsmen of means became successful rainland farmers. Such a farmer, with sufficient capital at his disposal, could disperse his holdings so that a failure in one locality, through the erratic incidence of rainfall, might well be compensated by plenty in another. Such wealthy families thus could almost inevitably harvest sufficient grain for their sustenance even in a bad year, and in a good year they would have a surplus to store in the matmura.

The value of animals in this mixed system of pastoralism and cultivation lay in the security they provided in an environment which was marginal for sedentary agriculture. When crops failed, animals could be sold, as a last resort, to buy dura and to allow another crop to be grown. Thus, even during the most prosperous years, stock-raising was never abandoned so that when factors other than climate, such as political unrest or exorbitant taxes, made it impossible to carry on agricultural activities, the farmer could at any time revert back to a nomadic economy. This is indeed what happened during the first years of the Turkish period (1821-24), in the 1870's, and during the Mahdiya when leading personalities were summoned to Omdurman by the Khalifa, and at the beginning of the Condominium rule (1899-1920) when slavery was abolished, thus depriving the landlords from their traditional source of man-power.(10) Moreover, joint pastoralism and cultivation by the same person also allowed a harmonious distribution of the activities, so that one did not hamper the other; animals and crops were kept apart during the crop growing season so that no damage should be done to the latter.

The Gezira was one of the main grain-producing areas in the Sudan (and in fact it still is although irrigated cotton cultivation is the main aspect where dura is part of the rotation). Being a rain-crop, the intensity of production varied from north to south with rain, and grazing also became better and sure as one moved southwards (Fig. 12). Thus, during the rainy season, July - September, the semi-nomadic tribes lived in small villages, cultivating dura and grazed their herds of cattle and flocks of sheep and goats round the villages. During winter and early summer months when all pasture near the villages had been grazed and stored fodder had been used, they moved south in search of pastures and where hafirs were large enough to hold water after the rains had stopped. To obtain water indeed presented a serious problem during the dry season, and in most cases it had to be hauled from deep wells by human labour to water their animals and themselves. For a sure supply all the year round, the wells had to be deeper to tap greater amounts of water, but such wells were too expensive and difficult to dig by human labour alone, and as a result many villages which did not possess reliable wells had to make long journeys in search of water.

However, for rain cultivation proper, the 400 mm-Isohyte can be taken as the northern limit for successful rain crop production, but north of this isohyte, grain could be raised by careful selection of site and prevention of run-off by erecting low earth banks to hold rain water (Chapter One). Thus, to the west along Dueim and its neighbourhood, which has too light rainfall for successful cultivation, the inhabitants, like the Hassanya mentioned above, depended to a large extent on the White Nile for their grain cultivation and livelihood, although in years of good rainfall they moved inland and practised rain-cultivation and animal grazing as has already been described. In the Manaqil region, where rainfall is still meagre, the cultivator selected harder varieties of dura, mainly Fetereita type, which had a short-maturing period, and grew them. To the west of Manaqil and round Kosti, on the White Nile, grazing was generally adequate, although local seasonal migrations were not uncommon in pursuit of better pasture on both sides of the White Nile. The Sennar region, which includes the south-eastern part of the Gezira, is the only part of it that has a rainfall exceeding 400 mm (15.75 in.) and as a result, grain cultivation was considerable, but the problem of water supply during the dry season, except along the Blue Nile and in the neighbourhood of the granitic hills, was a serious retarding factor.

In this harsh climate, dura, by virtue of its qualities, thrived well and supplied the natives with their staple food. Besides being easy to grow, there were (and still are) many varieties to suit different climatic and environmental conditions, and being hardy and storeable for long periods, it was an insurance against famine. In this region of precarious rainfall, cultivation of dura indeed reached a high standard of skill in seed selection, prompt weeding and preservation of moisture by constant hoeing and terracing. Here the most favoured type of dura was the Fetereita, which is a quick maturing type and possesses, to a marked degree, the capacity for bringing heads, however small, to fruition, even if deprived of water some time before flowering. In the southern Gezira, the varieties most favoured were Wad Mugud, and here a good cultivator, with careful management and under favourable conditions, obtained as much as a ton per feddan.(11)

The size of holding, however, depended on the ability of the cultivator to clear and construct earth-banks, either by family or hired labour, and accordingly, wealthy cultivators, who could afford to buy slaves, had an initial advantage. Nevertheless, it often happened that the population were forced to leave their lands because of excessive taxation and to take refuge in nomadism and trade which, by the constant movement they entailed, provided only a crude means of subsistence. Coupled with an unreliable rainfall, the Gezira was not properly cultivated or its potential agricultural resources efficiently exploited, and large tracts of it were still virgin in that sense, and it thus offered, with skilful management and proper scientific methods, a wide scope for agricultural development by a keen government any time from the 1850's to the time when the Gezira Scheme was launched in 1925.

Development of new areas for agriculture, or any other enterprise, has always attracted the attention of politicians as well as scholars, but the causal factors necessitating such development range from a rigorous increase in population as, for example in Egypt today, to the need to introduce a cash crop to augment the revenues of the country, or countries, concerned as, for instance, in the Sudan, Nigeria, Ghana, and Tanganyika. Of these two, the increase in population is the most pressing factor, but in the Gezira the second factor is the most relevant.

By and large, however, the limit of economic production is being pushed further and further outward, if it has not been reached yet in some cases, and few would question the justification of extending a measure of encouragement to agriculture by virtue of the almost unique conditions with which it must contend - namely susceptibility to, and only partial control of, the effects of climate and diseases. But this is not to agree that agricultural production should be fostered without due regard to cost; on the contrary, the aim should be economic production and the production of crops at prices which will find effective market.

Today, a few large land areas have remained unused, or fallen into disuse, because of mismanagement or lack of population which entails, if these lands are to be settled, the knowledge of the causes that led to its disuse and removing them. Where lack of population is the sole reason for land remaining uncultivated, there always tends to be the assumption that some other obstacle to the successful exploitation of this unoccupied land is present. These obstacles could be, as mentioned above, deserts or swamps, but even such obvious reasons may not stand alone; land may not be arid or flooded, but intrinsically sterile. The malarial mosquitoes and the tse-tse fly may not be the sole reason why wide areas in the tropics remain uncultivated.[12] Superficial indications may also be misleading: land which produces a luxuriant tree growth may be incapable of supporting annual crops permanently.[13] Above all, there is the inherent danger in the attempt to exploit land on the margin of cultivation as a sole means of livelihood, as in Tanganyika and the Mid-West, U.S.A.[14]

Thus, the first essential in the task of bringing new areas into production is knowledge and accurate information both of the local conditions in which that development will have to take place. Accordingly, development must be preceded by a preliminary survey of natural conditions, and this entails intensive field work. Thus, local topography must be examined, levels taken, maps drawn, tracks improved, rainfall pattern and river flow recorded, possible dam and reservoir sites reconnoitered, soils investigated and analysed, disease and pest hazards considered, possible markets and costs broadly assessed, and last, but not least, the whole scheme viewed against the setting of the overall national economy.[15]

A formidable task like this will definitely take time and money in the form of technical men and equipment from outside. But what is certain is that it will pay handsome dividends in the long run to build up from small beginnings and to expand on the firm basis of practical experience obtained from experimental stations and pilot schemes. However, in agriculture as in most forms of human activity, few judgements are final, and it is seldom that conclusions drawn from a survey will be permanently valid. The facts established by surveys are not immutable, and much often the conditions, under which these facts must be considered, are liable to change. A new crop, a new technique, new machines, a change in the human or other working power available, or new economic conditions, may upset the conclusions reached from a survey.[16] Land which was once quite rationally under crops may cease to pay for cultivation; abandoned land may again be productive. The valleys of the Tigris and Euphrates were once the granary of the Middle East, but much of this land now remains uncultivated partly, no doubt, through past neglect and maladministration, but largely, perhaps mainly, from physical causes - bad drainage, which can now be eliminated.(17) The hill pastures of Britain fell into decay and desertion as a result of economic and social causes, a change in which is thought to render these lands worth redeveloping, while the introduction of groundnuts in the first quarter of this century turned land values in the Dry Zone of Burma upside down.(18)

Whenever, therefore, a question of using land arises, the decision must be made on current facts and conditions, and not on mere historical inferences, still less on the basis of any rigid theory of land-use or upon empirical principles borrowed from other areas. The proper criterion is not whether land is intrinsically bad or good, but whether under the conditions of the time it will yield satisfactory income to the farmer, and whether these conditions, including the current fertility and the marketability of its produce will be maintainable long enough to justify the expenditure of capital on its exploitation.(19)

I. FACTORS BASIC TO AGRICULTURAL DEVELOPMENT:

From this general account, we can proceed to discuss some specific factors which are basic to agricultural development, namely, water, soils, transport, and capital.

(i) Water:

That a sufficiency of water at the right time is vital for successful crop production need hardly be stressed, but so much is heard today about irrigation that one is inclined to forget that field crops also depend on direct rainfall in many parts of the world, and that irrigation is but a a useful supplement substitute for natural rainfall. However, the unreliability of rainfall, particularly in the tropics and sub-tropics, is more often overlooked. In such regions it is difficult to over-emphasise the dependence of agricultural output on the pattern of rainfall; a rainfall map, even if available, gives little, if any, indication of how much rain will fall in a given week, or even in a given month. There is also the danger that when the rain does not fall, it is precipitated in torrential downpours which may be damaging to soil and crop.(20)

If rainfall is then deficient, either in the total annual amount or in its incidence throughout the year, in an area to be brought into effective agricultural use, it must be provided with an artificial supply of water. Irrigation, therefore, can be expected to provide the main hope for increasing agricultural production in all areas of sub-marginal rainfall, and also in areas of adequate rainfall for plant growth where an assured supply of water will reduce the hazards of sowing, planting, and cultivating during unexpected drought periods.(21)

By and large, irrigation projects involve the universal process of artificial application of water to the land by means of canals, distributories, etc. Apart from rivers, whose waters are regulated by natural storage facilities, like the White Nile by the lakes of East Africa, it is rare in tropical Africa for an irrigation scheme of any magnitude to operate successfully on the natural flow of a river. There are, of course, exceptions where the dry season low-level flow of a perennial river is sufficient to satisfy the needs of potential irrigation development without prejudicing riparian water rights further downstream, but more often the regime of a river is such, and the seasonal variation in flow so great, that recourse to artificial storage becomes necessary, i.e. building a dam to form a reservoir. This is typical of the Nile (see Chapters Two and Five).(22) In Dongola Province, for example, both 1913 and 1914 were famine years because of the exceptionally low Nile flood. The severity of the famine was such that the Government had to organise emergency relief work for the fleeing men, upon which a man could make 8 to 10 cents a day.(23) On the other side, heavy rains for ten days in 1870 in Bahrel Ghazal Province ruined crops in low-lying areas, while nine years later the rainfall was so irregular and scanty that the crops of dura almost failed, resulting in tribal disorder.(24) The British, desirous of promoting cotton growing in Nigeria, annually distributed seeds to the natives, but in 1914, the rains came so late, and planting had to be delayed so long, that the yield was the worst on record.(25) Similarly, the great drought of 1892 resulted in a severe famine in Wadai (Modern Chad), followed by serious tribal warfare, and again in 1913 when between half and three-quarters of its population perished from famine.(26)

Such droughts as these are bound to cause disaster to a population that seldom carries over a surplus of food supply from one year to another, and the occurrence of such critical conditions, as, in the Sudan, in 1864-5, 1888, and 1913-14, when the lowest floods coincided with low rainfall, may be regarded for the present as constituting an accepted agricultural hazard.

Moreover, damming a major river entails a large capital outlay, and if the expenditure is to be made to the greatest advantage, it should be preceded by prolonged studies both of the river flow and the state of the catchment.

Ideally, long-term records of the relevant hydrology should be available before designs of civil engineering works are embarked upon, but this is seldom possible in practice. Cases have been known, indeed serious difficulties have been encountered as a result of the flow of a river falling to values well below the mean dry season annual figure deduced from many years of records, as in the case of the Indus river.[27]

These records, however, are in general not costly to obtain, nor do they demand large numbers of technicians. The sooner, therefore, they are put in hand on a river likely to be used for irrigation, the more efficient are likely to be the capital works eventually built to harness its waters. It is also appropriate to examine the surface conditions in the catchment area, particularly in the headwaters, so that steps can be taken to minimise soil erosion and the siltation which might result therefrom in any storage work.

If we consider the Nile in the light of these points, it would be clear that a river with such fluctuation in the volume of flood as the Nile definitely needed careful study in the manner described above before any irrigation work was undertaken. Fortunately, as we have seen in Chapter Two, the Nile has records of discharge that date back to remote history, which were again supplemented by more records after the Sudan was reconquered in 1898, and indeed by 1920 hydrological reconnaissance in the Sudan, as well as in the catchment area, was practically complete.[28]

As important as water is the soil it is to irrigate; and thus soils constitute another facet of investigation which demands early attention in development surveys, for successful farming depends on favourable soil conditions.

(ii) Soils:

Surveys to ascertain the extent and quality of the particular soil types available is also an important part of the preliminary studies. However, so far as tropical soils are concerned, there remains much to be done, even in the field of soil classification as well as on the question of the reaction of the soil to different treatement. However, there is now a greater appreciation of the values of soil surveys for developing countries, and this nowadays is greatly facilitated and made accurate by aerial photographs, improved maps, coupled with extensive ground reconnaissance and soil samplings.[29] In many countries the impetus for soil surveys has arisen from the necessity to introduce new crops, as in the Sudan, to expand established ones, or to define areas for new settlement. Quite frequently, areas for detailed soil mapping have been chosen by politicians, and thus the soil surveyor has been expected to find suitable soils within the boundaries bounded by them.[30]

Reconnaissance soil surveys are invaluable in tropical Africa, particularly in an area where there is little agricultural development, for it enables the experienced soil surveyor to delineate these areas which are the most promising or the most easily developed for the range of crops to which the environment is suited. However, the state of development of a country's services is a very important consideration when deciding on the scope of detailed soil surveys, for there is little point in doing a detailed survey of a million acres if the country has the services to develop only 100,000 acres in a period of, say, fifteen years.

In tropical lands, however, there is practically no tradition as to what constitutes the misuse of the land, and accordingly the most urgent task of the soil investigator here is to detect, measure and control any changes in the soil which occur under native management, or which result from the introduction of methods of cultivation that are new to the country. Another important consideration is that in countries where the seasonal variation in climate is great, there is likely to be considerable seasonal variation in the moisture content, nitrogen status, physical condition, and other properties of the soil. Therefore, the main task in the tropics is to assess the effect on the natural sequence is not necessarily harmful, but, on the whole, the study of these natural changes is desirable in order that "the agricultural pioneer may knowingly utilise, rather than unconsciously defy, powerful factors which are, to some degree, beyond his control."[31]

In the Sudan, for example, investigation of soil demanded, in the first place, the patient long-continued and repeated examination of not very dissimilar materials.[32] This, of course, needed highly trained personnel on short-term contract which would have been costly while research officers on long-term contract found their own interest to devote their first years in the country to training a staff of native assistants to undertake duties of gradually increasing complexity. The results of this policy have been the soil studies described in Chapter Two. Moreover, it has been shown that in the Sudan about 400,000 square miles of the country may eventually become available for agricultural, and related, development. To obtain, within a course of a century, reliable data about this country may be regarded as a reasonable object, and what is required will be both to ascertain with moderate accuracy the geographical distribution of soil types, and also to obtain the necessary basic information concerning the natural and imposed changes to which the soil is subject. This, of course, will be speeded up by the development of the country's transport system.

(iii) Transport:

The lack of adequate transport facilities is one of the principal obstacles to the opening up of new areas, for transport is basic to development. Transport costs are as much as a production cost as the cost of material, labour and management, and unless the selling price of a comodity covers the total cost of production, including the cost of transporting it to an effective market, the production in question will not be a paying proposition.(33)

Unlike the developed regions, where any venture will be called upon to contribute only a relatively small share of total cost of providing transport facilities which are already available, it is in the less developed countries, where population densities are low, communications restricted, and where the bringing into production of a new area, that invariably involves the provision of new facilities. The facilities will comprise access roads to the centre of production and, frequently, longer distance roads or the improvement of the existing roads to collecting points for marketing.(34)

However, one of the more difficult aspects of expanding agricultural production in the hinterland of the former British Africa is the absence of markets of any size reasonably close to the growing areas. This means that crops grown for sale have to be transported many miles to the market, and long hauls involve substantial transport costs, particularly when the value of the traffic is low in relation to its weight. Consequently, agricultural crops exported from these territories on any scale are those essentially of relatively high unit value, such as cotton, tobacco, coffee, etc. However, once modern means of transport have been introduced in an area where already local requirements of food and fibre were produced, geographical specialisation of agricultural production rapidly follows, with consequent further increase in productivity.(35) Moreover, long hauls tend to impede agricultural development by pushing up the prices of imported fertilisers, thus creating a vicious circle especially in areas where fertilisers are not produced. It does not pay to improve transport facilities until a greater volume of traffic is in prospect and there is little chance of building traffic demands until the cost of imports, by means of land transport, is lower, thus justifying the stepping up of local production.

(iv) Markets and Problems of Cotton Marketing:

Even when the general use to which the land is best suited has been determined, there still remains many decisions to be made. Thus, in the choice of crops, it is necessary to know not only what will grow on the land, but, once the limited needs of the producers themselves have been met, what markets there will be for the regular and profitable disposal of surplus produce, and to consider whether the existing marketing facilities are adequate. It is useless to grow a crop which cannot compete with similar produce grown elsewhere at a lower cost. Great caution is especially necessary where the crop chosen demands considerable initial expenditure.(36) It must not be forgotten that the new producer must usually compete in the market with established producers and, for this reason, should be especially wary of produce for which there is only one buyer who is himself a producer. Thus, he will need advice on all these questions, and such advice can only be given if the questions have already been carefully studied.(37)

For example, it has to be recognised in connection with marketing that cotton is not an article having only one value at any particular time. It is not even an article the value of which depends only on its degree of ripeness and soundness or perfection of any kind. As was demonstrated in Chapter One, there are many kinds of cotton, differing in many ways, such as fineness, length, strength, colour, etc. Each kind has its own use, as Table 17, Appendix 17 shows, and to some extent spinning machinery especially adapted for one kind of cotton cannot deal satisfactorily with other kinds. It is necessary to point out that while the distinctions of quality referred to are of very great importance, yet they are so minute as not to be readily discernible by the ordinary uninstructed grower. The relative values of the different kinds of cotton is always a somewhat complex matter, simple in that it depends upon the laws of supply and demand, but complex in that for each kind of cotton the supply and demand may vary separately and may affect in varying degrees the supply and demand for some other kind. At the same time the supply and demand for the whole world's cotton crops has always been an overriding influence on price (Chapter One).(38)

Thus, it follows from this that, within the limits of quality which climate and other conditions make possible to any country, there is always some kind of cotton which pays better to grow than another. The first condition is, of course, productivity. The cotton that gives the largest out-turn of lint per acre or per man, is the best to grow if other things are equal. But other things may be far from equal: for example, 100 lb. per acre at 9d. per lb. are better for the grower than 120 lb. at 6d., though it must not be forgotten that it costs more to grow and pick clean cotton than to deliver dirty cotton. Everything depends on whether the arrangement for marketing are such as to secure that the grower does really get the better price for the more valuable cotton. It follows, therefore, that special arrangements should be made in the interests of the grower to secure good marketing. Since, then, good marketing is a necessary condition of successful cotton growing, it seems to be a matter of great importance, where cotton is a completely new product, that there should be some disinterested buying agency to be available to nurse the infant industry in matters of commerce.(39) Thus, it may be deemed necessary to fix somewhat in advance the prices to be paid for the cotton grown. This may not be financially possible: it will be desirable to fix a price at the time of sowing or even before, and this obviously must involve taking the considerable risk of knowing, or speculating on, what the market conditions will be nine or twelve months later when cotton reaches the market.(40)

For such purposes as these, it seems necessary that there should be available an agency independent of the government which will be willing to conduct this kind of business. It may be that so long as cotton is merely an experiment made on a government farm, the government will prefer to deal direct with the consumer. Eventually, if if cotton growing is firmly established in any district, the marketing must undoubtedly fall into ordinary commercial channels, but in the midway period when the production is too large for the government officer in charge to handle, and before the necessary commercial machinery is available, an independent agency is required.

(v) Capital

Essential as transport and marketing is the provision of capital to develop and finance the whole undertaking, for without capital the irrigation works, building of railways and roads, and research, are quite impossible, particularly in under-developed countries.

However, capital requirements of tropical crop production vary enormously depending upon such things as cost of land, utilities, irrigation schemes, communications, etc. The provision of capital on this scale will normally be beyond the capacity of individual entrepreneurs. Another problem is that in an under-developed country, the supply of capital is likely to be small. Thus, local capital resources, in a country with a low level of real income, will be limited, and the local capitalists are usually unwilling to accept risks involved, and the inducement to an external investor to put up capital will also be small since he will see that the local market is restricted for lucrative investment.(41)

In the case of agricultural development particularly, there is the further deterrent that its growth will tend to be gradual, the hazards of enterprise considerable, and the return on capital is long-term. All in all, therefore, it would seem that public and private capital should act in concert and that the government must take a lead in providing assistance in one form or another. A crucial problem today is the provision in many under-developed countries of favourable political "climate" for attracting needed local as well as foreign capital.(42) Another important problem, in case private enterprise is included, is to find a means of partnership which would create mutual confidence, thus removing the real difficulty of how to devise suitable forms of mutual insurance and some kind of agreed investment statute. Thus, governments themselves can do much to create basic conditions conducive to new development, not only indirectly by creating stability and harmony, but also more directly by offering a taxation system which allows of due reward for enterprise and risk, and by ensuring the absence of reasonably restrictive exchange regulation.[43] Moreover, more consideration should be given to more specific incentive methods, such as bonus payments for the adoption of good farming practices, some long-term assurance of market stability, or protection against vagaries of market conditions.

However, securing a good market will entail some kind of control over, say, cotton growing so that cotton of good and uniform quality can be produced to the satisfaction of the spinners.

II. CONTROL OF COTTON GROWING

(i) Seed Control:

The salient features of modern progress in cotton growing is the maintenance of pure strains. There may, perhaps, be differences of opinion as to the best methods for securing purity of strain and the degree to which it should be attempted under given local conditions. Improvement by elimination of rogue plants, by general selection of field types, by special selection of plants and consequent purification of strains, or by intentional hybridisation and subsequent purification, may perhaps, all have their sphere of influence. But by 1920, it was a matter beyond the region of controversy that if cotton is to be grown anywhere successfully and profitably, all possible steps must be taken to prevent the mixing of kinds (except inside the spinning mill, of course!) and that the distribution of seed for sowing should be under strict government control. This mixing can be brought about in several ways: there can be mixing, whether by fraudulent intention or carelessness, of two or more different kinds of cotton in ginning or baling. Again, it may be mixed through the fraudulent or careless mixing at the ginnery, or afterwards, of seeds to be subsequently used for planting; or, again there is the natural danger of mixing resulting from hybridisation by insects of one kind of cotton with the pollen from another. To avoid this mixing, strict control by legislation is important in order to maintain the purity of the seed, and this can be, and is being, done by seed farms (see Chapter 5).

As vital as control over cotton seed is the control of the pest and diseases that ravage the cotton plant and affect the quality and quantity of the crop produced.

(ii) Control of Cotton Pests:

By far the greater area in which cotton growing was contemplated from the 1890's and onwards was in the tropical zone. Hitherto, however, the greatest development of cotton has been in sub-tropical regions, and the principal studies of its needs and problems had been carried out under sub-tropical conditions. The cotton-growing districts of the U.S.A. are entirely sub-tropical, and cotton plant is an annual which is killed by the frosts of winter; the death of the cotton plant destroys insects and fungoid pests, or at least limits their survival (Chapter Two). In the tropics, however, where there is practically no frost, it was essential to fix arbitrarily a period during which the old cotton plant should be destroyed, and this can only be done by regulations made and enforced under government authority. Thus, in this respect the need for research becomes paramount.

The foundation of modern agricultural development have generally been laid either by pioneer farmers or planters in regions suitable for white settlers, or by the agricultural services of the different administrations in territories where agriculture was chiefly or entirely a native industry. In both cases there has generally been a basis of native agriculture to work upon. Whereas, however, such native agriculture generally catered for local requirements only, and interest was confined to those food and other products necessary for the family or the tribe, more intensive development of the agricultural resources of these areas has usually been associated with some crop for export. In some cases, the extension of cultivation has been in connection with products already grown by the natives; in others, and more generally, it has been associated with some crop or crops new to the area, or which had previously been an unimportant factor in local agriculture.

It is generally recognised today that the foundation of all agricultural progress must be based on science; this appears to be at least as true in regard to cotton as in regard to anything else. Everywhere in the tropical countries, there is a crying need for reliable information not only upon environmental factors of agricultural production, but of upon ways and means of utilising to best advantages the various procedures and techniques that may be available and adaptable to the particular conditions existing at the time. Thus, research is indicated again as a pre-requisite to improvement in cultural techniques, both from the standpoint of fundamental knowledge itself and from that of applying such knowledge to situations at hand through education and extension of work, and, of course, scientific investigation, as already indicated, must continue in such matters as soil analysis, plant breeding, disease and pest control, and fertilising practices. Some observers, in fact, feel that too much emphasis is being given to such institutional as fragmentation, size of farming units, and marketing arrangements, and too little to other means of increasing efficiency, for example, water supplies, seed farms for improved seed, fertilisers and agricultural extension services.(44) Thus, a definite framework defining the scope of agricultural research must be drawn up from the outset, where the fields of administrators, scientists, and educationalists must be clearly outlined and defined. In this respect, it is now appropriate to discuss this aspect as it applies to conditions in the Sudan, and how planners of the post-1900 agricultural schemes approached and tackled the various problems of agricultural development.

III. SCOPE OF AGRICULTURAL RESEARCH (1910-25) AND PROBLEMS OF DEVELOPMENT IN THE SUDAN

In a memorandum dated 1913, the Ministry of Education, under whose auspices all agricultural research during the experimental stage of cotton growing was carried out until 1918, set the general framework of agricultural research in the Sudan.(45) In this connection the view was adopted that "in human affairs science has little significance except for practical purposes"; that appropriations to an institution for agricultural research are investment since it makes direct return by adding to the productive capacity of the country. Thus, it was advocated that agricultural expansion must necessarily depend largely on the assistance that could be offered to producers by such an institution, and in this respect, the latter differs from all other administrative bodies. "A department divorced from experimental work is one which will never survive, a colony which does not place the experimental farm in the forefront of agricultural development is destined to fall, and the Sudan, if it would succeed with her farming industries, must surely follow the illuminating example of Canada, the U.S.A., Australia, and South Africa."(46) The Sudan had,(and still has) a single industry, the growth of which was to be determined by the scientific investigator; they must stand or fall together, and the measures of success obtained by the one will furnish a guage of progress in the other. In this respect, classification of function was thought necessary.

Thus, in this broad outline, the duties of the state to an agricultural community were defined as those of administration, research, and education, although it has been found possible and even desirable in several countries to dissociate the first from the two latter undertakings.(47) Administrative functions, especially in a country like the Sudan, with its vast areas and primitive means of transport, were thought to be little compatible with systematic research involving, as it does, in most cases fixed residence and continuity of attention. It has been noted that several earlier field experiments were vitiated by the conflicting duties of the investigator, entailing absenses from headquarters, losses of data and records, and lack of adequate supervision. So it was recommended that administrative officials were suggested to spend a probationary period at a research centre to acquire a knowledge of local conditions, approved methods of agriculture, and an insight into local agricultural problems. Such a system was thought to open the way for a valuable extension of the educational system.(48)

Thus, there must be a bridging of the gap existing between research and education, between the investigator and the practical farmer, which cannot be undertaken in its entirety by the administrative officer. As a medium of communication, the residential college or school has so many advantages that it has become to be regarded as an almost essential complement to the experimental station. Such an alliance rendered possible a scheme of instruction based on factual experiments. However, to communicate such news in an intelligible form to those by whom it was to be put to practical effect was as much the duty of the investigator as the conduct of the experiment from which it had been derived.(49)

It was consequently suggested that officers engaged in research should be called upon to assist in the work of tuition at a residential school connected with the research station. To teach at first the few and then wait patiently "for the seeds so scattered to spread from one or few centres" was, however, a method which did not commend itself to those who appreciated the vital necessity of hastened progress in agricultural development.(50)

In addition to officers entrusted with research and residential tuition, the need was recognised for agricultural officers, with a training at headquarters, to develop the agriculture of promising areas by means of land-owning village head, who by the time had shown himself abundantly capable of benefiting from advice and assistance. This class of "teachers" should not be encumbered with administrative functions, but to devote his entire attention to the work of field education, receiving and distributing selected seed from seed farms, possibly controlling water-supply, collecting data, combating insect-pests and plant diseases, arranging for the marketing of crops and generally accepting the responsibility for the agricultural welfare and development of the area in question.(51)

However, much importance was also attached to the provision of agricultural instructors, because they would be dealing, in a country like Sudan, with an agricultural population incapable of receiving instruction through the ordinary channels of agricultural journals, reports and bulletins, thus necessitating personal instruction and supervision supplemented by field demonstration at as many centres as possible, and this was thought to be the only available solution of the problem of agricultural education for the country at large. As already stated above, a thorough insight into local conditions and findings of the research station was regarded as an essential preliminary to active service in the field.

However, apart from the administrators and research assistants, the economist also has two fundamental contributions to make in the development of agricultural research. The first is the creation of a theoretical economic framework in which the work of the various scientific disciplines can be completely integrated. This involves the delineation of the problems which are of the greatest economic importance in the development of the agricultural industry as a whole, and of the form in which a solution to these is required.(53) As the solution of the basic economic problems facing the individual farmer involves the detailed knowledge of the productivity of the different farm resources, the establishment of the physical input/output functions for the different resources is particularly important. This will of course depend to a considerable degree on the results of the experimental work which is undertaken in the programme of agricultural research. The second contribution of the economist lies in assisting in the allocation of research facilities to the competing demand upon them. The optimum allocation involves problems which are of fundamentally economic character, and a better undertaking of the theory of resource use should lead to a better distribution of the available funds.[54]

Thus, the mission field was broad, and its problems far reaching, for adaptability to a wide range of climate, topography and soils had to characterise, as already mentioned, successful agricultural development in the Sudan. Systems, therefore, had to be evolved for more or less clearly defined areas within which the choice of staple crops, methods of cultivation should have direct reference to the prevailing local conditions.

Thus, it was considered that mean annual rainfall would determine the latitude of larger agricultural districts within which further subdivisions were to be based on considerations of soil, contours and natural drainage, labour supply, transport facilities, occurrence of timber, and seasonal distribution of rainfall.[55] Rain-farming, for example, over areas with a normal precipitation of less than 300 mm (11.81 inches) was regarded as of so speculative a character as to call for suppression rather than encouragement (Fig. 9). The total or partial failure of crops with attendant losses of seed and labour at longer or shorter intervals must necessarily discount any effort to introduce improved methods of cultivation. In the Northern province, for example, it was regarded as plausible that all efforts and resources should be concentrated on the development of the improved systems of agriculture based on river-bank, <u>saqia</u>, basin and pump irrigation respectively. But it had to be recognised at the outset that each system had its distinctive problems and difficulties calling for individual examination.[56] In the southern Gezira, on the other hand, a rainfall of some 400 mm (15.75 inches) occurring during the planting season and early growth of cotton, complicated the perennial irrigation (Fig. 12). Thus, if ploughing was done prior to the early rains, weed growth assumed a serious character before planting could be completed, while if it was postponed until the ground was sufficiently moistened to furnish a good tilth, the time factor was involved, the operations being possibly impeded by wet weather. This problem did arise during the experimental period at Barakat with the result that the area planted and with it the earning capacity of the ploughing outfits, had to be limited.[57] In this way, the introduction of an improved system of agriculture, based upon the systematic control of environment and crop, could, as an ultimate object, reduce the cost of production, enhance yields and a larger margin of profit to capital and expenditure at the time (pre-1915).

The cost of agricultural production in any country is mostly determined by the collective capacity of the cultivators and by the facilities at their disposal. Under the former heading can be included personal experience and knowledge of agricultural practice coupled with the degree to which the agriculturalist can avail himself of advice based on departmental research and education. Its facilities will include the terms on which he can obtain the use of land, the cost and character of hired labour, the nature of the seed supply, the implements with which he may be able to stock his farm, his draught cattle and livestock, and his capital fund or access to credit.

However, the security afforded by a reliable, though inefficient, means of irrigation, such as the saqia, was reflected by the size and value of the holdings, a very limited fluctuation in the irrigated area, and a far higher standard of cultivation than that obtaining then on the rainlands. Thus, an outstanding feature of the saqia cultivation was the degree to which sub-division of land had been affected, for with an average area of less than 10 feddans, which was equivalent of a single saqia in most circumstances, a saqia was frequently shared by the officially recognised owner, called Samad, with five or six paÉtners who were all title holders to a larger or smaller share.[58] In a census taken over a typical area of 150 feddans revealed the existence of 55 titles, while an adult population of 120,000 found employment and livelihood on 100,000 fedans.[59] The average land tax payable on saqia-cultivation during 1900-15 amounted to 40 P.T. per annum (App.46), and while disinclination and disability to sell under the establishment of a market price was almost impossible, the value of these lands then was certainly not less than £E.20.[60]

However, in lieu of the title payable by the tenant of the rainland, the saqia tenant, or partner, by local custom surrendered approximately half his produce for the use of the land and for the water required by his crops in addition to which he was responsible, by convention, for half the land tax. Thus, in both cases of rain-land and irrigated areas, ushur (a tithe calculated at one-tenth of the crop. See App. 43) was regarded as a fair rent of use of the land, while in the latter case four-tenths were regarded as the mean cost of water supply (see Chapter Six).[61] Moreover irrigation costs included purchase and feeding of four bulls (for a 10-feddan saqia), construction and upkeep of the saqia, and payment of the baseer, who kept the wheels in repair. Thus, under this system, the tenant, on average crops of cotton, wheat and dura at normal prices, annually paid, per feddan, an amount of about £E 2.900 for land and water, and 20 P.T. as his share of the land tax, from a gross average return of £E 5.800.[62] From the small balance remaining, provision had to be made for seed and implements, which local custom regarded as absorbing four-thirtieth of the crop, leaving four-tenths of it, valued on the above basis at £E.2.320, to cover the costs of actual cultivation, and compensate the owner for his labour (see Chapter Six).[63]

The cultivator of the rain-lands, on the other hand, had no such heavy bill of costs, for his expenses directly reflected the primitive methods then in vogue, in which ploughing was rarely practised, the seed being dibbled with the digging stick, seluka, in the freshly moistened soil. The cleaning was completed with the hoe, and subsequent operations were limited to harvesting and threshing. Peacock in 1906 estimated the average cost of cultivating and harvesting 5 feddans of land under dura in the Gezira at £E.1.250 which, with good rain, produced 15 ardebs, worth, on the previous estimate, £E.9, or a net profit of £E.1.550 per feddan after all expenses had been paid (see Chapter Six, and App. 43).[64] The speculative nature of the crop is further evidenced by the violent annual fluctuations in the market prices of such a typical rainland crop as dura. The total or partial loss of crop, seed and labour, at more or less frequent intervals, indeed went far to discount the profits of good years, and to limit attempts in the direction of improved cultivation.

Thus, the outstanding problem of rain-farming in northern and central Sudan was the speculative nature of cultivation dependent on a very uncertain rainfall on the one hand, while the saqia cultivator was burdened by almost prohibitive costs of irrigation. The provision of an adequate water-supply at a reasonable rate, it was thought, would consequently remove in both cases the principal obstacle to agricultural development, and pave the way for the introduction of improved methods, which could necessarily be based upon a broader margin of profit. The rainland cultivator was indeed a gambler, while the saqia owner was working in a vicious circle. Thus, the possibility of substituting pumping machinery by an anachromism as the saqia under such circumstances, necessitated serious consideration, and consequently until 1917 commercial tests of a variety of driving machinery and pumps figured prominently in the work of the Research Farm at Shambat.[65]

However, the chequered career of agricultural estates until 1915 in the Northern Province of the country along the main Nile, had been attributed variously to extravagent pumping costs, an unfortunate choice of crops and varieties of cotton, the difficulty of obtaining satisfactory tenants, inadequate and costly water supplies, and everywhere the difficulty of collecting arrears from debtors who could offer no preliminary security for water supplied on credit (see Chapter Seven). Of these drawbacks, the first two were directly attributed to the absence of exhaustive preliminary enquiry, while all other aspects of the problem involved the question of tenure (see Chapter Six).

Thus, to have an idea of the relative efficiency of saqia and pump, we take a 3-course rotation: cotton, wheat, beans or dura. Under this system, a third of the land would receive 12 waterings for cotton, a third 7 waterings for wheat, and the balance 5 waterings for dura or lubia (dolichos lablab), or an average of 8 waterings per feddan. As has been shown above, the saqia tenant would pay for this irrigation two-fifths of his crops, with a normal value of £E.2.320, representing very nearly the actual cost of supplying the water by means of the saqia. The same irrigation was effected with the steam pump at a net cost of £E.1.005, and a gross cost, including depreciation, of £E.1.025.[66] Thus, the effect of the extension of this system in the form of a chain of pumps along the whole length of saqia cultivation, and the ultimate elimination of the latter, could result in an annual economy on cost of production amounting to, say, £E.132,000 in the circumstances prevailing then, while this figure could have undoubtedly been further enhanced by the provision of facilities for the importation of liquid fuel.[67] Moreover, saqia irrigation was then confined, as it has always been, to a very limited and narrow belt on the crest of the river bank, as the maximum range of the flow for the small quantity of water delivered by the saqia rarely exceeded 400 metres. The conformation of the riverine lands, however, lent itself to the economic watering of a far wider belt corresponding with a gentle slope inland from the flood bank to the karu (see Chapter Six). Thus, it was consequently found possible in the case of the experimental area at Shambat, for example, which was typical of the Nile bank in the Northern Province, to extend irrigation on 1500 metres of river-front from about 60 feddans previously served by saqias to approximately 500 feddans under the pump.[68] On a conservative estimate it was also feasible to quadruple the total area of irrigation and reduce the cost of production by at least a fifth. Such additional margin of profit would constitute the capital fund for improvements in cultivation proper, from which further economies and better yields might confidently have been expected.

These are the problems of agricultural development that face the underdeveloped countries, especially in the tropics. They were discussed first generally, and then with specific reference to those pertaining to the conditions in the Sudan before 1925, where the traditional means of irrigation practised then, i.e. saqia and rain-farming, is compared in efficiency and range of irrigation as well as cost, with pump irrigation, to bring out the importance of cheap production of a competitive crop like cotton. Moreover, the importance of educating the staff who will supervise and instruct the cultivating tenants in the various cultural and physical problems of proper cultivation of cotton (themselves the result of constant research and experiments) is stressed. However, although most of these studies were carried out between 1900-15, the conditions under which they were conducted were the same as, if not worse than, those which had prevailed since at least the beginning of the 19th Century. Thus, in this context, it can serve as a background to the next chapters, which deal with the development of cotton growing in the 19th and 20th centuries respectively. Now we can turn to the first of the two: cotton growing in the 19th century.

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61. W.A. Davie, op. cit., p. 61

62. E.R. Sawer, op. cit., pp. 18-19

63. W.A. Davie, op. cit., p.62

64. H. St.G Peacock, op. cit., p.20

65. G.E. Pennington, "Pumping Machinery and Engine Tests", Bulletin No. 1, Education Department, (1915), pp. 141-67

66. E.R. Sawer, op. cit., p. 20

67. G.E. Pennington, op. cit., p. 149

68. E.R. Sawer, op. cit., p. 21

P A R T II

THE HISTORICAL GEOGRAPHY OF COMMERCIAL COTTON GROWING IN THE SUDAN BETWEEN 1860 and 1925

CHAPTER FOUR

THE DEVELOPMENT OF COMMERCIAL COTTON GROWING: 1860 - 1899

In the previous chapters, the discussion was centred on the various aspects of the physical and other factors which are basic to agricultural development in general, and which also affect cotton growing in particular, together with a consideration of the various problems of agricultural development in new areas as well as in the Sudan. With these chapters serving as a background, we will proceed to discuss the development of commercial cotton growing in the country, and since this venture was undertaken in two different periods and under different governments (but under the same environmental conditions and for more or less similar motives), we can grasp, by studying their approaches, the underlying causes for the failure of one and the success of the other. Thus, bearing this in mind, we can turn to the first of these periods: the nineteenth century.

I. COTTON GROWING DURING THE TURKISH PERIOD (1860 - 1883):

As mentioned in Chapter One, cotton growing for domestic use has been known in the Sudan from early times, and although opinions differ as to where from cotton was first introduced into the Sudan - some pointing to Egypt and North Africa,(1) others to India,(2) and some to the Sudan as the origin(3) - the fact remains that people wore cotton clothes woven by their looms, and that the handicraft was well established when the first European travellers began to arrive in the country in the late sixteenth and early seventeenth centuries. Nevertheless, it is still also true that the impetus for growing cotton for commercial purposes came from Egypt in the latter half of the nineteenth century, and although the whole venture was motivated by the cotton famine created by the American Civil War of the 1860's (see below), the Turkish authorities were, however, long before impressed by some cotton fabrics of Sudanese make (see Chapter One). According to Hill, Mohamed Ali Pasha, the Viceroy of Egypt, having seen a piece of cloth woven from "Sennar Cotton", asked the governor of that province to send him a sample of the cotton together with a consignment of seeds.(4) The governor's successor, Mahu Bey, is said to have complied with the order, and thus gave his name to the first variety of cotton bred in Egypt by Jumel. Jumel, as stated in Chapter One, is said to have started to experiment with a new type of cotton he had found in a Cairo garden. Thus, the Turkish authorities knew that the climate of the Sudan was suited for cotton growing, and accordingly they contemplated turning the country into a large cotton field which would provide the money so much needed in Egypt and to make the Sudan pay itself.

However, it was during the cotton famine of 1861-64 that more or less practical steps were taken, and enough zeal was shown by the authorities in Egypt to grow cotton in the Sudan. England, for long dependent on American cotton for Lancashire mills (Fig. 25), was the first country to feel the pinch, and to avoid such shortages in future, cotton growing was encouraged in some parts of its Empire, including Egypt - at the time a satellite country. Thus, it was the necessity for securing cotton supplies for the English textile industry, created by the cut off of cotton from the Southern States of America during the Civil War,(5) that indirectly encouraged commercial cotton-growing in the Sudan.

III. THE COTTON FAMINE, 1861 - 64, AND PROBLEMS OF WORLD AND BRITISH COTTON SUPPLY:

The danger of the dependence of the British cotton industry upon a single source of supply for the bulk of its raw material - 80% of Lancashire's total imports of raw cotton in 1860 came from the Southern States - had been recognised by some far-sighted men and cotton merchants, as a result of whose efforts a Select Committee on the Growth of Cotton in India was appointed in 1848 (which published its report in 1849), and the formation of Manchester Cotton Supply Association in 1857 with the main purpose of widening ".... the sources of Lancashire's cotton supply by distributing cotton seeds and gins, by circulating instructions on methods of cotton farming, and by sending agents to encourage cotton growing" within the Empire.(6) During these years, India alone supplied

Britain with just over 70% of the imported cotton,[7] and in the meanwhile, English spinners also vigorously supported the huge irrigation programme for Egypt which eventually helped to make the Nile valley one of the main cotton-growing regions in the world by virtue of its fertile soil, water supply, climate together with abundance of labour, which combined to make her the producer of the world's finest cotton. Moreover, France and Germany, also equally desirous of reducing their dependence on American cotton, likewise encouraged cotton production in their colonies, but with unsuccessful results - a fact which goes far to show how inadequate is any attempt to explain world cotton production in terms of purely natural geographical conditions.

However, in the face of increasing population in India, more emphasis had to be put by the peasant into raising of food crops, and as a result India failed to supply England regularly with a large quantity of good cotton.[8] Other reasons were attributed to the primitive traditional agricultural methods, the abject condition of the peasants, and the lack of capital and proper roads, which made it longer "to convey the cotton to port than to rear the plant" in Indore.[9] An economic factor was the irregularity of the prices and irregularity of demand for Indian cotton.[10] Usually, the Lancashire merchants took Indian cotton only when they could not obtain American, which until 1861 amounted to 1,840,000 bales. Imports from India, however, increased from 568,000 bales in 1860 to 1,390,000 in 1863 and 1,866,610 in 1866.[11] Unfortunately, the quality was poor: "the sudden rise in prices in the middle of 1862 has ... caused all the sweepings and refuse of the bazaars to be sent to the ports for shipment".[12]

Apart from India, other sources included the British West Indies and British Guiana, the former supplying 70% of England's total cotton imports in 1786-9. But supplies declined to a bare 2% during the nineteenth century due to scarcity of labour and low prices, and attempts to revive cotton, which was already replaced by sugar-cane, failed except in Jamaica.[13] In Natal, in South Africa, where some wild cotton is known to have been grown for some time, an early attempt in 1847-49 to grow cotton on a large scale, likewise failed mainly due to scarcity of labour - a problem which was solved in 1862 by the introduction of Indian coolies. Similarly, attempts at growing cotton in Queensland, Australia, failed (Fig. 1).[14]

Thus, supplies of cotton from the Empire were not enough as had been expected, and the immediate prospects were not encouraging. No conscious attempt seems to have been made either by the British Government or by merchants to encourage Empire cotton rather than any other kind of cotton. Indeed, Lancashire merchants and manufacturers, with a very few exceptions, showed astonishingly little interest in the question of cotton supplies until the crisis had become acute.* When the need was appreciated, merchants consoled themselves with the facile hope that cotton could be grown in any tropical or sub-tropical region, and indeed the most extravagant and sanguine hopes were entertained of the most unlikely sources of supply. No sufficient distinction was made between places like India, Egypt, Brazil, and the West Indies, from which supplies could be immediately increased if capital to improve means of transport, and methods of cleaning and packing, and to secure labour, were forthcoming, and places like the West Indies and Australia, where appreciable increase could reaonably be expected for many years. Nor was sufficient distinction made between those measures, which would ultimately increase the permanent supply of cotton, and those which might temporarily increase that supply to meet the urgent situation of 1861-64.

However, with regards to Egypt, which was nominally under the Ottoman Turks, many Englishmen were interested in increasing the acreage of cotton there, and to this effect the cotton estates of the Nile Delta, where cotton cultivation was commenced in 1821, were examined.[15] Thus, in 1862 when Said Pasha visited Lancashire, he was urged by the Manchester Chamber of Commerce and the Manchester Cotton Supply Association, to increase acreage under cotton, for which the Pasha assured them.[16] Again in 1863, when Ismail Pasha succeeded to the throne, he expressed in his first speech to the foreign consuls in Egypt his desire to develop Egypt's resources in an orderly and diligent manner.[17] Accordingly, the duty on exported cotton was reduced from 10% to 1%, and the Manchester Cotton Supply Association, in an attempt to assist cotton growing in Egypt, sponsored the establishment of a system of government-guaranteed advances

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* In England there was no immediate anxiety among manufacturers. The 1860 American crop, the largest on record, had served to glut the market at a time when exports of cotton cloth were falling, and the news of War came to many spinners as a source of temporary relief.

by English capitalists which would relieve the fellah of his dependence on rural money-lenders, who charged high interests, and even the establishment of a cotton bank to provide loans for cultivators was suggested.[18] Thus, packages of New Orleans seeds were sent to Egypt by the Association, with full instructions as to their cultivation, and several improved hand gins were presented to the Viceroy, but nothing came out of these innovations, and all ended with the death of Said Pasha in 1863. However, more machinery, including steam ploughs, cotton gins, and packing presses, worth £71,000, was sent to Egypt in 1863 in co-operation with the Manchester Chamber of Commerce.[19]

Nevertheless, it was the improvements in the cotton-spinning machinery in the direction of utilising the medium and long-stapled cottons, characteristic of the American and Egyptian kinds, which led to increase in cotton production in Egypt (Table 18 App. 18 and Fig. 27). Other reasons included the rapid extension of irrigation, and the decline of world wheat prices in the late 1870's - because of increased supply from the Black Sea, the Americas and Australia - and the rising cotton prices after the turn of the century.[20] Prices in 1862 reached 16-18 dollars per kantar as stocks from the 1860 record American crop began to dwindle, and supplies from America came almost to a stand still. Thus, in the first six months of 1862 only, 11,500 bales were received, or 1% of the usual quantity imported, while average weekly consumption (in Lancashire) fell from 45,648 bales in 1861 to 22,097 in 1862 (Figrs. 25 & 26).[21] However, the deterioration of Indian cotton crop, the swing to sugar-cane in the West Indies, and the rapid recovery of the American cotton after the Civil War, and the marked improvement of its quality, made Lancashire depend again on the American cotton - a fact which, as we shall see in Chapter Five, was later to be resented by Lancashire Spinners.

The speedy recovery of the American cotton after this war, and the rapidity with which it re-established itself in the British market can be seen from Table 19 Appendix 19 and Fig. 26. The Civil War undoubtedly reduced the American crop to very small dimensions, but due to the absence of exact records of the movement of cotton during the war period, we can only speak of averages. The average annual crop for the years 1857-61 was about 4,000,000 bales (of 500 each), then it dropped to 1.6 million bales in 1862, to 400,000 in 1863, and to 300,000 in 1864. The dislocation, however, continued long after the end of the war, the average annual crop during 1865-69 being 2,000,000 bales, and pre-war production was only attained in 1873. It may be noted in passing that the average yields of American cotton in 1892 (209.2 lb. per acre) and in 1898 (220.6 lb. per acre) were the highest recorded since 1866.[22]

The increase in prices of American cotton can be seen from Table 18 below and Fig. 28, but the figure for 1863 (101.5 cents per lb.) was probably the year's average, and is subject to question as to the value of the currency.

TABLE 19 PRICES OF AMERICAN COTTON, 1859-1866

Year	1859	1860	1861	1862	1863	1864	1865	1866
Price: Cents/lb	11.0	13.0	31.3	67.3	101.5	83.4	43.2	31.6

Source: M. Darwish, *op. cit.*, p.642

In the meantime, Egypt was slowly capturing the English market as a producer of long-staple cotton, and by 1866 production had increased four times in size, the area by five, and *Jumel* was able to increase its share of Liverpool market from 3% to 12% during the war period, and its earnings from £1,500,000 to £14,000,000 (Table 20).[23] However, considering the prices of the time, the cause for increase can easily be discerned from Table 20 and Fig. 28. Moreover, unlike India where cotton changed hands many times between the grower and exporter thus becoming dirty, the Egyptian system, whereby the Alexandria merchants sent their agents to buy cotton at the main Delta collection points and made payments according to grade, allowed some control to be exercised over quality. In this respect Egypt also benefited from the presence of a few rich proprietors, who were traditionally concerned to produce cotton by the most up-to-date methods and were eager to set a standard for the cultivator to try to emulate.

Cotton prices in Liverpool reached their peak in the summer of 1864 and then began to decline, falling from 52 dollars per *kantar* in August to 37 in December, and by the end of the War, business came almost to a standstill in many Egyptian centres; third of the harvest remained in the field. However, a revival in prices was effected when it became known that cotton stocks from the Southern States were small, and because there was no immediate prospect for return to pre-war levels

TABLE 20 EGYPTIAN COTTON EXPORTS FROM ALEXANDRIA AND BRITISH IMPORTS, 1860-66

Year	Egyptian Exports		British Imports	
	Kantars	£E	cwt.	£
1860	501,415	-	392,477 (87.7%)	1,480,895
1861	596,000	1,430,880	365,108 (68.6%)	1.546,898
1862	820,119	2,920,660	526,897 (72.0%)	3,723,440
1863	1,287,000	9,356,490	835,289 (72.7%)	8,841,557
1864	1,740,000	14.842,700	1,120,479 (72.1%)	14,300,507
1865	2,507,000	15.443,120	1,578,912 (70.5%)	13,906,641
1866	1,785,000	11,424,000	1,055,900 (66.3%)	9,200,580

Source: E.R.J. Owen, op. cit., p. 90 N.B. £1 = 97.5 P.T, £E.1 = 100 P.T

(Table 21). But an examination of Table 20 App 20, will make it clear that American in some occasions attained higher prices than the Egyptian, as in 1824, 1846, 1847, 1849, 1850, and 1852-4, but it is during and after the American War that the disparity is most noticeable. Thus, with the exception of 1871, prices of American cotton kept above those of Egypt for the whole period of 1861-72 (Fig.28). The fall after the Civil War became merged in the great general fall of prices from 1873 onwards, which carried cotton prices to the lowest on record when in 1894 and 1898, American Middling was below 3d per lb., and this level was more or less maintained until 1896, when prices began to rise steadily.(24)

However, cattle plagues, high and low floods, and chaotic transport system in 1863-64, together with the lack of adequate shipping and handling facilities and wharves at Alexandria, caused vexatious problems for foreign merchants, and had serious repercussions on Egyptian agriculture in general, and on food production in particular. As a result, Khedive Ismail was in a chronic shortage of funds to finance his various schemes in Egypt aimed at improving the economy of the country, but faced with mounting government expenses on public works connected with, and started during, the cotton boom, and meeting obligations under the disastrous Suez Canal arbitration decision of 1864, and of paying

TABLE 21 EGYPTIAN COTTON PRICES BY MONTHS AT ALEXANDRIA, 1861-66

Months	Prices at Alexandria : Dollars/Kantar					
	1861	1862	1863	1864	1865	1866
January	13½	16	35	44	37	41
February	12¾	16½	34	42½	35	37¼
March	12	17½	32	42½	29	42
April	11¾	18½	32	44	26	40
May	12½	18	33¼	47	22½	36
June	13¼	18½	31	49	24	33
July	14	22	30	50	30	37½
August	13¾	25	35	52	27	26½
September	15	28	40	49	29	30
October	16	31	46½	44	33	33
November	17½	31	43	39	40	30
December	15	32	43½	37	41	27

Source: Statistique de l'Egypte (1873), pp. 172-3

interest on the debt of well over £10,000,000 run up by his predecessors, he became obsessed with cotton, and saw in it the only salvage from his financial problems. However, with his hands tied by bankruptcy and capitulations and increasing foreign influence in Egypt, and with surplus land in Egypt already allocated for cotton, his eyes turned towards its colony to the south, the Sudan, where he envisaged millions of acres of cotton which would bring him the money he so desperately needed. But this profit-motive attitude coupled with over-taxation and reckless supervision resulted in harsh agricultural conditions, which, together with other factors (see below), eventually undermined the whole venture.

III. AGRICULTURAL CONDITIONS IN THE SUDAN IN THE NINETEENTH CENTURY

According to Muslim Law, all land held from the state on payment of a rent were considered the property of the public domain, the cultivator had, therefore, ~~been~~ held merely the usufruct. The right held of inheritence did not exist as we know it today, but nevertheless the traditional laws gave the preference to the heirs of the deceased holder if they were in a position to pay the rent or taxes. Accordingly, the government took from the cultivator a tithe of the land's produce plus further taxes on the livestock and other agricultural plants.(25)

Before the coming of the Turks in 1821, conditions were more or less different, especially in the rainland areas like the Gezira. Here, for example, there were two categories of land: privately-owned land and tribal lands (Chapter Three). Individual landholding was recognised only for land which showed signs of regular cultivation, such as the earth embankments, (terus), by which cultivators retained rainwater. If the holder failed to cultivate his land for a few years, it returned to the community when all traces of occupation had disappeared. There was no exception to this rule. The natural depressions, ugud, which received larger quantities of rainwater every year and which did not need terus for cultivation, were privately held; because of their privileged location these were cultivated annually, except in case of total dought. All other lands occupied only intermittently, or abandoned for several years by the cultivators, were the communal patrimony of the village or the tribe. Communal lands were used mainly as pasture land, but could also be cultivated by persons who did not hold private land. When clashes occurred between tribes over the use of these grazing lands, the dispute was brought before the Kings at Sennar who formalised the existing land rights by issuing a document defining the limits of the disputed areas.(26) Private ownership of riverine lands seems to have been recognised.

These systems of land tenure were upset during the political unrest at the beginning of the nineteenth century. Certain tribal groups invaded territories of neighbours who were unable to retaliate, some lost their land rights, while others who were in the favour of the rulers of the time were given freehold rights. During the latter part of the Turkish period, the class of small landholders and cultivators of communal land strongly increased. Population pressure on the riverine lands induced growing numbers of people to take their chance as rainland farmers; moreover, dependents of landlords, who wanted to improve their social status tried to grow crops themselves. This development of small-scale agriculture in the rainlands occurred at the expense of pastoralism, since the frontier between farmland and pasture land moved gradually towards the west.(27) As pasture land became rare around villages, it happened more frequently that the animals strayed in the fields of small cultivators and caused damage to the crops, thus creating dissatisfaction and complaints, which gave rise to conflict and permanent antagonism. Like in the struggle between the rancher and the farmer in the west of the U.S.A., the herdsmen of the Gezira were also compelled to retreat more to the west. Some did it spontaneously and founded villages where some of them went to live. In some areas, an open conflict precipitated which resulted in the most wealthy families leaving entirely with all their slaves and animals and founding villages that still bear their names, such as Azraq and Barakat.(28)

Thus, although the country enjoyed a measure of prosperity in terms of livelihood, compared with the chaotic years before 1820, this by no means signified that everything was alright, especially in the field of agriculture, where the Turks hoped and indeed tried their best, to procure money the easy way. The evil character of the Turkish rule, however, was the heavy arbitrary taxation imposed on every aspect of economic life. In the field of agriculture they brought the land tax that was in force in Egypt into the Sudan, and the traditional Sudanese taxation system was ignored. As a result of this change, existing economic relationships were disrupted, many areas were depopulated, and the tribal balance was upset because of the habit of confiscating tribal land from one and giving it to another tribe. This policy inevitably led to widespread revolts, especially in the Gezira, during the 1820's, and a new assessment had to be made to appease the rebellious people. Thus, by late amendments of land morgaging and taxation of produce, certain amount of land had to be given to any one returning to his village, tax on produce was also added to the land tax, legal titles of possession, formerly endowed by the Fung Kings, were introduced, and each heir acquired the title to inherit the land. The Jada'a (a tax collected on 5½ feddans of land) was made payable by most of the cultivators of the Nile valley, and those who did not own land, paid an equivalent amount.(29)

Taxes on saqias and land were the real devastating feature of the Turkish rule, the saqias being divided, for fiscal purposes, into four classes based on the type of land watered by these devices. However, during the early years of their rule, taxes were levied in a more or less haphazard way pending the introduction of cash crops, such as cotton, indigo, and sugar-cane. Even then, when as yet no step had been taken, the Turks set about counting the sums they were to draw from these lands, for they heard or thought of nothing else but gathering money in such sums as by cunning, injustice, oppression, or violence they could lay their hands on. Nor even did they trouble their heads that in so doing they might ruin the future welfare of their subjects, and at the same time destroy all sources of revenue for themselves.(30)

The taxes on saqias ranged from 15 to 20 dollars (250-400 P.T.) plus two ardebs of wheat, or, as in some districts of Dongola Province, 15 dollars in cash and 5 dollars' worth of produce.(31) However, M. Cadalvene, writing in early 1840's, states that ".... these taxes are very arbitrarily levied by the Government (imposition by individual officers do not come under this heading) and amount to 22 Spanish Dollars for each saqia; but that an infinite quantity of natural produce must be delivered besides, which the Fellah is afterwards obliged to re-purchase at high prices from the Government."(32) The tax on saqias was first officially assessed in 1856 at 500 P.T. per saqia, and then was reduced to 150 P.T. to be raised again to 600 P.T. in 1870. The tax on land was made payable by all riverine cultivators, and for that purpose land was classified into two main categories according to situation from the river, and, obviously, to the ease with which it could be irrigated as the following table shows (Table 22).

TABLE 22 TO SHOW TAXES LEVIED ON SAQIA AND LANDS UNTIL 1857 (TURKISH PERIOD)

Objects	Taxes First Levied	Reduction of 1857
Saqia	300 - 500 P.T.	150 - 200 P.T.
Shaduf	250 - 350 P.T.	-
Saqia - on-wells	175 - 350 P.T.	-
Island lands/feddan	52 - 60 P.T.	25 P.T.
Riverine banks/feddan	22 - 45 P.T.	20 P.T.

Source: D.H. Stewart, op. cit., p. 13

The reduction was effected by a viceregal order from Said Pasha after his visit to the Sudan in 1850. However, in 1860 an enactment was issued prescribing the classification of lands according to their quality, and fixing the land tax, on an equitable scale, at an average rate of 20 to 60 P.T. per feddan. But this measure was carried out incompletely, and instead a new 5% was added to the land tax in 1862 and another 10% in 1870.[33] Indeed, the change in taxation undertaken by Said Pasha consisted of substituting a land tax for the poll tax (under which every member of the community was obliged to contribute according to his means) to the great relief of the nomads and tradesmen, but to the disadvantage of the agriculturalists, the poorest part of the population. Thus, whilest the nomads, who as a body were richer, contributed but one-half of what they formerly did to the support of the Government, the wretched peasants had to pay not only more taxes, but also to make up for the loss accruing from the reduction in nomads' share. The consequence was again the throwing out of cultivation of considerable tracts of land, a scarcity of grain, and dearth in the country, the price of maize and millet having, between 1850-1860, increased tenfold, and thus, unaware, Said Pasha caused considerable suffering and privation.[34]

Moreover, there was a fractional addition calculated at the rate of 5.95 P.T. per each Egyptian pound (£E) in Dongola, and 1.13 P.T. in Berber Province in lieu of taxes abolished on boats and native beer, and to pay for the salaries of tax collectors, and thus the Government exacted an additional amount of £E.4,228 per annum from the poor peasants without anything in return, as we shall see below.[35]

TABLE 23 CLASSIBICATION OF SAQIAS AND LANDS AND TAXES LEVIED ON THEM IN DONGOLA AND BERBER PROVINCES DURING TURKISH RULE

Item	Tax in Piastres (P.T.)				
	Class A	Class B	Class C	Class D	Class E
Tax levied on Saqia:					
Per Saqia (in Dongola Province)	500	400	350	300	-
Per Saqia (in Berber Province)	450	400	350	281	-
Per Shaduf	350	250	-	-	-

Item	Tax in Piastres (P.T.)				
	Class A	Class B	Class C	Class D	Class E
<u>Land Tax:</u>					
Land irrigated by Well or Rain, per feddan	350	250	175	-	-
Islands, per feddan	60	60	52	-	-
Guruf (river banks) per feddan	45	26	22	-	-
Karu land, per feddan (in Berber Prov.)	56	40	28	20	15
Date Palms, per tree	2	-	-	-	-

Source: D.H. Stewart, *op. cit.*, p. 14

N.B.

Taxes on saqias depended on the ease of irrigation and the fertility of the land they irrigated.

Karu land is a land of clayey soil with a rather high salt content and situated away from the river (Chapter Two).

Against these grievances the Commission of Dongola Notables was set up to look into the whole taxation system, and to find a new basis for taxing in the future. Thus, they assessed the net return from one *saqia* irrigating average land at 391 P.T. and 201 P.T. for others. This assessment they arrived at by calculating earnings and working costs of two *saqias* irrigating fair average land, and on this basis, they proposed the following: (a) To reduce taxes from 500 to 400 P.T. per *saqia* with the exception of some 130 *saqias* which were to be charged 350 P.T. each because the land they irrigated was below average in fertility, and also some *saqias* situated at cataracts to be charged only 250 P.T. because of the narrowness and patchiness of the cultivable land and difficulty of irrigation there. (b) Each *shaduf* to be charged 10 P.T. only. (c) Land irrigated by rain (*amtar land*), mainly in the southern parts of Berber Province, to be taxed at 300 P.T. per *feddan*. (d) Islands at 40 P.T. per *feddan*, and *guruf* (river banks) at 35 P.T. per *feddan*. (e) That the government should not charge the owner for land he no longer irrigated. (f) Also to remit the taxes due on ruined *saqias* since 1877 so as to encourage the owner to cultivate the land. (g) To appoint capable land surveyors, and not to continue to levy taxes on land and date palms carried by the flood, and (h) to diminish tax on karu land to 25 P.T. per feddan.[36] But the whole thing was shelved following the deposition of Ismail, and the revolt of the people under the Mahdi from 1882 onwards, put an end to any hope of carrying out these proposals.

All these taxes the peasant paid by order of the provincial governor or the local village head, the Sheikh, and the central government kept no supervision over the functionaries with the result that the land of the weak was over-taxed to make up for any deficit of taxes from the rich and powerful personalities.[37] Thus, all these factors contributed to render the condition of the peasants one of almost unparalleled poverty and wretchedness. Taxation was not, in fact, established on any clear-cut basis; it was not proportional either to the quality of land or the capacity of each respective individual to pay it. Taxes were assessed as it happened in 1865 when the Governor-General, Mumtaz Pasha, frankly admitted that, although the tax of 500 P.T. per saqia he levied was excessive, and beyond the capacity of the peasants to pay, he wanted to see for himself how much the peasant could afford to pay in an interval of three years. But the tax stayed the same, and was even increased to 600 P.T. some years later.[38] The peasant was ignorant of the laws by which tax collection was made; if he could not pay in cash, he was obliged to sell his standing crops at half their value or borrow money from a merchant usurer at the rate of 4-7% a month. If the sale of crops did not suffice to pay the requisite contribution, he was forced to sell his cattle and eventually to part with the land itself, on the produce of which he was striving to subsist.

Moreover, the exaction of taxes was carried on in the most arbitrary manner, and imprisonment and corporal punishment were inflicted to enforce payment. According to Stewart, for every pound that reached the Treasury, the tax collector robbed an equal amount from the people.[39] Furthermore, these taxes did not vary with time, and the same amount had to be paid whether the number of inhabitants of a village had decreased or not, or whether the date palms, which had been taxed perhaps ten years ago, still existed or had been cut down or destroyed by floods or storms. Thus, a survey of saqias in Berber Province in 1827 showed a total of 706 operated by a tribe in contrast with 2,437 recorded in the tax registers.[40] Other taxes, such as that on salt, the professional tax, tax on sale of cattle, etc., were also extracted from the peasant, thus ruining him and putting a stop to any small scale local commerce that might have arisen.

Such an atmosphere was, undoubtedly, not conducive to the development of agriculture and had, in addition, serious social repercussions. First, many people were ruined, especially in the riverine areas where, due to the limited irrigation capacity of the _saqia_, and the variations of the flood level (see Chapter Two), yields were precarious. The low income of the peasant, if there was any, could not bear these taxes. Secondly, as a result of these harsh conditions, the Nile reach between Shendi and Dongola, and the Gezira, were depopulated, and this emigration to seek sources of livelihood in trades other than agriculture, drained the region of its young and robust people, who were much needed to develop the agriculture of the area. Those left behind were the old men, women and children. Thirdly, this depopulation meant abandonment of _saqias_ and lands. Thousands of people from the Gezira fled to the borders of Abyssinia; by 1881, 1,442 _saqias_ in Berber Province and 615 in Dongola were abandoned. Similarly, from the total number of 5,900 _saqias_ in Dongola, 551 were completely ruined, and the owners and labourers of 2,010 _saqias_ ran away, and in some places only one man and one ox, or two of both, per _saqia_ were left behind.[41] Even as early as 1837, Hoskins noticed many houses entirely covered up by sand, and continuous tracts of land left untilled between Merowe and Urbi, south of Dongola town, and the encroaching sand made people shift from the threatened river banks to islands.[42] In 1837, Puckler-Muskau commented on the deserted fields near Hafeer, to the north of Dongola, where artificial irrigation ceased and the fields covered with mimosa and _usher_ (_Calotropis procera_).[43] Between Hafeer and Dongola, he noticed many abandoned fields, and people were constantly emigrating, not solely because of the peculiar disease as Muskau tried to have us believe, but largely because of the unbearable conditions brought about by the heavy taxation. The appalling truth and the rapidity with which people were moving out can be discerned when one considers the fact that in 1830 the number of _saqias_ in Berber Province was 1,368, each paying a tax of 20 dollars, and in 1834 Dongola district alone possessed from 4,00-5,00 _saqias_, Ambikol district about 340, and Merowe area about

1,200 <u>saqias</u>.[44] Many of these displaced people found employment with European and native traders, who dealt in ivory and slave trade, while some of them became itinerant merchants, and as such found their way into the various centres of trade scattered throughout the Sudan.

It was under such conditions that cultivation of cotton for commercial purposes was introduced into the country, first in a small scale in the Baraka Delta, in the 1850's, and in 1860 on a large scale. But in the same way as the Government, irrespective of the capacity of the people, ordered a collection of taxes whenever the needs of the Treasury required it, it also told them to grow cotton so as to sell it at the high prices prevailing at the time (Table 21 and Table 21 App. 21). Thus, to this effect Munzinger, a Swiss adventurer who was the Governor of the Red Sea privinces of Abyssinia, and an ardent advocate of Turkish expansionism, wrote between 1855-75 many memoranda, stressing the vital necessity for Egyptian control of the land drained by the Blue and White Niles. One of his historic tracts, <u>Observations sur la Situation Economique du Soudan</u>, written in 1871, stimulated the imaginative mind of Khedive Ismail to continue his efforts to pacify and control the country. Manzinger thus set out to divide the country territorially into divisions based mainly on ease of irrigation, suitability for agriculture, and his knowledge of the area. These divisions can broadly be termed regions, and as such are worth studying because, considering the idea behind it, it clearly shows that any economic venture motivated mainly for political reasons, without realisation of other factors whether economic, physical and social, is bound to fail. However, although Munzinger was more realistic in his division of the country than others, as we shall see later, the sweeping conclusions he arrived at were erroneous and unscientific. This will be discussed later in this chapter, and for now we can briefly outline the regions into which Munzinger divided the country.

VI. <u>MUNZINGER'S DIVISION OF THE SUDAN, 1871 (Fig. 29)</u>

The Sudan is divided broadly into six regions as Fig. 29 shows, which will be summarised as follows:

(i) <u>The Blue Nile land, the Sennar and the Nile land from Khartoum to Dongola:</u>

These regions mainly consist of strips of alluvium along the river banks where irrigation is mainly done by saqias, and although the cultivable land is narrow, the region is well-peopled, and produces mainly dura sesame and wheat. To the south along the Blue Nile, especially near Fazogli, the country is hilly and rich in timber - mainly acacia and ebony - and gold.

(ii) The Delta Regions of Gezira and Meroe:

These possess, according to Munzinger, very rich alluvial soil, and inundation is easy in many parts of the region. Moreover, there is 'enough' rain to allow for cultivation of crops, but there was no cultivation practised at the time, and instead nomadism prevails and there are large herds of cattle that graze on the fine pasture. Thick mimosa forests cover large parts of the Delta, and the Athara river, which flanks the region on its eastern side, can by canals be forced, despite its high and gullied banks, to overflow the lands of the Meroe on the right bank and Taka plains on the left.

(iii) The River-Lands Between the Nile, Dinder and Rahad:

Munzinger considers this region as the richest part of the country, and consists entirely of alluvial soil and heavy clays. The land between the Rahad river and the Nile, however, is little disturbed and is largely made up of prairies and forests and is mainly inhabited by cattle-owning nomads. The Gash Delta contains more than half a million feddans about one-fourth of which is cultivated with dura, yet it is essentially a cotton area, waiting only for some encouragement from the Government. The Baraka Delta, though a little inferior to the more prospective Gash Delta, produces good quality cotton.

(iv) Kordofan:

This province mainly consists of light sandy soils in the north and fertile clay plain in the south. Dukhn (burlush millet) the staple food crop, is widely grown, and there are large forests of gum trees (Acacia senegal) and immense prairies inhabited by nomads, though the region is less peopled towards the south. The main products are gum, hides, ghee, and ostrich feathers.

(v) Gadaref:

This, observes Munzinger, is a sort of an oasis, which mainly consists of undulating ground separated by plains covered with forests, but deprived of water (especially during the dry season). The inhabited parts of the region are dotted with hundreds of villages, and are highly cultivated with dura and cotton using rainwater only. The output of dura is large, and cultivable land extends as far as Gallabat (on the Abyssinian border).

(vi) The country between the Gash, Atbara and the mountain chains to the Red Sea between 15-19°N, contains several torrents noted among which are the Gash, and Baraka streams which have irrigable low banks. Apart from these, the region is hilly, and cattle breeding by some Beja tribes is the dominant occupation.

To understand the crop pattern of northern Sudan, a brief account of the main agricultural regions and the physical factors affecting them is given in Appendix 22 but certain salient points must be made here. To begin with, topographic factors have little direct influence on the crop pattern, though they are of considerable importance in modifying edaphic and climatic factors. Edaphic factors affect crops everywhere, the main biotic factor, man, affecting crop production was, at this time, greatly influenced by climatic and other physical conditions because of the backward way of life. The major factor that influences the crop pattern of the Sudan is the climatic; even if we consider other biotic factors affecting crop ecology, such as vegetation, fauna, pests and diseases, the main causal factor is again climatic, which is, broadly speaking, continental tropical (Chapter One). Rainfall distribution and incidence show great variations from one part of the country to another (Figrs. 9 & 10), and if the minimum rainfall for successful crop production is taken as 300 mm. (11.81 in.) per annum, it becomes clear that except where a certain supply of water is available, people used to abandon agriculture in favour of nomadism or collect natural products, such as gum, ostrich feathers, ivory etc. as a source of income.

However, if we compare these agricultural regions with Munzinger's divisions of the Sudan, we can indeed find some similarities in the description of the physical conditions within, and economy of, each region. The only difference is a matter of delimitation and choice of title as, for example, in the case of the Central Clay Plain, which Munzinger divided into three regions (Figrs. 5 & 29). But, whatever were the shortcomings, Munzinger's Observations, stripped from his exaggerating cliche, clearly revealed the main obstacle to any kind of economc development, and that was the lack of efficient means of transport, as we shall see below. He admits that the isolation of the Sudan had resulted in the production of crops for local consumption only, and that the difficulty of transport confined trade to more accessible areas. This, he thinks, was the reason why, by 1870, little cotton was grown for export, although eight years ago the Sudan, especially Gadaref area, sent a great deal of seed cotton to Egypt. Thus, if transport difficulties hindered development of trade the more or less primitive and inefficient agricultural practices were by no means adequate to raise an exhaustive crop like cotton.

V. AGRICULTURAL PRACTICES:

These consisted mainly of, first, irrigation. This was done by saqias and shadufs, and was practiced mainly along the Dongola reach of the Nile, but were later introduced up the Nile as far south as Kamlin, on the Blue Nile, and also in parts of the Gash river banks near Kassala. In the Gash and Baraka Deltas proper, uncontrolled flush irrigation was common, although some crude damming to direct water into carefully selected areas was practised in the Gash Delta. This is the shiote system described in Chapter One. Secondly, river bank (guruf) cultivation, as noted in Chapter Three, was practised along the main Nile, White Nile, and parts of the Blue Nile. When the flood receded, the exposed banks and islands were grown with various crops, and thus this practice was seasonal and the area cultivated depended on the level of the flood and the form of the valley itself. Thirdly, shifting cultivation, which was, and still is, common in all rainlands, particularly in the Central Clay Plain (Fig. 29), because of its simplicity, low labour requirement, and the availability of extensive land. But the system was precarious and casual and yields fluctuated with the amount of rainfall, and hence quick-growing crops were grown exclusively for family consumption, and thus the method was not conducive to production of perennial crops for cash because of its marginal nature. Other methods practised besides shifting cultivation, included ugud and terus cultivation by more sedentary people, as stated in Chapters One and Three, and as will be described in Chapter Six. Finally, hoe cultivation which was prevalent in the deltaic fans of Gash and Baraka, but this was not efficient because only surface scratches were made, which led to crop failures, especially when rainfall failed or inundation was inadequate.

It is clear that such practices under the prevailing conditions of backwardness and nomadism - which involved over 80% of the population - were not conducive to production of cash crops on a large scale as envisaged by the Turkish rulers. Irrigation by saqias and by flush method, which under the conditions seems to offer a more successful way of raising a crop like cotton than other practices, was in itself hampered by the limited irrigation capacity of one and the fluctuation and uncertainty of the other. The river bank (guruf) cultivation was in no way better, despite its easiness and less labour requirement, mainly because of the high salt content (Chapter Two), and the nearness of the water-table, which would have induced heavy vegetative growth at the expense of flowering. Moreover, the river banks were in many places narrow and often precipitous, and were already sub-divided into plots of various sizes belonging to many families, who cultivated their animal fodder, some vegetable, and one or two crops, such as lupine, which, depending on the amount of food produced in the saqia-land, could be exchanged for some articles such as damour, soap, etc. By allotting this seluka-land to the production of fodder for their herds and flocks and the saqia oxen, the saqia-land could be devoted to production of the foodcrops the people subsisted on. So any attempt to devote both types of land to production of cash crops only would have been ludicrous and of serious consequences, as it eventually turned out to be.

Thus, in the face of these hazards, one would have expected well-planned economic and social measures to achieve the ambitious ends. But, unfortunately, the Turkish authorities, often deceived by grossly exaggerated reports and travellers' tales describing the flat clay plains covered by "luxuriant" vegetation during a brief rainy season, over-estimated the true potentialities of these lands and problems associated with their development (Chapter Three). Thus, true to their colour, there appeared many articles and reports in which the Sudan was pictured as a very fertile country, just waiting for the magic touch of any ruler, to give forth millions of pounds' worth of agricultural products, above all cotton. Now, we can proceed to discuss the reports which, by the influence they had on the viceroys, can be regarded as the main aspect, or indeed the cornerstone, of the Turkish approach to, and their plan for, developing the agricultural and commercial resources of the country.

VI. FERTILITY OF THE SUDAN AND CULTIVABLE AREAS ACCORDING TO REPORTS:

Of all the Turkish Government officials in the Sudan, no one wrote so extensively and with ardour about the economic conditions of the Sudan and, so erroneously, its agricultural resources and prospects, and left such an indelible, but misleading effect on the mind of Khedive Ismail about the commercial and agricultural possibilities of this country, as F. Munzinger. In his Memorandum about the Sudan, already referred to in this chapter, which he called "The Little America of Africa", Munzinger gave this striking statement: "To give a short resume of what I am going to explain, I will state that in the Sudan there is no dead desert. There is rain enough for any cultivation. There are rivers and torrents easy to be made use of for irrigation and navigation. ... The Sudan ought to be one large cotton field."(46) Two-thirds of the surface, he went on, were cultivable, the rest was all pasturage, and soil everywhere was rich alluvium. "I now in no way exaggerate", Munzinger emphasised, "when I state my firm opinion that the Sudan, properly managed, will, together with Egypt, produce as much cotton as America. The province of Taka (Kassala now, Fig. 50) could furnish more than 3,000,000 cwt., and the Red Sea coast is still available which could grow easily 200,000 <u>feddans.</u> I mention here that the Sudan cotton plant, unlike the Egyptian, lives for five years, thus sparing considerable labour".(47) No doubt he is referring here to the "Sennar cotton tree" already mentioned in Chapter One, but he missed the fact that this particular type of cotton could not have thrived well outside the area from which it derived its name, and that the saving in labour he claimed would have been negated by the inferior quality of its cotton which would, undoubtedly, have placed it, if at all, along the grade line much below the fine cotton Egypt was producing then (1870's). Thus, although he advocates proper management, without specifically stating how, as a prelude to developing these resources, one can, nevertheless, see the tone of exaggeration. Without any doubt, such over-optimistic views, based on no scientific experience and research but sheer imagination, did influence Ismail (who could not visit the Sudan, as his successors, and see the real conditions for himself) in the formulation of his grandoise, but unrealistic, schemes to develop the Sudan economically.

Another government official called Gessi (1870's) wrote from Bahrel Ghazal Province that cotton grown there was "superior in fineness softness, and length of staple to that of America and Lower Egypt."[48] In about 1865 Samuel Baker wrote: "A dam across the Atbara (river) would irrigate the entire country from Gozragub (Goz Regeb) to Berber .... and the same system upon the Nile would carry the waters throughout the deserts between Khartoum and Dongola, and from thence to Lower Egypt. The Nubian Desert, from Korosko to Abu Hamed, would be a garden."[(49)] Again in 1890, Baker recommended the construction of railways and irrigation projects which would make the Sudan a mine of wealth: ".... because it would bring an area of 30,000,000 acres of the most fertile soil under cultivation and supply England with cotton, thereby making her entirely independent of America".[(50)] A canal from Abu Hamed to Korosko or down the Wadi Alaqi was suggested several times and it is said that a survey was made in the time of Mohammed Ali. This is practically impossible because it would have involved extensive tunnelling. Others, including Baker, suggested a series of dams to hold up water to store water for irrigation and power, and to improve navigation by drowning the rocks in the river. Brun-Rollet, a trader dealing in the products of the White Nile, writing about the agricultural potentialities of the Sudan, said that sesame could be bought in the Sudanese markets at one-eighth of its selling price in Egypt, and that the country grew the finest cotton in the world, "The parent of the celebrated Mahu Bey variety then grown with such success in Egypt". But, unlike others, his vision of increasing the wealth of the country was by large-scale growing of groundhuts in Kordofan.[(51)]

F. Verne, writing about 1841, praised the soil and the cotton it produced between Goz Regeb and the Gash Delta, and claimed that "anything" could be successfully grown for domestic use and for export. Cotton, which was then grown in small quantities, could become a trading object of considerable importance. "When one beholds in what abundance it flourishes, even under the present careless and low culture, one must at once be convinced what an immense crop might be produced, merely by some little more attention being bestowed on it."[(52)] Unlike Egypt, Verne goes on, there was no need for regular watering, a work of immense labour, but a secure supply of water could be obtained by using pumps. However, "To once accustom these unruly tribes to settled dwellings and regular labour will be a formidable task, and of all the Turks we have met with in Bellad - Sudan (the Country of the Sudan 'Blacks'), not one seems in the least qualified to effect it".(53) In 1837, Holroyd, writing about the Gezira, which by that time was not completely re-habilitated after the revolt of the 1820's, commented more prophetically about its agricultural possibilities: "If a canal were cut from Wad Mediniєh (Wad Medani) to Monkara (Manjera on the White Nile) with branches N. and S., almost all the land might be used for the production of cotton, indigo, tobacco, sugar, grain & c.".(54) He maintained that much might be accomplished by means of tanks for collecting the rain-water during the rainy season, and by sinking wells, although he admitted that this alone would not suffice to irrigate the whole of this rich and valuable land. In the 1840's, Prince Pucklar-Muscau, confirmed Holroyd's opinion of developing the Gezira, stating that by this canal system a delta "still more luxuriant" than that of Egypt, would be "obtained" as far as Khartoum, ".... a gold mine for Mehmet Ali, where-by the cultivation of cotton, sugar-cane, indigo, most species of corn, and senna .... - he might obtain immense revenues."(55) About the Island of Meroe he claimed: 'We cannot entertain a doubt that the whole of the country visited by Giovunni (Dinder, Rahad and southern Butana), and probably also the greater part of the Peninsula of Meroe, was at a former period cultivated and consequently irrigated .... What is now desert needs but men, industry, and capital to be once more converted into a rich province."(56)

Similarly, M.F.Fox, in his report about the Sudan (1887) claimed that, with the exception of the belt of desert to the north, the larger proportion of the land of the Sudan, might be described as most fertile, offering great potentialities for development and "abounding in agricultural resources and, it is believed, in mineral wealth."(57) In 1886, an African Map (published by Justus Perthes, 1886) showed the uncultivable land in the Sudan extending everywhere to within sixty miles of the Abyssinian frontiers, and half the cultivable area was made to lie between the Red Sea and the Atbara river - which, with the possible exception of the Gash and Baraka Deltas, today constitutes one of the most barren areas of the Sudan. However, J.T. Wills limits the cultivable area in the Sudan in the north by the rainy period of three-and-a half months duration, and in this he included the plains between the White Nile and the Gash, which he extended southwards to embrace the whole area lying between the Abyssinian foothills and the Blue Nile (Fig. 29).(58) This area, Wills observed, was an almost dead level of very rich alluvium of the White Nile. The size of the level fertile area ".... contains at least something like 25,000 square miles .... All along the White Nile, the Rahad and the Dinder about Abu Haraz, and above Goz regeb, the levels favour irrigation."(59)

Nine years later, when the British and the Mahdists' fight to control Suakin was drawing to its end, and the prospects for the quick revival of trade with the interior were high, grave concern about the suitability of Suakin harbour for handling the Sudan trade and receiving large steamers, were expressed by some people. The approach to Suakin was through a deep, but narrow and winding, channel that was studded with coral reefs on both sides, thus making the entrance quite dangerous for large steamers. Moreover, the lack of spacious harbour, good quays and wharves, reduced the chance for Suakin being a future port for the country. Thus, in 1895, Heatley wrote advocating Aqiq, to the south of Suakin (Fig. 30A), as the best alternative port because of its nearness to the strategic Tokar (Baraka) Delta. To support his argument, he described the Delta as being "well-fitted by soil and sky for the growing of cotton" which had "a fine and long staple and commands the highest price".(60) Of the other parts of the Sudan, the trade of which was supposed to be attracted by Aqiq, Heatley had this to say about the Dinder-Rahad area: "By way of Abu Haraz (on the Rahad), there will come (to Aqiq) the trade of the fertile district, consisting of some 3,000,000 acres of good land, between the Rahad and the Dinder".(61)

The obvious results of such over-optimistic views, reports and articles, with the possible exception of Holroyd's and Verne's, was the appearance of exaggerated estimates of cultivable areas in both official and individual reports. One must remember in this connection that what was meant by "cultivable" is the amount of land that would immediately be available for development by any government wanting so at the time and under the prevailing conditions of backwardness already referred to. Thus, according to official sources, as it appeared in the Statistique de l'Egypte (1873), the cultivable area was put at 14,125,000 feddans, while M.F.W. Fox's estimation (1887), came to between 21,000,000-28,000,000 feddans,(62) as the following table shows (Table 24):

TABLE 24 CULTIVABLE LAND IN THE SUDAN (IN FEDDANS) ACCORDING TO TWO SOURCES

Place	Blue Book, Egypt No.2 (1873)	M.W. Fox (1887)
Between Blue and White Niles	7,000,000	8,000,000-15,000,000
Islands in Blue and White Niles	1,000,000	
Between Dinder and Rahad Rivers	3,000,000	
West of Atbara River	3,000,000	10,000,000
Tokar (Baraka Delta)	125,000	500,000
Taka (Gash Delta)	?	2,500,000

Sources: (1) Blue Book, Egypt, No. 2 (1887)
(2) H. Russell, op. cit., p. 344

The variant assessments of different individuals, such as Heatley's, Wills's, and Baker's, have already been mentioned above. The real official report, containing an account of possible cultivable and irrigable areas in each of the provinces of northern Sudan then (Fig.35) appeared in 1871.(63) Briefly described, the contents are as follows:-

(i) Suakin Province (Fig.30A)

This province, according to the Report, contained large areas suitable for cotton cultivation to the N.W. of Aqiq, Tokar and Suakin, and extending along the coast as far north as Rawiya (Fig. 30A). Tokar (Baraka) Delta alone was estimated to contain 200,000 feddans of excellent land, while in the coastal area another 20,000 feddans could, the Report claims, be irrigated by the wadis draining from the hills and debouching on to the coastal plain. Moreover, there were large wadis to the west of these hills (the Red Sea Hills) which could be cultivated by utilising the water they carry during the rainy season. The best noted wadi among these was Wadi el Arab, where the Arabs of the area could be encouraged to cultivate an area of 20,000 feddans without any difficulty. With regard to marketing, the produce of Tokar and the coastal areas was to be sent to Suakin, while that from Wadi el Arab and the adjoining areas was to be transported to Goz Regeb.

(ii) Taka Province (Fig. 30B):

In Taka Province, the Report estimates the total unoccupied cultivable area at 7,000,000 feddans of which the Gash Delta alone contains over 2,000,000 feddans, which were irrigated by the Gash river, while the rest was watered by rain which is described as a "heavenly deluge". Thus, if cotton growing was introduced into all the cultivable area, the Report states, the crop from the northern part was to be despatched to Suakin for export, and that from the southern part to Goz Regeb and then down the Atbara river and the Nile during the flood time to Egypt. Accordingly, the Cairo Government urges the authorities here to encourage the Arab tribes to grow 100,000 feddans in 1872.

(iii) Sennar Province and District of Gadaref (Fig. 31A):

According to the Report, the Gadaref District was well suited for cotton cultivation-indeed all land within it was claimed to be cultivable - and consisted of flat clay lands that cracked during the dry season and sealed up when the rain soaked through them, a phenomenon which, despite the difficulties it imposed on camel transport for about two months, was a clear sign of the "extreme fertility" of the soil (c. Chapter Two). However, due to marketing difficulties, only a small quantity of cotton was then grown for local consumption (exports from the area having dwindled after the American War) together with dura, the staple food crop. Thus, the Report claims, an area of 200,000 feddans could be brought under cultivation if marketing facilities were provided at Safieh, whence the crop could then be despatched either north to the Atbara river or east to the Blue Nile, where, in both cases, boats to transport the crop down to Egypt were available or could be assembled within short notice.

In Sennar Province, and to the east and west of the Blue Nile between Walad Abbas and Fazogli, the Report claims, there was no trace of hills or sandy tracts, the rainfall being ample and the land fertile for the production of various crops, particularly sesame and cotton. However, since cotton growing was of first importance in the area, and the population large enough to provide labour, the land under cotton, the Report urges, could be easily increased to 300,000 feddans within two years.

(iv) Khartoum Province (Fig. 31A):

The most fertile lands in this province, according to the

Report, extended on the east and west of the town, mainly along the Blue, White and main Niles as well as along the Atbara river, where a number of tribes, who would provide labour, resided. Besides the rain-fed areas, there were 1,000 saqias that would provide irrigation along the riverine lands. Furthermore, the province was well situated in terms of river transport. Thus, considering these assets, it is claimed that the area under cotton could be conveniently increased to 200,000 feddans in the course of two years.

(v) Kordofan Province (Fig. 31B):

Although this province contained extensive lands, the Report states, the soils were, however, sandy in the north, growing tobacco and dukhn, while in the south and adjacent to the White Nile, there were fertile clay lands where, the Report asserts, 100,000 feddans could be grown with cotton, with good possibilities for future extensions. The presence of cattle in large numbers in the southern area, the Report claims, was a good sign of the fertility of the land. So far as the transport of cotton was concerned, the various villages along the White Nile were to serve as collecting centres for its dispatch, during the flood time, to Egypt.

(vi) Berber Province (Fig. 32):

In this province, according to the Report, there were more than 3,000 saqias between Hager el Asal and the end of the Rubatah area (at about Abu Hamed), irrigating fertile riverine land, apart from islands plus an area of some thousand feddans to the south and east of the Nile-Athara confluence that could be cultivated by rainwater. Furthermore, a canal taking off from near their confluence and going north parallel to the Nile, could bring some 100,000 feddans under cultivation.

(vii) Dongola Province (Fig. 32):

In this province, after clearing Letti Basin, the Report claims that it was quite possible to bring under cultivation 600,000 feddans on the islands and along river banks by means of saqias.

If we closely examine these statements and figures of cultivable areas and consider them in terms of climate and soil, the over-estimation can readily be discerned (Chapters One and Two). Even today, with more efficient and sophisticated agricultural techniques, the cultivated areas in the above provinces, whether by rain or perennial irrigation, amount to a little over one-third of the totals quoted above. (~~see also Table~~ Indeed, although it is true that, in terms of soils and rainfall, the Central Clay Plain has high potentialities, the peculiarity of the soils, however, necessitates careful management if cultivation of any commercial crop, cotton or otherwise, is to be introduced (Chapter Two). The clay plains of Taka, Sennar, and southern Kordofan, with adequate rainfall, are also lands of high capabilities, but proper soil and water utilisation practices have to be applied. Moreover, the undulating lands of Kordofan are large and extensive, but are of low and medium capabilities because of steep slopes and shallow soils in presence of heavy rains.

Thus, conservation, under such conditions, was - and still is - the first pre-requisite in planning or developing any agricultural scheme whether it was in the rainlands or irrigated areas. Today, as it definitely was in the nineteenth century, rainfall and consequently rural water supply, is very unevenly distributed (Chapter One and Figrs. 9 & 10); about one-third of the country is semi-desert and the area west of the Nile and north of latitude 18^{o}N is in fact an extension of the Sahara. As a result perennial irrigation is only possible along the Nile and its tributaries; elsewhere there is lack of detailed and exact information about soil characteristics, rainfall, vegetation, pests and diseases, and consequently the difficulty of exactly delimiting the boundaries of areas to be utilised for crop production is great. These difficulties, together with the absence of land capability surveys, were - and still are - the problems facing any effective use of these areas. Moreover, the small number, and nomadic nature of the population,[64] harsh agricultural conditions, and the very low - or indeed the lack of - cost of investment, made agricultural development of the rainlands quite impossible without serious social, economic and political problems. Furthermore, the lack of drinking water supply in central Sudan is one of the main problems facing land-use and the productivity of the people themselves. The shortage of water indeed makes it impossible to exploit much of the country where soil and rainfall are favourable for grazing or for the cultivation of unirrigated crops. Today, one person in Kordofan, Darfur and Kassala Provinces, is estimated to be getting less than half the minimum requirement of water for domestic need set at 4 gallons per day.[65] As a result, much potential labour is lost in the search for water and many people are unable to look after their rain cultivation during the dry season, and this in many cases led to the abandonment of the standing crop, and leaving it to rot or to be devoured by the birds.[66]

Thus, it is imperative to say that these problems and difficulties must have been worse during the nineteenth century, considering the backward economic, social and political conditions of the time. So of necessity the cultivated areas, and even the cultivable tracts, had to be confined to lands adjacent to, or to more favourably situated areas along, the rivers. The extensive areas the authorities thought to be "cultivable" under the existing agricultural conditions, had to wait for more efficient and developed techniques, and a scientific approach that realises the various problems, as we shall see in the next chapters.

Indeed, cultivability of land varies greatly; some regions can be cultivated over the great part of their extent, others are wholly uncultivable. In drier lands, possibilities for irrigation and, ultimately, total rainfall and run off set a limit to cultivability, and in desert countries the potential for cultivation depends upon the availability of water at low costs. The Northern Province (236,000 sq. miles), for example, has only about 500 sqare miles of cultivable land, and this consists of a narrow strip along the Nile varying in width from a few metres to four kilometres (c. 2.5 miles), while in the comparatively well-watered Equatorial Province, (159,000 sq. miles), about 87% of the total land is available for agriculture, although water supply remains a limiting factor (Fig. 50).[67] In the former, the saqia, although cheaper to run, was not enough for thirsty crops, like cotton, because of its limited irrigation capacity (see Chapter Three). Development of basin irrigation, one would think, could have been an obvious choice, but the main problem here is that this system depends on a natural flood level which, without a barrage to raise it, is very variable as we have seen in Chapter Two.

These general examples illustrate the variability of this factor: the cultivable percentage of land, and the variety of meanings that may be attached to the term. It cannot be defined precisely except in relation to other factors, some of which may be liable to change. Thus, in commercial agriculture, the amount of land which may be cultivated profitably varies with production costs and commodity prices. We must also accept the limitations of traditional implements, skills and customs, and adapt the conception of cultivability accordingly.

All these problems pose great difficulties in mapping these areas of cultivable land in each of the provinces enumerated above. However, the method adopted is to map each of the provinces concerned on which are superimposed the various agricultural regions - as described in Appendix 22 - within the respective provincial boundaries. Since it has been shown in Chapter One that moisture is the most important factor influencing plant growth in the tropics and taking the 300 mm. isohyte (11.81 in.) as the northern limit of successful rain crop production, isohytes are inserted in each map to give the reader some idea about how unrealistic were the assertions made by the various people mentioned above about the possibility of cotton growing in some of the areas concerned. Cotton at least requires 20 in. of rainfall to thrive, and except in favourably located situations such as the uguds, the area north of Sennar can be considered as marginal for successful cotton raising by rainfall. Moreover, the unreliability and the variability in incidence and distribution of rainfall is so great (Chapter Two) that irrigation is indeed a necessary pre-requisite for growing cotton of the Egyptian type. To illustrate this point Fig. 33 is given, and here irrigation was recommended for long-staple cotton rotation. The 300,000 feddans of cotton suggested by the Turkish authorities as a possible target which should be achieved within two years, were found later by the British, as we shall see in the next chapters, to be impossible without irrigation and the expenditure of large sums of money to achieve this. In Kordofan map (Fig. 31B), modern cotton growing areas of American Upland by rainfall are given to show where, later in the twentieth century, cotton growing was found possible and this was not in all of southern Kordofan as the report of 1871 claimed, but in only two areas where water was enough to bring the crop to maturity. For Berber and Dongola Provinces, where crop production depends on irrigation from the Nile, the main problem is the economic limit to which water can be raised by the pump. According to a survey recently carried out to determine the irrigable area in the region by locating the 15m. isopotamon on either side of the river, an isopotamon being defined as "the intersection of the land surface with a plane at a given height above the mean low level of the river at its nearest point".[68] The figure of 15 m. was chosen on geomorphological as much as on economic grounds, in that the highest alluvial terraces throughout the two provinces are generally situated below the 15 m. isopotamon. Fig. 34 was drawn from this survey which also included digging of soil pits to investigate both the clay percentage and the sodium value of the soil. The inset maps showing areas under pump and basin irrigation today are included to give an idea of what the Turks could have done if they genuinely tried.

Any scheme for the production of cotton on a commercial basis and for world markets, should have considered the problems mentioned above, if the crop was to procure a profit and stand the competition of other producing areas which, undoubtedly, had the advantage of better means of production and transport than the Sudan.

VII. AREAS CULTIVATED WITH COTTON:

In the face of these hazards, the area actually cultivated with cotton was very much less than what the authorities had hoped for; even in this respect, the figures quoted by officials are so variant that one is left at a loss as to what the true figures were. The following table shows the amount of cultivated area according to two official sources (Table 25):

TABLE 25 TO SHOW AREAS UNDER COTTON AND CROP YIELDS IN THE SUDAN DURING THE TURKISH PERIOD

Blue Book, Egypt, No.2 (1887)		Statistique de l'Egypte		
Place	Area in Feddans	Place	Area in Feddans	Yield in Tons
Berber	150,000	Taka	37,000	3,600
Kordofan	36,000	Berber & Dongola	9,885	8,236
Tokar	25,000	Tokar	26,000	-
Suakin	600			
Aqiq	500			
Total	212,100		73,485	

According to the latter source the cultivated area in Berber and Dongola Provinces was irrigated by 6,590 saqias, but the yield from the same provinces is quoted by another source as 3,207 tons per year, while in Sennar and Khartoum Provinces the area cultivated with cotton is reported to amount to 3,000 feddans in the 1870's.[69]

Such contradictions and lack of proper scientific surveys make mapping these areas quite difficult since all acreages and yields are unverifiable. They represent incomplete samples taken at random from the various producing areas which, if taken as being remotely true, suggest a great change in the location of productive areas of the Sudan since that time. Moreover, it should be remembered that these figures were compiled by a Finance Minister, who was negotiating for loans with foreign money-lenders.(70) However, the concentration of cultivation in Taka and Tokar (Gash and Baraka Deltas respectively), and the riverine areas can reasonably be attributed to good physical conditions and transport facilities. Thus, in terms of the former, the Gash and Baraka Deltas possess, as already discussed in Chapter One and Two, fertile and moisture-retentive soils together with easy irrigation by means of flush which, apart from erecting crude dams or earth banks to direct water into already chosen areas, did not entail costly preparations (see Chapter One). Nevertheless, the Gash Delta remained almost uncultivated until 1910, and crop yields were low because of improper tillage and lack of clearing of the land, the primitive implements used, and excessive taxation already referred to.(71) The riverine areas similarly enjoyed the advantage of rich soil plus perennial irrigation, though by inefficient means. The <u>saqia</u> and <u>shaduf</u>, which provided regular watering along here, were both expensive in man-power and, in the case of the former, in animal power. A <u>saqia</u>, for example, required the full-time employment of a team of oxen and two drivers, if it was to be kept working day and night to water a crop like indigo or cotton, and, moreover, they had to remain constantly at work from the planting of the crop to near harvest time, and this was too exhaustive for both man and beasts.

In terms of transport facilities, Tokar and Taka again had the obvious advantages of being situated nearer to the Red Sea, which was a vital asset in those days, while the riverine areas in Sennar, Khartoum, Berber and Dongola provinces had the advantage of cheap river transport, at least in the navigable reaches if not along the whole course. However, sending cotton from these areas down to Egypt by a combination of, first, river and land transport, and later by land-river-railway, not only meant a cumbersome change in mode of transport, but also a very costly one. As a result the cotton from the Sudan was not in a position to compete in the outside market with other producing areas, including Egypt itself. It may, however, be true that the high prices during the American Civil War made such costs to be little felt;

but the fact remains that this cost of transport and lack of proper scientific method of cotton cultivation plus other problems, which will be discussed later, were the main reason why cotton growing was neglected after the breakup of hostilities between the warring factions in America, and the resumption of normal trade relations between them and other countries, particularly Britain.

(i). COTTON CULTIVATION

Khedive Ismail's obsession with cotton growing and his sanguine hopes to turn the Sudan into a 'little America', were the work of yet another man: Ahmed Mumtaz Pasha, first Governor of Suakin Province, and later the Governor-General of the Sudan. If Munzinger can be taken as the theoretician, Mumtaz can well qualify as the one who tried to put the theories into practice. But he was as imaginative as Munzinger, and as unrealistic as his own master in Cairo. He happened to entertain wild dreams of being the saviour of Egypt from its economic problems, and the only way to do that, he thought, was by planting cotton in every feddan of cultivable area in the Sudan. To that end he did, assisted by the Khedive, everything at his disposal and within his capacity as a governor, from recruiting people to grow cotton to erection of ginning factories, while at the same time giving every assurance to the Khedive that his economic problems would soon be over.(72) To back up his words, he put forward his grandiose scheme in 1870. Eastern Sudan, he claimed, possessed unlimited agricultural lands, plenty of labour and enough rainfall, and there was the river Atbara to float cotton down to the Nile then north to Cairo for ginning and marketing. There were, he declared, 16,000,000 feddans waiting to be cultivated by 2,000,000 impoverished inhabitants. He proposed to send 3,000 ardebs of cotton seed to Egypt in 1871, when at least 100,000 feddans would be grown with cotton, and indeed he had visions of a crop of no less than 2,000,000 kantars in four years. In fact, the Khedive's problem, after the return of American cotton to the world market, was how to grow more cotton to recoup himself for the fall in its price, and thus he was delighted with Mumtaz's zeal in this respect.

Thus, to encourage people to grow cotton, the Government adopted various methods. First, taxes on lands and crops were reduced by a Khedival decree, and only lands actually under crops were to pay a tax of 25 P.T. per feddan - a method devised to attract the peasants who fled from their lands because of the excessive taxes already referred to above. Moreover, six in every fourteen saqias plus four out of every one hundred feddans, owned by local chiefs and village heads were exempt from paying any taxes.[73] Secondly, irrigation methods were to be improved, and to this effect many Egyptian peasants, apart from those who fled there from the harsh conditions in Egypt, were brought into the Sudan to teach the Sudanese the proper method of irrigating and cultivating cotton and other crops. Each province in Egypt had to contribute its share of men: "In order to develop agriculture in Sinnar (Sudan) which we have conquered with so much fatigue .... we require skilled men for the task."[74] Thus, an engineer, called Chelu, was sent to investigate the possibilities of installing pumps for irrigation of cotton and other crops, especially in Dongola and Berber Provinces. Mattocks were received from Egypt for digging canals and irrigation ditches in Berber Province, while Kerma and Letti Basins in Dongola Province seem to have been the subject of a request from the Governor, who wrote to Cairo asking for engineers to cut an irrigation canal in each.[75] Moreover, building of water wheels was encouraged first along roads from Sennar and Kordogan to provide water for cattle exported to Egypt, and later along the Nile as far south as Kamlin, on the Blue Nile, and along the Gash river, for irrigating crops. However, in the Gash Delta proper, some sort of control over the flood was necessary for the proper inundation of land and the successful growth of the cotton plant. For this purpose, a weir was constructed along the Gash near Kassala in 1841 not solely for growing cotton, however, but curiously enough, for the purpose of forcing the Hadendowa and Halenga tribes, in whose territories the Delta lay, to grow cotton and pay their taxes without arrears. When they complained that there was not only insufficient rain to grow cotton, but also that there was likely to be a famine in grain supply, Mumtaz brushed aside their objections, and began instead to entertain the idea of making the Shukrya - the main tribe of the Butana - to grow vast areas of cotton.[76] However, the Hadendowa alone seems to have refused to submit, and the Governor was induced by the Halenga Chief to dam both arms of the Gash and thus stop water from flowing to irrigate the dura fields on which the Hadendowa subsisted. The weir, built by the Halenga tribe with the help of a Swiss engineer called Werne, was 1,613 metres long and 5 metres wide, the earth being stayed by tree trunks erected in the bed of the river before the earth banks were put up.(77) The water was thus diverted into Khor Kwenti (Fig. 8) and the rebellious Hadendowa grudgingly paid the tax until 1844, when they revolted, killed all guards on the weir, and successfully diverted the water into its original course - an act for which they were ruthlessly punished. Thus, apart from this dam and a canal dug at Khor Kwenti to water the Kwenti-Kalahote area of Western Gash, there is no evidence of any major irrigation works having been attempted before the British occupation in 1898.

Thirdly, cotton seeds imported from Egypt were to be distributed free, and accordingly in 1871 one hundred ardebs of seed were sent to the Governor of Berber, who was told not to charge the peasants with the price of seed or expenses of cultivation.(78) Fourthly, lucrative prices were offered for cotton, in 1872, the price for unginned cotton from fiscal lands ranged from 60 to 70 P.T. per kantar, and a price of 70 P.T. for the kantar was offered to cultivators in Dongola and Berber Provinces in order to rehabilitate the deserted lands.(79) Again, in 1873, the offer prices at Khartoum was made at 70 P.T. per kantar, at Abu Haraz, Wad Medani, and Kawa at 65 P.T., at Fashoda and Fazogli at 55 P.T., and at Sennar at 60 P.T. per kantar. Moreover, the Government offered an extra 10 P.T. per kantar to encourage the people to pay the arrears in taxes. The other main reason behind these measures was to encourage them to return to their abandoned lands. Fifthly, a land settlement programme was put forward so as to stop the tax evaders from escaping payment of taxes which by 1873 resulted in arrears amounting to 33,600 burses (£E.198,000).(80) Along the riverine areas individual ownership was recognised, and the people were left at peace as long as they paid the taxes, while all rainlands were declared a government property, except where someone produced conclusive evidence of ownership. Here a whole village community or other individuals could cultivate as much as they could comfortably manage, but the priority was given to those who erected saqias or wells. Those who showed any neglect were evicted, the only merit for continuous cultivation being proper cultivation of the land and payment of tax which was levied on people and not the produce of the land - since this could be easily hidden away. If a cultivator died without heirs his land was given to any one who showed zeal for cultivation, but if the deceased left any arrears the inderitor must first pay them before cultivating the land. Sixthly, ginning plants were introduced into the country as a result of a recommendation by the Privy Councillor, whom Khedive Ismail sent to the Sudan in 1871 to report on the progress of cotton production in eastern Sudan.[81] The first was a steam-driven machine owned by a Syrian merchant in the Baraka Delta in 1867, and in 1874 another complete factory was erected in Taka at a cost of £20,000 - 30,000, and had a 100-horse power steam engine and 20 gins - but it seems to have been operated for one successful crop in 1875 before it reverted to disuse.[82]

With regard to the method of cultivation, there were some differences according to each region. In the Gash Delta, for example, the shiote system, already described in Chapter One, was practised, and assisted by crude earth banks for direction of water to suitable plots, the cultivated area was increased to 2,500 feddans in 1871. The cotton first grown here might have been introduced from Sennar area, while in the Baraka Delta, where cotton was introduced earlier (1850), the first 50 feddans were sown with Ashmouni seed imported from Egypt for this purpose.[83] In 1875, Junker described the method of cultivation in the Baraka Delta as follows: "On the subsidence of the first flood, tillage begins, the ground now being softened by the water and manured with the fertilising mud. By dams and canals of somewhat primitive form and insufficient in number, the water is distributed over the sorgo (sorghum) fields, but the native also grows two varieties of cotton, the American and Egyptian (Ashmouni). It may happen, however, that the next inundation is too strong to be dammed; then the seed, often already sprouting, is swept away, and all has to be done over again."[84] Cotton took four months to ripen and the harvest period continued from February to March. The market price of unginned cotton was 6$ per cwt. at the time of his visit (1875), the Egyptian cotton fetching a higher price than the American because of its longer and more easily spun staple. Of the cotton grown in the low coastal areas near Suakin in 1871, L. Rokeby states that the seed was of inferior quality and the value of fibre was about 43 shillings per kantar of 112 lb. purchased on the spot or about 60 shillings delivered in Cairo.[85]

However, much of this cotton was exported in unginned form to Egypt, but unfortunately there are no figures for the quantity exported except for these years, and they represent only that amount passing via Suakin. Of the quantity going to Egypt by the Nile route there are no reliable records. In 1879 the quantity of uncleaned cotton exported via Suakin amounted to 19,612 kantars, and 14,626 in 1880, while in cleaned form the quantity for the same years was 3,180 and 3,283 kantars respectively, and only 665 for 1881. For cotton seed the figure available is 172 ardebs for 1879.(86)

The diminution in the export figures in itself was a clear sign of the deteriorating political and economic conditions in the country, and before the Turks fully realised what was wrong, they were forestalled by the Mahdi's revolt against their rule in 1881. This brings us to another phase of the history of cotton growing in the Sudan which is characterised by two things: first, the attempts to grow cotton were, for political and military reasons, localised; and secondly, the British interest in the Sudan began to influence and direct the course of events there.

VIII. COTTON GROWING BETWEEN 1885-1898:

In 1863, some Americans rejoiced that cotton was a great success - "a financial recognition of our independence" - and that "Cotton was King at last".(87) Thus, in an attempt to minimise their dependence upon American cotton, British entrepreneurs sought new sources of supply, and, as mentioned above, Samuel Baker in 1890 suggested the Sudan as the country which could ppoduce all cotton that England needed for its industry. This dream, however, did come true thirty five years later, but during the time he wrote, and in fact since 1885, the country passed into the hands of the Mahdi's successor, Khalifa Abdullahi, whose austere but unwise rule brought financial bankruptcy and economic disintegration to the country. With the whole agricultural economy geared to the production of food crops to feed the army and the teeming population of Omdurman, all attempts to grow cotton were necessarily confined to the Baraka Delta, which changed hands between the British, stationed at Suakin and in the coastal area, and the Mahdists' forces led by Osman Digna, which controlled the whole hinterland. The issue at stake was the blockade the British set up at Suakin to prevent imports into the country of "contraband of war" which included firearms, metals or goods made of lead, gunpowder or nitre, and trade in general.

This, however, was a matter of intense controversy and speculation among a large number of mostly civilian people who preferred and advocated the opening of trade with the interior as a means of pacifying the rebellious Sudanese tribes, as against the militarist's view who saw in putting up the blockade, and maintaining it, at Suakin to stop any kind of trade with the interior, as the best measure to cripple the Mahdists financially, and to eventually bring the regime down.[88] This view carried more weight in the official circles in Cairo and London. The pacifists, to present their case in a more convincing way, began to talk of millions of acres of the most fertile land waiting to be cultivated with cotton. But, as during the Turkish period, imagination rather than reality characterised these ventures, though to a lesser degree. The advocates of reopening trade with the interior, among them M.W. Fox (see above), in order to present their case in the best agreeable manner, especially to the more vulnerable Lancashire spinners, quoted large figures of cultivable areas in the Sudan (Table 24). For Tokar, Fox put the high figure of 2,500,000 feddans as cultivable, while Consul Baker in 1887 estimated the amount of cotton that could be produced there at 500,000 cwt. per annum, which, if compared with the area under cultivation in Tokar then, would give 4 cwt. to a feddan, and this, Baker assures, "at the price at Alexandria (in 1887) would procure 1.5 million pounds Sterling".[89] This yield is based on a high average, and considering the fluctuations of floods and consequently the area watered and cultivated, it could be taken at 2 cwt. per feddan. However, "even if one-quarter of the estimated area was under cotton at any time, the return would have been nearly £20,000,000 at the current price (1890)."[90]

As expected, the lure of cotton was infinitely stronger, and in 1885 an English company was given a concession to grow cotton in Tokar (Baraka) Delta, and in 1886-7 season ".... about 300,000 - 500,000 acres of cotton of Ashmouni type were grown there on the basis of share cropping between some Europeans and the native sheikh".[91] The crop, yielding up to 6-cwt. per acre, was ginned at Suakin at half to a penny per lb. and sold in auction there.[92] However, this venture was terminated by renewed military activities of the Mahdists, and thus cotton growing went on haltingly under physical and political hazards.

(i). Cotton Production and Export, 1883-98 (Table 26):

After disappearance from the export list for six years (1886-92) cotton came back after some successful trials by the English company since 1885. The drop in cotton export since 1883 was, however, phenomenally great, mainly due to the political instability that followed the Mahdi's revolt, and to some extent to the drop in prices and the financial slump that followed the end of the American War. Thus, exports declined from a peak of 28,727 cwt. valued at £40, 432 in 1883 to 670 cwt. in 1884, and to the humble figure of 12 cwt. in 1885.[93] The first crop sown under the auspice of the English company was reaped in 1886-7, amounting to only 21 cwt. valued at £500.[94] However, due to renewed political instability in the area, cotton production ceased and exports accordingly dropped out of the list until 1892 when, with copious rainfall, a crop to the value of £6,258 was exported, the greater portion of which went to Egypt and India "uncleaned", while that destined for other countries, mainly England and Austria, was cleaned at Suakin by hand since there was no gin in operation.[95] The varieties grown were the Ashmouni and American both of which had a quality inferior to those grown in lower Egypt. However, a consecutive series of droughts and severe locust attackes from 1893-95 reduced the exported crop from 1,824.05 cwt. in 1893 to nil in 1895.[96] The year 1896 started with

TABLE 26 VALUE AND QUANTITY OF COTTON EXPORTED VIA SUAKIN TO VARIOUS COUNTRIES (1883-1898)

Year	Quantity Cwt.	Value £ Sterling	Receiving Countries (in Cwts.)				
			England	Egypt	Austria	India	Massawa
1883	28,727	40,432					
1884	670	1,045					
1885	12	13					
1886	21	500					
	NO EXPORT						
1892	16,897.9	6,258	32.8	4,502.8	7.02	12,151.4	186.4
1893	1,824.05	4,040				1,491.6	326.8
		240					
1895		-					
1896	1,331	787	326	388	562		
1897	40.97	2,443	0.17	40.7			
1898	17.9	1,062		17.7			

Source: Accounts Papers, 1892-98

In 1886 Turkey imported 55 cwt., while in 1893 and 1897-98 the remainder went to "Other Countries" ample rainfall and absence of locusts and political disturbances in the area and as a result the total export in cotton rose to 331 cwt. for that year. However, the meagre rainfall from 1897-99 and the resulting poor floods reduced the crop exported to 40.97 cwt. in 1897 and 17.9 cwt. in 1898.(97) Indeed the years 1893 and 1899, as Table 27 shows, had the poorest flood on record for that decade, and this fluctuation coupled with heavy locust visitations were the main scourges of the cultivators and the chief cause, apart from political disturbances, for the unimpressive progress in cotton growing in this delta throughout the 1890's.

TABLE 27 TOTAL AREA PLANTED, CONDITIONS OF LOCUSTS AND FLOODS IN BARAKA DELTA, 1891-99

Flood of Year		Total Area Planted	Area Planted Cotton	Locust
1891	*	8,749 acres	2,507	Bad
1892	≠	10,000	709	Bad
1893	++	150	Nil	Bad
1894	+	2,000	100	Bad
1895	‡	6,000	?	-
1896	§	9,000	427	Bad
1897	e	2,897	?	-
1898	11	4,000	?	-
1899	++	1,994	?	-

* Fair flood. ≠ Good flood. ++ Very Poor flood. ‡ Fair flood, good crops. § Very Good flood. e Poor flood. 11 'Indifferent'

Source: Report on Tokar, op. cit., p. 52

This is the story of commercial cotton growing in the Sudan during the latter half of the nineteenth century, and if the Turks succeeded in proving the suitability of at least some parts of the country for cotton production, the fact remains that they failed to establish it as a permanent source of revenue. The whole venture shows evidences of failure in almost every aspect: failure to realise the basic requirements of successfully raising a crop like cotton and its transportation to markets; failure to bring an ignorant and conservative people round to accept such an innovation, and, on the whole, failure to create the right atmosphere, whether political, economic, or social, for the sort of development they wanted to accomplish. Thus, the great struggle for the economic development of the Sudan had but little effect: the Governors in the Sudan, who were entrusted to carry out and supervise the wishes of Cairo, were incompetent in this mundane sphere. Indeed, "War was their business, not the raising of crops or founding of industries".(98) There is no trace of the weir at Kassala; the ginnery and the spinning shed, brought with infinite pains over the mountains to Kassala to start cotton spinning industry in the Sudan, were beaten into implements of war by the Mahdists when Kassala fell into their hands in 1885. The only enduring thing was a personal legacy: the memory of the harsh and ruthless Mumtaz Pasha, the cotton-obsessed Govenor, who gave his name to the plant which people, until very recently, grew in Kassala and on the Rahad banks, and from which they spun a damour of fair quality.

IX. FAILURE OF COTTON GROWING IN THE NINETEENTH CENTURY

There is no doubt that some of the Turkish rulers were sincere in developing the Sudan economically whether to increase the revenue to the Egyptian Treasury or to make the country pay itself. It is also true that they were the first to introduce cash crops for export, to span the country with telegraph lines and postal services and caravan routes, to ply the Nile with steamers, and, most important, to bring the country to the notice of some European countries, particularly Britain, and to expose the agricultural potentialities of the Sudan which, later and under the British rule, were to become the main asset and source of revenue, of the country. Nevertheless, the Turkish authorities, despite some genuine efforts, were working against obvious obstacles, most of which were the result of their own creation, and some of factors and circumstances beyond their control, although the possibility of at least tempering them were by no means remote. Of the first category, the following are the most important.

(i) Arbitrary Taxation:

The system of taxation imposed on the people and the produce of the land, and the devastating results it had on them have already been discussed above. The Turks interfered with everything and taxed everybody, and taxes were collected in money and kind (Table 23 App. 23). This evil practice of forcing the peasants to pay part of their tax in grains or cloth at scarcely a quarter of its true market value, filled the government warehouses with these articles, but drove up their prices in the country. The taxable assessment of the Sudan in 1854-60 was £E.100,000, but during the first year of Ismail's rule (1864-5), this was raised to £E.232,000, and the country could not sustain the burden.[99] The ruinous effect of this rapacity on the riverine areas of Berber district was described by a traveller in 1851 as follows: "Half of the houses were uninhabited which was said to have been caused by taxation. Out of Berber Province, the Government at Cairo receives annually 6,000 burses (£E.30,000). In this highly fertile district there are not more than 5,000 persons who can pay anything, and they contribute six pounds £E.6) a-piece annually on the average. The consequence of this is that the rivers for miles and miles are left uncultivated while the desert swarms with the Arabs, who prefer a wretched subsistence in those obscure and arid plains to remaining by the fertile land near the river. It must be added that in the taxation, only a quarter is ever paid in money - the rest in produce which the Government takes at most favourable price."[100] In Dongola Province the tax on saqia was, for example, raised to 132 P.T. plus a surtax of 117 P.T. where millet was raised by irrigation during summer, because Dongola enjoyed more peaceful conditions than Berber (where the tax amounted to 15 P.T. per saqia).[101]

Thus, all taxes were based on an arbitrary basis: each governor was expected to pay the expenses of his government and at the same time send money to Cairo, and to procure it more taxes and custom duties had to be levied on every taxable object. The various customs posts built along the route had no fixed tariffs and consequently the duties collected differed from one station to another, depending on the attitude of the officials, who were bent on one thing: as high and as much tax as they thought possible because Cairo's favour was only shown to those who displayed a zeal in that respect. However, an attempt to regulate customs was done by introducing tariffs, but equally they were unbearable: "Separate sums were paid at each of the chain of customs houses until the arrival of the goods at the gates of Cairo when the final imposts were charged."[102] By the raftieh system, all imports into the Sudan, which had already paid duty in an Ottoman port, entered the Sudan free, and thus the country was deprived of its own revenue, because these duties were put to the credit of the Egyptian revenue.[103] Consequently, the budget always showed a deficit (Table 24 App. 24) - a discrepancy for which Cairo blamed the Governors who in their turn tried to make up the deficit by levying more taxes. Moreover, the Government practised manipulating currency exchange by paying her employees (who were formerly paid in silver) in gold against which silver lost as much as 25% in exchange, and only in this depreciated basis were the dollars available in Khartoum for commercial transactions.[104] In the Treasury, dollars passed exclusively through the hands of the higher officials, who used private agents to effect exchanges to the detriment of the country and commerce.

(ii) Cultural Factors

Another important factor is that cotton cultivation was imposed on a people who were technically, so to speak, not prepared for it under the existing conditions. It was carried out without any real change in the farming system then practised; people were just told to grow cotton, and they did it in the traditional manner, using hoe, digging-sticks, axe etc. In practising cotton cultivation, food production, especially in the limited saqia-irrigated land, had to be drastically reduced, or even dropped out, because this cumbersome water-lifting device could not cope with the irrigation demand of the thirsty crops introduced: cotton, indigo and sugar-cane, and this posed vexatious problems.[105] The production of food crops had always been regarded as the first priority by all peasants, and these were subsistent in the sense that they grew their own food crops. There was no sign, however, when the Turks decided on the introduction or imposition of these crops on the existing pattern, of any real change in that position. Indeed, in the face of the grave risks and uncertainties, such as rainfall and flood failures and raids and pillage by marauding tribes, to which they were exposed, the peasants wanted the security which the production of their own food crops provided. Moreover, they had no additional capital, if any at all, to expand production for the cash sector. The Government could have encouraged them to increase production by, for example, introducing new farming implements, by raising their interest in developing their lands by giving security of title to them, and, in case of the nomads, by offering them lucrative terms, such as low taxes and free access to fodder for their animals, to induce them to settle at least for the period of cultivation and harvest. At this, however, the authorities made an attempt. Thus, to increase the taxable power of the people, nomads were induced gradually by the Government to settle down and cultivate in the Gezira, and indeed some section of the Shukrya tribe there began to respond but had to revert again to nomadism after a short while because of the insatiable greed of the tax collectors.(106)

Moreover, the peasant in the Sudan did not remain, at any time before, sufficiently used to operating within a money economy to be stimulated by the prospect of profit which the cultivation of cotton, or other cash crops, originally held out. Undoubtedly, such measures need, first of all, co-operation between the people and the Government and this was singularly lacking during the whole Turkish period. For instance, farm plans drawn up on the basis of experience in the field and on research farm, were definitely beyond the realm of the ignorant officials Cairo dispatched to rule the Sudan. Yet, it is a paradox to note that, Mohamed Ali, deluded by the idea of making a second Manchester of Cairo, procured a quantity of Sea Island cotton seeds in 1827-8, which he urged to be sown "... first on experimental plantations, and then cultivation on a large scale."(107) He helped Jumel in his research on cotton, first by allowing him to spend time away from his factory (a spinning and weaving mill at Bulaq of which Jumel was a Director), and later by exempting him from paying land taxes on the fields he devoted to experiments, and by giving him in 1822 a sum of 128,000 P.T. (£E.12,800) with which to conduct further researches on cotton.(108) Moreover, he allocated suitable land for cotton, instructors and experts on cotton growing were brought from Syria and Turkey, and the Egyptian peasants were given the necessary orders and simultaneously provided with credit, seeds and cotton gins, and markets for Egyptian cotton were opened up in Lancashire. Each one of the experts was assigned a number of villages in which the peasants were placed completely under his control. The experts also chose the land best suited for cotton, and then supervised every stage of the process of cultivation as well as showing the peasants how to prepare the crop, once harvested, for export. So great was the success of these measures in Egypt that by

1838 the amount of cotton produced had risen to well over 200,000 kantars, and its quality was given a premium over all but the very best American varieties.[109] Moreover, in 1873, a new breed called Bamia, which caused a sensation in America by virtue of its high yield, was selected in the Delta by crossing Ashmouni with Hibiscus esculentus, and other varieties of Jumel, Ashmouni, and Abiad were firmly established in the world markets.[110] Said Pasha and his successors were indeed active in importing machinery to improve methods of cultivation in Egypt and it was said of Khedive Ismail that "buyers fought to purchase his cotton because he paid special attention to tilling the soil so as to produce the best crops and to realise the best price for them".[111] In fact, Ismail was known as a "model farmer", and during his reign the ease with which money was provided, first to finance then to move, the crop, was a vital factor in promoting the extension of cotton growing in Egypt.[112]

All these methods show a really more practical approach to cotton growing than is the case in the Sudan where, instead of trustworthy agricultural supervisors and field instructors, who were to explain to the Sudanese peasants the farm plan and see to it that it was really understood and properly carried out, the same Government at Cairo sent degenerate army officers whose job was to collect taxes. This attitude undoubtedly generated deep mistrust and suspicion on the part of the people towards the Government and anything that was connected with it, and these were well-founded. After all, these cash crops were not meant to increase the material wealth of the people, but to increase their tax-paying power so that they could pay the various taxes levied on them without arrears. Instead of injecting capital into the peasant farming, or provide them with credit, they were being fleeced and depleted of any penny they managed to earn. Moreover, the Sudan was not like Egypt where quite frequently peasant associations could pool their resources to provide working capital to grow crops, such as indigo, or where merchants from the nearby towns financed other crops, such as rice.[113] For the ordinary peasant, equipped with only the most simple tools and subject to extortionate taxation, there was no chance, under the circumstances, of accumulating sufficient surplus of his own, or of persuading someone to lend him the money to enable him to produce the more lucrative crops. Beside the lack of capital, the growing of high value crops could be practised only on lands which lay beyond the narrow tract commanded by the saqia, and bringing such lands under irrigation, especially during the low summer period, needed resources which only the Government could provide. Furthermore, the political conditions after the decline of the Fung Kingdom until the Turkish conquest in 1820 and immediately afterwards, were not conducive to settled agricultural life because of the frequent raids of the nomadic tribes, such as the Bisharin, Ababda, Shaigya, the Arabs of Mograt, on the sedentary agricultural communities along the Nile as far as Dongola, and this must have militated against investment of any capital in agriculture.(114) The attitude of many people towards agriculture as a menial job worthy only for slaves might also have contributed to this aversion, while trade, regarded by Islam and tradition as the most blessed business, attracted the attention of, as well as any capital made by, the landowners.(115)

Moreover, Mohamed Ali's successors, particularly Ismail, disillusioned by the continuous foreign penetration in the Egyptian economy, especially after cotton proved a financial success in Egypt, wanted to keep the Sudan out of their reach, and thus was lost any chance of foreigners providing capital or credit and machinery for agricultural development, as they did in Egypt.(116) However, there were valuable cash crops and articles, such as gum, ivory, ostrich feathers, and slave trade, in the Sudan that provided lucrative alternatives to agricultural crops which need fixed capital assets and labour, thus making them an easy target for the tax-collector. By trading in those "natural" products, the European merchant could evade customs posts and also operate in remote areas and out of the Government reach, and procure profits by various illicit means.

Besides, one can contend that choice of crops was perhaps limited by conservatism and requirements of traditional agriculture, by which is meant that year after year the great majority of cultivators, particularly along the Nile, continued to cultivate the same land, use the same technique of production, and bring the same skill to bear.(117) Moreover, the assertion of state monopoly and control over the economy of the country, undoubtedly, generated friction, and the peasant lost much of their former freedom, and were often the victim of fraudulent practices by officials in the measurement and valuation of their crops.

These factors were essentially part of this peasant economy, where there was little saving, and production for family consumption was a seasonal exercise, where there was timelessness about society and production was considered in terms of immediate wants, and where the peasant had minimal subsistence goals and low production targets in terms of physical output. Once he was assured of an adequate supply of food, it became a matter of indifference to him whether output was increased or not. To him the growing of a crop from which there was no remunerative return and at the expense of his food crops, was unthinkable. At Qoz Regeb and Taka, for example, formerly grain-producing areas, grain had to be brought from Gadaref area by the 1870's, because the Government told them to grow cotton instead. Conditions were even worse in the riverine areas of Berber and Dongola, and only after strong protests and representation by the people there that compulsory growing of cotton, indigo, and sugar-cane, on land formerly devoted to food crops, was made optional.(118)

Cotton, moreover, could not be fitted into the existing pattern of agriculture administration, as it did in Egypt, because there was no pattern as such in the Sudan, and cotton was a semi-cultivated, or wild, perennial tree that barely occupied any of the peasant's time or his farm activity, as we have seen in Chapter One. Thus, it would have been worthwhile to study, for example, the effect of any increase in cotton production in the rainlands on the food resources of the country. *Dura* was, and still is, the staple good crop here, and in some years of good rain there was considerable trade in it between the various parts of the country. However, if rains were bad, local prices rose and made export quite impossible, thus depriving the people from any cash source because the tradition was to keep large reserves against years of scarcity. This lack of another cash crop had, in fact, been the weakest point in the economic position of the native in the rainland, as already mentioned in Chapters One and Three. The Turks, by forcing people to cultivate more cotton than *dura*, and by keeping the return from the sale of cotton to themselves, foolishly deprived the people ~~from~~ of any source of cash as well as plenty of food. Consequently, cultivators had to leave their lands and seek money in trade, and the nomad cultivator had to be content with the income he received from hiring his camels to merchants and acting as guides for caravans.(119)

(iii) Administrative Problems:

These problems, with the political instability they created, were mainly due to the great number of Governors and Governors-General who were appointed and then rapidly called back to Cairo before they had had time to get acquainted with the problems of the country, and to be replaced by inexperienced ones. "Nothing", wrote the British Consul-General in 1857, "contributes so much to perpetuate the disorder and confusion which prevails throughout the different branches of the Egyptian administration (in the Sudan) as the frequency with which ~~offers~~ officers are removed from important posts, by secret intrigue, or from motives of mere personal caprice".(120) In fact, since Mohamed Ali's death in 1849, the term of office of the Governors-General of the Sudan became shorter until there comes a , time in 1856 when it is difficult to keep pace with the quick succession of appointments and recalls which marked the less responsible aspect of Said Pasha's rule. "He economised in the quality of his Governors, sending to the Sudan a succession of no-bodies .... and then withdrawing them before they could put their hands on their tasks."(121) Indeed, this vast country, which was loosely linked by an inefficient means of transport and inhabited by diverse tribal groups with conflicting interests, needed strong and competent men with a long background of experience in public administration, so as to bring political cohesion and economic integration and progress. On the contrary, all the rulers were soldiers with the shortcomings of soldiers, and during Abbas Pasha's rule (1849-54), the Sudan was used as a place of banishment, and thus politically undesirable people from Egypt were exiled to the Sudan to rule.(122) Many of them did not bother about the country, and some were corrupt, and only a handful of them who really did try to remedy the wretched conditions of the people, but found themselves hindered by the bureaucrats of Cairo. Their job was to collect money and not to reform, and for that they were asked to show zeal and aptitude.

(iv) Transport Problems:

Another important factor was the inefficient means of transport which depended on that slow beast of burden, the camel. With its limited load capacity, which necessarily restricted goods to those of high value per unit of weight, and the long distances which were to be traversed across harsh deserts to reach the market, this mode was not conducive to economic development. Moreover, the rigid marketing policy of the Viceroys for long hindered contact, commercial or otherwise, with foreign countries, apart from Egypt and some Ottoman dominions, and this necessitated cumbersome change in the mode of transport and unnecessarily added to the cost of imported and exported goods. A bale of cotton goods from Manchester to Berber, for example, had to travel a distance of 1,200 miles and to undergo seven changes in the mode of transport from Alexandria to Berber: first railway, then river, railway, river, and finally camel (Fig. 35). In Gadaref area, grains were allowed to rot on the ground, although at famine price at Suakin, because of bad transport.[123] After the opening of the Suez Canal in 1869, ivory shipped via Suakin reached London "in less than six weeks from Khartoum, and was sold six months before the Government ivory via the Nile arrived in London".[124] The Viceroys set their faces against the easy, short and cheap route via Suakin because they suspected that some foreign powers, in collaboration with a dissedent Governor-General, might work to separate the Sudan from Egypt, and thus ".... the traffic has been made to come down the Nile - a long and, in many parts, an unnavigable river". (Fig. 35.)[125]

However, Khedive Ismail was in fact aware of the need to improve means of transport to help in the economic development of the Sudan. Thus, he set out to send steamers up the Nile, and to improve the navigation in the Nile by blasting some cataracts, laying submarine cables between Suez and Suakin, and the establishment of the 'Khedivial Mail Line' to serve between the above ports and also Massawa, linking the various parts of the Sudan by postal services and telegraph lines with each other and with Cairo and Alexandria, and improvement along some desert routes by supplying water and providing proper supervision and protection for caravans (Fig. 36).[126] In 1863 the Sudan Company was launched at Alexandria to develop the resources of the country, to foster export trade, to build railways and launch river steamers. But none of these purposes were fulfilled, and without railways and steamers to carry the produce to the frontiers, there could be no serious economic development, and the Company was liquidated in 1868. Indeed the Khedive's choice of routes, mainly influenced by his unhappy relations with the foreign-controlled Suez Canal Company, was all defective: he wanted his envisaged railway line in the Sudan to be Egyptian, serving Egyptian interests and, therefore, had to pass along the Nile valley. But because of his own economic problems and foreign debts, and lack of enough products in the areas which were to be served by these lines, his plan did not materialise (Fig. 35), apart from a 30-mile track south of Halfa. The Suakin-Berber line, so long advocated by various people and some of the Khedive's surveyors, was, after much controversy, finally agreed upon, and the work started in 1883, but was stopped a year later after laying only 22 miles from Suakin because of the hostility of the Mahdists who by then had occupied the hinterland.

Thus, vast districts capable of growing a variety of crops, including cotton, were left uncultivated because it was impossible to carry away the produce. To the Egyptians the river was a vital means of communication with Cairo, and when trade expanded in their dominion, it was the Nile and the foutes running along, and parallel to it, that carried the bulk of trade.[127] This attitude was stressed when the 1871 Report on the cultivable areas in the Sudan, already referred to above, was drafted in Cairo. Mumtaz Pasha, in his struggle to fulfil his dreams, built rafts at Qoz Regeb, on the river Atbara, to transport cotton from the Gash Delta to Egypt, despite the fact that it was easier and cheaper via Suakin. It would have sounded feasible to develop river transport as a feeder or subsidiary to the railway. Thus, it was pointless to encourage river transport while the main economic outlets were separated from it by hundreds of miles of deserts.

Thus, it is no wonder that all efforts to develop the resources of the country ended in failure. Mumtaz, in fact, was keen in developing cotton industry in the Sudan, and to that effect he built a barrage at Shaata near Suakin to provide water for the ginnery and the town itself, and established a port at Trinkitat to ship cotton from the Baraka Delta, and marked out the areas suitable for cotton growing along the Red Sea coast from Aqiq to Rawiya (Fig. 30A). Nevertheless, typical of all Egyptian ventures, he missed the main point: to create incentive for the people and stirring, not forcing, them up to the innovations and changes he was planning to introduce until they came by convinced that their prosperity and welfare would accrue from such an enterprise. Thus, his first difficulties rose over cotton - the crop in which he saw the only salvation for the economic problems of the Khedive, as well as the future image of himself as the great miracle performer and saviour of the Khedive's empire. To achieve that end, he did unjust and irresponsible things without paying any heed to the feelings of the people. He outraged the tax-payers' sense of justice by taxing them in unaccustomed ways. To increase cotton production he levied taxes on cotton, instead of in cash, and much worse he

"....cooked his returns to Cairo, affecting to show a larger number of cultivators than there really were".(128) Instead of these alienating measures, the excellent Egyptian peasants, who were sent to the Sudan, might undoubtedly have carried out part of his agricultural programme if life had been made bearable for them, and if there had been able supervisors knowledgeable enough to have weaned the Sudanese from traditional to scientific farming.

However, whatever Mumtaz's follies and mistakes, his place among the founders of cotton growing in the Sudan is secure, and the fact will always remain that he was the first to reveal the possibilities of cotton growing in the country. But the development of these possibilities, and consequently the realisation of his dreams, had to wait the coming of the British - who had already shown interest in the 1860's and 1890's, and who in fact did so much for the development of cotton industry in Egypt itself. However, their choice of suitable areas was more cautious and planned than that of Mumtaz, and what they finally chose was far from his "wonderlands". It is true that the Gash and Baraka Deltas were first tried, but this, as we shall see, was for financial reasons: the impoverished country needed revenue until the more ambitious schemes along the Nile got going. But it was between the Blue and White Niles, and not in the eastern Sudan as envisaged by Mumtaz, that the British attention was first attracted; the initial experience at growing cotton was gained, not from the eastern inland deltas, but from an experimental plantation along the Nile in Berber Province. Where Mumtaz failed, the British succeeded although confronted by the same, or even worse, obstacles that faced him, and made General Gordon utter his famous fatalistic statement that Sudan was a useless country.

Thus, from now on, the discussion will be concerned with the reasons why the British succeeded in establishing cotton industry in the Sudan, and this will take us to the third, and most important, stage in the history of the development of commercial cotton growing in the country, the twentieth century: and here it will be appropriate to start with discussing the motives for growing cotton here and the problems which had to be solved before this objective was achieved.

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W. Junker, *op. cit.*, pp. 103-6

72. In his efforts to accomplish these dreams, Mumtaz fell out with the Governor-General who complained to Cairo. Once there Mumtaz seduced the Khedive by his scheme and eventually won the governor-generalship.
(See R. Hill, op. cit., p. 58

73. Abdin (Haiya) Doss, 1946, Corresp. No. 2 (1875), p. 15

Abdin (Maiya) Doss. 1874, Corresp. No. 9 (1975), p. 18

74. Letter Book 19, Turkish Office of maiyet-i-sœniya , No. 354 Feb. 7 (1825), produced in R. Hill, op. cit., p. 50

75. Ibid, p. 50

76. C.H. Richards, op. cit., p. 9

77. F. Werne, op. cit., pp. 213-16

W. Junker, op. cit., pp. 102-3

78. Abdin (Maiya), Doss. No. 1938, Corresp. No. 8 (1871), p. 24

79. Abdin (Maiya) Doss. No. 1875, Corresp. No. 1 (1871),p48

80. Abdin (Maiya) Doss. No, 283, Special Council Corresp. No. 3 (1873), p. 136

81. R. Hill, op. cit., pp. 161, 41

82. J.D.H. Stewart, op. cit., p. 14. Stewart was told by the farmer that they had to give up cultivation of cotton since every passing traveller or the irregular troops were in the habit of allowing their camels to graze in their fields.

83. G.J. Fleming, "Kassala", Sudan Notes and Records, Vol. V, No. 2 (1922), p. 70

84. W. Junker, op. cit., pp. 62-3

85. F. Parry, op. cit., p. 152

86. J.D.H. Stewart, op. cit., p. 34

87. Morrison, et al., "The Growth of the American Republic, New York (1942), vol. 2, p. 715.

88. Blue Book, Egypt, No. 2 (1887), Inclosure 2 Despatch 65
Inclosure in Despatch 75
Despatch 99
Inclosures 1 and 2, Despatch 129

89. ibid, Inclosure 2, Despatch 65

90. H. Russell, op. cit., pp. 346-50

91. ibid, p. 350

A.B. Wylde, "The Red Sea Trade", The Journal of Manchester Geographical Society, Vol. III (1887), pp. 190-2

92. ibid, p. 192

93. Accounts and Papers, vol. LXV (886), p. 215

94. <u>ibid</u>, vol. LXXXIII (1887), p. 669

95. <u>ibid,</u> vo. 93 (1893) pp. 147-50

96. <u>ibid,</u> Vol. LXXXV (1849), p. 647

<u>ibid,</u> Vol. 97 (1895), p. 431

<u>ibid</u>, Vol. LXXXV (1896), p. 569

97. <u>ibid,</u> Vol. XCV (1898), p. 145

<u>ibid</u>, Vol. XCIX (1899), p. 169

98. R. Hill, <u>op. cit</u>., p. 58

99. <u>ibid,</u> p. 107

100. G. Melly, <u>Khartoum, the Blue and the White Niles</u>, London (1851), pp. 182-3

101. R. Hill, <u>op. cit</u>., p. 41

102. <u>ibid,</u> p. 42

103. C.M. Watson, <u>op. cit</u>., p. 174. In one of his letters, Gordon wrote complaining about this. "They (The Finance Ministry at Cairo) wrote to me from Cairo to send them down £12,000. So, I answered 'When the nakedness of my troops is partially covered, I may talk to you; in the meantime send me up at once the £12,000 you unfairly took in customs on goods in transit to the Sudan'."

104. R. Hill, <u>op. cit</u>., p. 108

105. G.A. Hoskins, <u>op. cit</u>., p. 175. According to Hoskins, a saqia could easily irrigate five <u>feddans</u> of food crops without any undue strain on the oxen but in case of indigo, one could afford only three-quarters of a <u>feddan,</u> and one <u>feddan</u> in case of sugar-cane.

106. W. Junker, <u>op. cit</u>., p. 156. The tribe here concerned was the Gezira branch of the Stiukoya, and in fact this inducement was mainly done with the help of their influential Head, Awād el Kerim Abu Sin,

107. J.A. St. John, Egypt and Mohamed Ali etc....., London (1834) Vol. 1, pp. 413-7

108. <u>ibid,</u> p. 415

109. T. Ellison, <u>op. cit</u>., p. 188

Charles Issawi, <u>op. cit</u>., p. 416

110. Gerald C. Dudgeon, op. cit., p. 44

"The New Cotton Plant", The South, New York, April 7 (1877)

"The New Egyptian Cotton", Rural Messenger, July 27 (1878)

"Bamian Cotton", The Boston Economist Bulletin, Dec. 8 (1879)

F.O 78/2638 (P.R.O.)

111. F.O. 78/1755 (P.R.O.)

112. E.R.V. Owen, op. cit., p. 15

113. ibid, p. 10

114. J.L. Burxkhardt, op. cit., pp. 149 - 50

115. H.A. Aziz Ahmed, Caravan Trade and Routes in Northern Sudan in the 19th C., Unpublished M.A. Thesis, Durham (1967), Chapter One.

116. E.R.V. Owen, op. cit., p. 115

117. T.W. Schultz, Transforming Traditional Agriculture, New Haven (1964), pp. 29-33

118. F. Parry, op. cit., p. 160

R. Hill, op. cit., p. 95

119. H.A. Aziz Ahmed, op. cit., pp. 30-31, 44, 50-53

120. F.O. 78/1336 (P.R.O.), Consul General Bruce to the Earl of Clarendon, 2 April (1857)

121. R. Hill, op. cit., pp. 85-90

122. ibid, p. 87

123. C.M. Watson, op. cit., p. 176

J.D.H. Stewart, op. cit., p. 13

124. A.B. Wylde, op. cit., p. 187. Problems of transport were also chronic in Egypt, in most cases trains being reserved for the transport of cotton from the Khedive's estates.

125. C.M. Watson, op. cit., p. 172

126. H.A. Aziz Ahmed, op. cit., pp. 46-50

127. ibid, pp. 46-50, 34-36

128. R. Hill, op. cit., p. 118

M. Shebeika, A History of the Kings of the Sudan (Arabic), Khartoum (1947), p. 39

N. Shoucair, op. cit., p. 125

CHAPTER FIVE

DEVELOPMENT OF COTTON GROWING IN THE TWENTIETH CENTURY - I

General Gordon once stated - and his opinion was accepted as final for a long time - that the Sudan was a worthless country that could never pay its way, and in accepting this fatalistic attitude, he failed to see the real cause behind his, and the country's dilemma: the singular lack of an efficient and just Government that cared for the well-being of the people and of the country alike. There was nothing wrong with the Sudan; its potential resources, though limited, were there waiting to be developed by the right kind of Government - and this neither Gordon nor his masters in Cairo could provide during the sixty years of their rule. Yet he had travelled over considerable parts of the country - perhaps more than any Governor during the entire Turkish period (1821-1883) - and might have known better its potential wealth. But he was concerned with the pacification and appeasement of the restive tribes and people rather than studying, leave alone remedying, the real cause for their restiveness. Moreover, he, like most travellers, reached the Sudan through Egypt, and so unconsciously compared the conditions of the Sudan with the blatant richness of Egypt without reflecting that Egypt, from time immemorial, has had easy communications with the outside world by means of her open waterways that carried its goods to the sea in exchange for what the stranger had to give. But in the Sudan, the Nile is not so kind; all throughout its length up to a few miles north of Khartoum, it passes through a series of cataracts which hinder its utility as a means of transport (Fig. 5). The chief exports, such as gum, ivory, ostrich feathers, and imports were dependent on the slow camel transport, which undoubtedly restricted trade and any sort of economic development.

Thus, what Gordon and some other people failed to notice is that the country needed a benevolent Government with a strong and genuine zeal to develop the country economically and at the same time create an atmosphere to attract foreign capital, and give incentive to the people to produce for their material benefit and not for the tax-collectors' pocket. None of these, as we have seen, could the previous Governments, Turkish or Mahdist, provide. When the Sudan was re-occupied in 1898, and a civil Government was re-established after the fall of the Khalifa, the country was in a state of extreme poverty and destitute: during the Mahdist rule of thirteen years the population had, it is believed, been reduced from some 7-8 million to an estimated total of 1.5 million, and trade and production of all sorts had been practically wiped out. Some 3.2 million are said to have perished through warfare and 3.4 million through attendant diseases (Table 25 App. 25 and Fig. 37).(1) In Dongola alone nearly 7,000 saqias were out of use in 1897. Consequently, for many years after the restoration of peace and order, and the return to their homes of the remnants of the population from Egypt and other parts of the Sudan, progress in every direction had to be slow. The country was impoverished and advances of money from Egypt were small. Thus, at the same time when, above everything else, the country required liberal provisions of funds for the improvement of communications and experimental work of all sorts, it had to be content with the sorriest pittance merely to maintain order and carry out the more glaring necessities of public administration. A natural consequence of this state of affairs, with a Government zealous to see the country go ahead, was that private individuals were encouraged to come to the desolate land and invest capital in undertakings for its development and so provide wages for some of the indigent population and revenue for the Government (see Chapter Six).

Many of these individuals came through Egypt obviously impressed by her prosperous cotton fields and, undoubtedly with the idea of introducing it along the Nile valley in the Sudan.(2) The possibilities of the country for growing cotton had, as already stated, been known to be fairly good since the time of Mumtaz Pasha. The British interest in the Sudan as a possible cotton producer dates back to 1868 when its Consul in Ethiopia was told, among other things, to go to Kassala to investigate the possibility of cotton growing there.(3) With the country this time securly under their control and the Empire cotton supply again facing another shortage crisis, the British embarked on similar lines of agricultural development as then practised in Egypt.

But unlike the Turks 40 years ago, their approach was more aware of the problems involved and their whole agricultural plan was guided, though not always as during the initial stages, by knowledge gained from actual experience in the field. Besides this scientific approach, the success of these plans can also be attributed to the whole-hearted support of, and assistance rendered by, the British people and institutions concerned about supplies of cotton for that vital British enterprise, the cotton industry, which was, for the second time in 50 years, being threatened by an acute shortage.

I LANCASHIRE AND EMPIRE COTTON SUPPLY (Fig. 38):

"Year by year we are gradually approaching a very serious crisis, as the shortage of cotton is regular and progressive, and unless supplies of raw fibre are obtained from other fields than those of America, the Lancashire industry will not only gradually languish and decay, but will completely perish. For this reason it has become all important that the industry of cotton-growing in British colonies should be fostered and developed."[4] It is hardly necessary to emphasise the vast economic importance of the cotton trade to the welfare of Britain at that time; it was the largest manufacturing industry in the country and it was, therefore, a matter of grave concern to people like J.H. Reed, from whose speech (1910) the above quotation is taken, and manufacturers that additional sources should be established. In 1913, out of the total value of exports of £411,800,000 from Britain, cotton yarns and piece goods amounted to £125,000,000; the capital engaged in this indstry amounted to over £500,000,000, and the industry employed directly or indirectly 10,000,000 people.[5] Moreover, the British cotton trade was very largely an export trade: it is estimated that four-fifths of the British production of cotton yarns and goods then were for export. Thus, whenever this was the case the difficulties which arose from any shortage in the supply of raw materials were found to fall most seriously upon the country supplying the surplus. It had certainly been the case that in those seasons, when mills had to run short-time or to stop altogether in consequence of shortage of cotton, Lancashire had suffered more severely than either America or Europe.[6] In 1904, the shortage of cotton was so acute that the mills of Lancashire could only be run 40 hours a week instead of 55.5 hours.[7] As a result, in spinning trade the loss on share capital worked out at 12.12% per annum, after allowing interest on loan. The net profit and loss of the spinning trade from 1884-1914 and shipment in textile goods for twelve months are given in Table 40 App. 40.[8] The serious decline in exports shows that the reputation of Britain as a cotton-manufacturing country, which then rested partly on the total volume of trade, partly on the extensive range of fine yarns produced in quantity, and partly on the high quality of fabrics and articles made from these fine yarns, was in grave danger. Furthermore, in accordance with the natural laws of commerce, each country, as it develops its own manufacture of cotton, begins with the coarsest numbers, and what Lancashire was able to retain was finally the "finer end of trade", due to many reasons: in coarse goods of low value freights are proportionately a more heavy charge; the Lancashire climate also was more suitable for fine cotton than that of many other countries. Thus, it was customary in Lancashire to divide the trade according to varying 'fineness' of the yarn under the headings of 'Coarse', 'Medium', 'Fine', or 'Extra-fine', but all of these headings represented finer yarns than were usual in most other countries, and the 'coarse' numbers manufactured here were finer than the finest numbers spun in many other cotton-manufacturing countries.[9]

It follows from this that it was of vital importance to Lancashire not merely to obtain increased supply of cotton but to get cotton suitable for the counts it spun. Since the development of cotton growing in the Sudan was a direct result of this shortage in Lancashire cotton supply, which was also connected with the general problem of supply in the world, these two aspects will now be discussed in some detail.

(i) World Cotton Supply, 1902-24: (Table 26 App. 26 and Figrs. 39,40)

The cotton crop of the world, as estimated by the Census Bureau of the U.S.A., averaged about 22,600,000 bales of 500 lb. each in the three years ending July 31, 1915, this figure representing only the cotton destined to enter commercial channels. The origin of this cotton is shown in Table 28 below. Many of these figures are only approximate estimates, and comparisons of a reasonably accurate character are only available for a few years back. There is, however, very little doubt that for the past half century there had been a fairly regular increase in world production, but after the good crop of 1913/14, the drop in production is almost steady (Table 29). The American crop, which was always the dominant factor in world markets was only slightly more than

TABLE 28 AVERAGE WORLD PRODUCTION OF COTTON, 1912-15

Country of Origin	Production in bales of 500 lb.
United States	14,000,000
India	3,600,000
Egypt	1,500,000
China	1,300,000
Russia	1,000,000
Brazil	400,000
Rest of the World	800,000

Source: Report to the Board of Trade, p. 53

that of 1915/16 (Tables 26, 27 App. 26,27), and this, despite an increase of the area under cultivation, was through unfavourable weather, lessened fertility in many localities owing to restricted use of fertilisers, and damage by insects over an important area.(10) India ranks second, with about 3,600,000 bales or considerably less than in 1915/16 season, while the Egyptian yield of 1,500,000 bales shows an increase over that of

TABLE 29 WORLD PRODUCTION AND CONSUMPTION OF COTTON, 1910/11 - 1916/17

Season	World Production Bales	World Consumption Bales	Stocks at the end of year. Bales
1910-11	16,862,737	16,750,484	4,844,744
1911-12	20,529,915	18,565,732	6,808,927
1912-13	19,197,979	19,544,007	6,462,899
1913-14	20,914,660	19,858,176	7,519,383
1914-15	19,578,954	18,746,669	8,351,668
1915-16	17,371,166	20,843,752	5,379,082
1916-17	17,900,099	19,240,603	4,128,578

Source: The Financier and Bullionist, Sept. 29 (1917)

1915/16, although for 1916/17 the decrease was due to restriction by the Government of the cultivated area.[11] However, after the shortage during the war and the immediate post-war slump the total world supply of cotton showed a marked recovery by 1923, and 1925 was the first year to show a total in excess of pre-war figures, and 1926 again established a new record (Fig. 40A).

Consumption, on the other hand, varied much less, and had on the whole been almost unaffected by the war owing to the increased need for explosives and medical appliances, and to greatly increased industrial activity in the U.S.A., which in 1916 took about 7.5 million bales as against only about 5.5 million in 1913/14.[12] However, the world consumption was necessarily limited by the supply, and Table 28 App. 28 and Fig. 40B clearly show that consumption for the two years, 1915/16 and 1916/17, was steady in excess of production, and this inevitably resulted in stocks being reduced by 50% - a fact which did not favour lower cotton prices for sometime to come. Thus, the balance between supply and demand is reflected in the price since records for some years of world consumption are not available. Measured in this way, it is evident that even before the war, supply had become noticeably insufficient for the world's needs. The price of Middling American affords a good index of the relations between supply and demand and the average price for the period, 1895-1914 is given below (See also Table 30 App. 30 and Fig.41).[13]

TABLE 30 AVERAGE PRICE OF AMERICAN MIDDLING, 1895-1914

Period				Price in Pence/lb
Five	Years	-	1895 - 1899	3.76
"	"	-	1900 - 1905	5.44
"	"	-	1905 - 1909	5.78
"	"	-	1910 - 1914	7.16

Source: Board of Trade, p

However, to get a good picture of the movement of prices before and after the war, Table 29 in App. 29 is given, and to have some parallel indication of the general movement of all prices, the last column of the table shows a continuous index number throughout the period, thus enabling us to trace how far the great movements of cotton prices coincided with, and to some extent at least caused by, the movement of general prices, and how far they were due to conditions affecting cotton. A comparison between this table (29 App. 29) and Table 21 in App. 21, will give a true perspective of these prices as compared with those of old days. It is interesting to note from both tables that the general level of prices turned in 1896 and rose steadily till 1913. It will be seen again, however, from the comparison of the index number with cotton prices that before the world war cotton prices were rising more rapidly than the general index number, this being due to the steady increase of the demand for cotton and the uncertainty of the American supplies.(14)

After the first great slump of cotton prices on the outbreak of war, it soon recovered, although the recovery in cotton was slower than the rise of the general index number until 1916/17. The highest point reached during the war was in June, 1917, when the intensive submarine campaign seriously interfered with the imports from America, and Middling American fetched 19.45d in Liverpool.(15) This, however, was far behind the record of the 1860's, and it remained for the post-war boom of 1919/20 to establish new records. The highest actual price traced was 32.11d for Fully Middling in Liverppol, and the highest point was reached the day before for Egyptian Fully Good Fair Sakel 99.00d/lb.(16)

Another interesting point is the comparative prices of different varieties given in Tables 30, 31 Appendices 30,31, the first one showing spot prices of American and Egyptian cotton in Liverpool, Alexandria and New Orleans, with the premium of Egyptian over American in Liverpool shown as a percentage, and the second table showing similar prices of other kinds of cotton in Liverpool for comparison (Fig. 41). The year 1919 is chosen as the start, first because it gives details of the movement of prices during the post-war boom and the deflation slump, and secondly, because it shows the effect since then of the increasing alarm with regard to the supply of American crop. However, the main points of interest are: (a) the effects of the periodic fears with regard to the American crop, some of which proved to be false alarms, especially that of 1921 due to the serious understatement of the acreage in that year by the Department of Agriculture.(17) (b) The extraordinary movement of the premium of Egyptian over American cotton, first during the boom of 1919, which was largely due to an unintentional corner created in Alexandria by the American demand for Egyptian cotton for tyre fabric, and secondly, the extraordinary slump in Egyptian prices which resulted partly from the collapse of the tyre boom and still more from the shortage of American and the resulting demand for Egyptian, especially Uppers.(18) The effect of that is shown in a striking way by the relative prices of Uppers and Egyptian given in Table 31 App. 31 (Fig. 41).(19)

TABLE 31 WORLD COTTON CONSUMPTION, 1911/13 and 1924/26

Two Seasons' total	U.K.	Continent	U.S.A.	Asia	World
All kinds					
1911-13	8,548	15,989	11,028	8,700	46,423
1924-26	6,257	13,573	13,946	13,144	49,399
Per Cent	73	85	126	151	106
American					
1911-13	7,401	9,730	10,713	1,026	29,134
1924-26	4,437	8,203	13,496	1,784	28,409
Per Cent	60	85	126	147	97
Indian					
1911-13	98	1,614	9	6,087	7,810
1924-26	351	2,171	61	8,438	11,093
Per Cent	358	135	678	139	142
Egyptian					
1911-13	767	754	254	40	1,829
1924-26	822	684	265	91	1,892
Per Cent	107	91	104	228	103
Sundries					
1911-13	281	2,892	52	1,547	7,650
1924-26	647	2,515	124	2,831	8,005
Per Cent	229	65	238	183	105

Source: E.C.G.R., 4(1927), p. 56

However, if we carry the figures back to 1911/12 season we can get a clear picture of cotton consumption, because that year was the year of the record pre-war consumption of American cotton which was not exceeded even by 1925/26.[20] But the pre-war consumption of "All Kinds" was actually beaten both in 1924/25 and 1925/26 (Table 28 App. 28), and this suggests the desirability of an analysis of the consumption of various kinds of cotton in particular groups of countries. Table 31 above gives the total consumption in the two years, 1924/26, compared with the first two years, 1911/13, with the result expressed as percentages.[21] The consumption during the whole period, 1911-26, of American and all kinds of cotton is given in Table 28 App. 28 and shown in Fig. 42.

From this summary (Table 31) it appears that U.K. consumption of all kinds in the post-war years was only 73% of pre-war consumption, while that of the Continent was 85%, the U.S.A. 126%, and Asia 151%. For American cotton Britain's percentage is only 60%, while the Continent and the U.S.A. are again 85% and 126% respectively, with Asia advancing to 174%. With regard to Indian the total figures for the U.K. and U.S.A. are very small, but the increase in the Continent and Asia is noteworthy.[22] In the case of Egyptian the figures for Asia are negligible but apart from them the U.K. percentage makes the best showing which would have been still better but for the sharp fall in 1925/26. In "Sundries", U.K. again shows a big increase, but the figures for the Continent must be taken with reservation as they mainly refer to the Russian consumption of native cotton. However, the high consumption in U.K. of Indian cotton was due to shortage of the long-staple Egyptian and American <u>Upland</u> - the latter case arising from the increasing consumption inside the U.S.A. of American cotton (see Table 32 App. 32 and Figrs. 41 & 43).

(ii) <u>British Supply of Raw Cotton:</u> (Table 33 App. 33 and Figrs. 38 & 42).

In normal times Britain required for her own use (exclusive of raw cotton re-exported) about 4,000,000 bales (of 500 lb. each), and of this about 75-80% came from America, 15% from Egypt, and the remainder from other countries.[23] In this connection, however, special attention must be drawn to the then prevailing position as regards the American supply. There was no other country in the world that could supply Lancashire in any considerable quantity of cotton of the right kind to replace the 3,200,000 bales it drew from America. Referring to Table 28 App. 28, Indian cotton was for the most part unsuitable for Lancashire mills because of poor quality and Chinese cotton was entirely so; Russia only grew for local consumption, and Egyptian cotton was limited in quantity, though of excellent quality. Thus, on the whole it was strictly true to say that the regular Lancashire trade depended on American cotton as it did during the American Civil War in the 1860's (Fig. 43).

The danger to be faced, as it was then, was the insecurity of this supply. Great uncertainty was felt about both the volume and quality of cotton likely to be forthcoming from America in the future - uncertainty aggravated by war-time curtailment of the crop having coincided with several unfavourable seasons. Apart from increase in home consumption (Fig. 43), the great fluctuation in yield due to climatic vagaries was aggravated by the devastating attack by boll-weevil. Since its appearance in 1892, great damage was incurred: in 1912 it caused damage to the extent of 3.26% of the crop; in 1921, the damage was increased to 30.98%, and consequently cotton production declined from 13.4 million bales in 1920 to less than 8,000,000 in 1921, with a corresponding drop in yield from 178.4 lb. per acre in 1920 to 124.5 in 1921.(24)

However, particular alarm was also expressed about the supply of extra fine cotton (Figrs. 39 & 42). The reduced crops produced by Egypt during the war, the immediate post-war shortage of cotton goods and the rise in the price of cotton to a level far in excess of anything recorded since the 1860's (Tables 29 App. 29) heightened the fears of the fine spinning industry. The most alarming thing was the severe damage the boll-weevil caused to the much needed Sea Island Cotton. Available reports indicated a likely severe fall in this variety, and indeed Sea Island production in America fell to 50,000 bales in 1918, to 2,000 in 1920, and to only 10 bales in 1924. Formerly, a crop of 10,000 bales of fine long Sea Island was commonly raised in South Carolina, and the supply (to Lancashire) of this quality of cotton was supplemented by about 4,000 bales from the West Indies. In Florida and Georgia a lower quality of Sea Island was grown in amounts averaging about 70,000 bales and a further 2,000 of somewhat similar cotton were grown in the West Indies (Fig. 39).(25)

From this account it seems certain that the shortage of American cotton was likely to be a constant recurring if not of a permanent difficulty. The Egyptian cotton, which filled a special place in the

British industry, declined from a total of 7.5 million bales before the war to 5,000,000 during the war. Despite some increase in production in later years (Table 34 App. 34 and Fig. 42), the decline was due to low yields per acre, which was attributable to exhaustion of soil, ravages of insect pests, and suspension of irrigation and drainage works during the war.(26) The Empire Cotton Growing Committee viewed the position with anxiety and in its report (1917) emphasised the necessity for remedying the causes of the decline in order to achieve maximum production. Among the resolutions passed to that effect was the necessity to maintain the quality of existing varieties and to secure and hold in reserve other varieties for introduction when and as expedient, as well as extension of irrigation and drainage.

Thus, new supply sources for the greatest British industry, which more than held its own against the competition of the world, were vitally urgent. As we have seen, it was not an indigenous industry, nor one which was essentially impervious to attack: 80% or more of its raw material was drawn from foreign sources, and 70-80% of its products were exported to colonies or elsewhere. Nevertheless, there was within the Empire the opportunity for growing both in quantity and quality all the cotton Lancashire required, among which the long-staple variety which was essential for spinning the great bulk of what was known in England as "fine yarn". With the disappearance of the American Sea Island, the E.C.G.C. reported that the whole question of maintaining an adequate supply of cotton of Sea Island type demanded serious and early consideration, especially because there appeared to be little chance that the West Indian Islands could provide an increase sufficient to make good the disappearance of the American Sea Island crop. Little hope, therefore, was seen for cotton growing in Jamaica and Trinidad, or in British Guiana, but the B.C.G.C. was favourably inclined to the view that among the islands throughout Oceania there must be an aggregate of a relatively large area suitable for the production of this variety of cotton if demand for this growth were maintained.(27) This opinion was reflected for a number of years in the struggle to grow Sea Island varieties and hybrids in Fiji Islands. The B.C.G.C. was not infallible and could not foresee neither the great cotton slump of 1921, which affected particularly the demand for long fine cottons, nor the subsequent changes in fashion which caused a permanent decline in this demand, and the later further erosion of many of the traditional outlets for Sea Island cotton.(28) In the long run, it was perhaps better that the future soon made itself apparent, and a vigorous lengthy and expensive campaign for extending the growth of Sea Island cotton was never firmly undertaken. Instead the long-staple variety known as the Egyptian was slowly replacing the Sea Island and the best places for successfully growing this cotton on a large-scale were Egypt and the Sudan (Figrs. 38 & 44).(29)

However, to ensure a constant supply of good quality cotton, the emphasis was put on experimentation, close co-operation between Government and grower, and a full utilisation of anything that science can offer to make all undertakings a success. An outcome of this desire was the appointment by the British Government of a special committee to investigate the best means of growing cotton in the Empire and to advise the authorities as to the best measures to be taken for that purpose.(30) As a result of these efforts, a new approach to cotton growing, especially in new areas hitherto undeveloped, emerged and it was in many respects different from the one adopted by the Turks (Chapter Four).

II A NEW APPROACH TO COTTON GROWING

This experience eventually led to the initiation of the International Federation of Master Cotton Spinners and Manufacturers' Association, which practically brought all the cotton growing and cotton manufacturing countries of the world into, or in friendly co-operation with, this Federation. In 1902, the British Cotton Growing Association (B.C.G.A.) was founded for the development of cotton growing in the colonies and dependencies of the British Empire.(31)

At this time, however, very little knowledge was available as to the conditions, whether physical or economic, under which cotton could be grown with commercial success in these dependencies most of which were in the tropics. Consequently, it speedily became evident that pioneer work on a large scale would be necessary. Thus, the necessity for studying cotton systematically and scientifically was emphasised, and the necessity for prolonged investigations in new districts of the immense areas included in the Empire, and afterwards to conduct experiments in cotton growing in the more promising localities was acknowledged. To this effect the policy was adopted that "time is past when it is necessary to try experiments blindfold".[32] Accordingly, the specific functions of each body were defined. The B.C.G.A. was to do the pioneer work as outlined above, and to this effect a study of cotton scientifically was carried out in India, Egypt and elsewhere and as a result it was gradually learnt, by practical experience, that there were large areas, formerly thought suitable, in which cotton could not, for one reason or another, be grown commercially, and others in which prospects were extremely favourable. Eventually, it became clearly known that in weighing up the possibilities for cotton in any country with adequate transport facilities, the three most important factors to be determined were suitable soil, suitable climatic conditions, and sufficient labour (Chapter Three).

Thus, in this respect it was agreed that the colony or dependency was to decide for itself whether its climate, soil, population and its means of access to markets were suitable for cotton. If these were found to be suitable, then it had to decide what kind of cotton would pay the grower best. The colonial Government, on the other hand, was to try the experiements, to establish model farms, to secure the purity of seed, to regulate the industry so as to minimise pests and to create confidence in the regularity of the quality of cotton produced. The Government was also to provide capital for any big schemes of irrigation or drainage that might be necessary, and to arrange for such services as railways, roads or water facilities as might be necessary for the marketing of the cotton produced, and of other crops which would probably be necessary as rotations. Moreover, there were other matters, such as assistance necessary in the early days of the industry, mainly in the form of financial help and advice to the inexperienced planters, and marketing facilities until the growers had known, and established in, their markets.[33]

However, the magnitude of the task which the B.C.G.R. had set out to accomplish proved to be too great and as a result of recommendations, the Empire Cotton Growing Corporation (E.C.G.C.) was formulated and was established under Royal Charter dated November, 1912.[34] Under this Charter, the E.C.G.C. was given the power to, amongst other functions, first, assist in the enlargement and strengthening of the agricultural departments of the colonies and dependencies, and to provide facilities for training men for posts under these departments. Secondly, to establish a bureau for the dissemination of information on cotton growing and to issue a journal containing useful information on the subject. Thirdly, to undertake the marketing of crops where this would prove of assistance to the local Government - this latter work being done in conjunction with the B.C.G.A.[35]

The validity and usefulness of such bodies were brought to the limelight by the events of the 1914-18 War, during which the British and Egyptian Governments controlled the buying and selling of Egyptian cotton according to a general policy of the Allies to withhold cotton exports to Germany.[36] Thus, adequate quantities were to be available for the use of the Empire and its Allies at reasonable prices which would, at the same time, safeguard the positions of the native-grower in case any further restrictions of shipping facilities should deprive him of a market for cotton.[37] However, half of the money accruing from this sale was retained by the Egyptian Government, and of the balance that came to the British Government, one million pounds (£1,000,000) were handed over to the B.C.G.C. Moreover, spinners and manufacturers also approved of the proposal of a levy which was made obligatory on all users and enforceable by law. The B.C.G.C., however, retained its separate identity and its chief work in the development of new areas included, where necessary, the handling of cotton when grown, i.e. ginning, baling, and marketing, and attending to its disposal in the home, that is, British market, with the help of an independent agency in the growing country - especially when the quantity to be handled was too large for the officers of the agency (see next Chapter).[38] Furthermore, the principle was established that while expenditure which directly benefited the general interests of a colony should be borne by the colony itself, the cost of promoting the cultivation of cotton in preference to other crops should be recognised as a charge on the cotton industry.

Thus, was laid down the secure foundation of successful cotton growing in the colonies, and the Sudan, together with India, was given the priority in this respect. In July, 1917, the E.C.G.C. appointed by the Board of Trade to investigate the best means of developing the growing of cotton within the Empire, and to advise the (British) Government as to the necessary measures to be taken for this purpose, specifically stated in a Memorandum to the British Prime Minister that "the authorised Irrigation Works for the development of the Gezira Plain should be pushed on with the least possible delay".(39) The urgency attached to the development of this area was the result of earlier reports and ideas assessing the possibilities of this area for cotton production, which by 1917 had been proved to be excellent.

III REPORTS ON COTTON GROWING IN THE SUDAN, 1903-17:

As already mentioned in Chapter Four, the first appraisal of the agricultural possibilities of the Gezira was expressed by Von Puckler-Muskau who, writing in 1837, combined praise with prophecy: "This fertile and now no longer unpeopled Delta would bring a rich reward for Mehemet Ali if he would but consent to open some kind of communication between the two rivers by means of canals."(40) The Englishman, Holroyd, writing in the same year, re-echoed the same prophecy.(41) But the first engineer to bring out into notice the possibility of the Gezira for irrigation and as a cotton-producing area was Sir William Garstin of the Egyptian Irrigation Department.(42) Although his main task was to find ways of increasing the flow from the Upper Nile sources for the use of Egypt, he also investigated, between 1899-1903, into the possibilities of utilising the Blue Nile water for the irrigation of the Gezira. The factors he considered were land, quantity of water available, crops to be grown, and population.

Land of suitable slope and apparently good quality was in abundance (Chapters One and Two). With regards to water, the fact that the whole natural flow during the low period was used by Egypt, posed the problem of water supply, and it was clear that either the crops to be grown in the Gezira must require no irrigation from the beginning of March and onwards, or else storage must be provided. As regards to crops, cotton, the most valuable, was then grown in Egypt from March to November, and required water throughout the period of shortage. To provide summer water for growing cotton in the Gezira, Garstin originally proposed the construction of a reservoir at Lake Tana, and in case this could not be done, he proposed to grow only wheat and other winter crops, using a barrage or weir across the Blue Nile for raising the water to a level sufficient to command the head of his main canal. However, the construction of the Lake Tana Reservoir at the time was not found possible. Working on the alternative proposal, C.E. Dupuis in 1908 submitted a project for a barrage near Sennar to hold up the water-level some 7.8 metres only, and for a canal system to irrigate some 500,000 feddans gross north and west of Wad Medani on which the main crop would be wheat (see below).(43)

In 1903, Leigh Hunt, an American philanthropist, wrote from the Sudan that "There are millions of idle acres of land along the Nile in the Sudan capable of being developed into as fertile fields as those lower down the Nile in Egypt", and when physical conditions were understood and the Suakin-Berber railway was completed, "there will be no lack of men and means ready and anxious to proceed with the development of these millions of acres which now practically lie vacant".(44) Then followed the reports of Sir William Mather in 1910, that of Anno Schmidt in 1913, and various preliminary reports by W. Himbury and E. Goulding - all prominent members of the B.C.G.A. and ardent advocates of cotton growing in the Sudan.(45)

However, the difference between these reports and those of the nineteenth century is that the former are more cautious and realistic in their appraisal of the problems and more versed in the scientific spirit of the time, while the latter were casual and imaginative. From the outset, the reporters of the twentieth century were guided by the various principles and plans carefully formulated and set down by a panel of experts concerned solely with cotton-growing in the Empire, and as a result all these reports acknowledged and considered the various problems which had to be solved before the aims were realised. In the Sudan, the first main obstacle rose over the allocation of the Nile Waters, or particularly over the summer supply for Egypt, because without an assured supply from the Blue Nile for irrigation the whole Gezira project was doomed. Equally important was the necessity for scientific research into the physical and cultural factors affecting cotton production as already discussed in Chapter Three (see also Chapter Seven). To carry out this research, it was emphasised, the assistance of the Government was needed to finance and educate officers on various agricultural methods and problems so that they could supervise and direct the native cultivators to proper scientific methods of cultivation (see Chapter Three). In this respect, it is appropriate to discuss briefly the history of the organisation of agricultural research and experimental farms during this period before we turn to a discussion of the various problems.

IV AGRICULTURAL RESEARCH AND EXPERIMENTAL FARMS, 1900-25:

The first scientific organisation in the Sudan was founded by Henry S. Wellcome which came to be known as the Wellcome Research Labs., and in the field of agriculture the concern was with chemical and entomological work. The laboratories were then incorporated in the newly-founded Gordon Memorial College in 1901. In 1904, as part of a pumping scheme to irrigate the land on the east bank of the Nile, an experimental farm was established at Shambat on an area of 100 *feddans*, four miles north of Khartoum, as part of the Department of Agriculture and Lands. Its proximity to the capital gave it a convenient central site for research fieldwork, and it was here that trials were first made on many crops, including cotton, and pumping machines.(46) When work was extended in 1912, the farm was transferred to the Department of Education, and became closely associated with the Wellcome Labs. which provided the staff for the first agricultural laboratory, and until 1919 all research work was carried out under the Director of Wellcome Labs. However, although all botanical work was transferred to Shambat, chemical and entomological work remained in Khartoum.

With the progress in cotton cultivation in the Gezira, the Shambat Farm by 1918-19 proved not to be a suitable site for a large experimental farm. In 1918 the Gezira Research Farm was opened at Wad Medani and this, together with Shambat Farm and the botanical work, were placed in the Department of Agriculture. However, the isolated situation of Shambat from commercial cotton areas allowed complete freedom of experiment and growing crops out of season.(47)

The Gezira Research Farm is the headquarters of all agricultural research in the Sudan. When the Gezira was proved to be suitable for the growing of Egyptian cotton by the pilot schemes of Tayiba and Barakat, commenced in 1911 and 1914 respectively, the Government decided that "considering the large issues at stake, a supplementary, but smaller, farm was necessary where research would be carried out in detail".(48) Thus, in conjunction with the B.C.G.C. and the S.P.S., the Government made arrangements for the carrying on of a comprehensive programme of scientific research in connection with the agricultural problems of the Sudan. An advisory committee was set up in London in which the above bodies were represented, whose duty was to consider the annual reports upon agricultural research carried on in connection with the Gezira Project, and to consider and advise regarding the programme of research work each year which was to be submitted to them. As a result the Gezira Research Farm was started in 1918 to be the centre for work in this connection. The site (Fig. 45) then 3 miles outside Wad Medani, the administrative centre of the Blue Nile Province, had the advantage of proximity to the town for supply of labour, and availability of irrigation water from the pumps at Barakat (Fig. 59).

The land here was low-lying and thus was used as a spill area for surplus water from the Barakat canals. Consequently, it was heavily over-cropped with dura and the soil was almost exhausted. So levelling of the earth-banks, terus, for roads and blocks was commenced originally in an area of 350 feddans which, by subsequent extensions, was enlarged to what it is today (Fig. 45). The Farm was divided into blocks of 5 feddans each, a uniformity which greatly facilitated the conduct of experiments, although for some experiments sub-plots consisting of two strips with each strip divided into 5 sub-plots were practised.[49]

Moreover, in order to maintain the quality and uniformity of the cotton grown, a seed farm was established by the S.P.S. in collaboration with the Government at Barakat (Fig. 59). The farm and the accessory areas for the propagation of seed and testing of the varieties were to be managed by the S.P.S., and all in all consisted of (a) a seed farm of 1,200 feddans, (of which 400-900 feddans were to be under cotton), to provide a pure and high grade supply of seed; (b) a variety test area of 270 feddans, (of which 90 feddans were to be under cotton), and (c) a special experimental area of 60 feddans (20 feddans of which were to be allocated to cotton).[50] A seed farm, unlike the commercial area, allows for the principles of mass selection to be followed, and for this purpose seed of an approved pure strain is sown in a small area under very close supervision, the plants produced being subjected to close examination, and seed only kept for sowing from those which, in growth, yield and quality, come up to a high standard. Seed from this plot is to be used for the sowing of a larger area which will be subjected to similar scrutiny and roguing of plants not up to type until a sufficient bulk of seed is obtained for sowing under ordinary conditions throughout the irrigated commercial area.

Before the establishment of the seed farm, however, fresh Sakel seed was imported, first every year and later at intervals, into the Sudan from Egypt.[51] The first consignment of Sakel seed arrived about 1913 and up to 1938 perennial importations from the State Domains in Egypt maintained the seed supply of the Sudan commercial crop.[52] Only since the decline of Sakel in Egypt has the Sudan relied on its own resources for the production of planting seed, and since its establishment the Barakat Seed Farm has supplied all of the seed for long-staple cotton, while the Gash Delta, by virtue of its relative freedom from diseases, acts as "filter" for Gezira seeds before sowing on the irrigated area. Experiments with cotton varieties and seeds will be discussed in Chapter Seven.

The first problem which faced the planners of the Gezira Scheme, rose over the allocation of the Nile waters between Egypt and the Sudan, but before going into this matter, it is appropriate to give a brief history of this project.

V THE BLUE NILE OR GEZIRA PROJECT, 1905-25 (Figrs. 46 & 47)

As stated above, the concept of utilising the waters of the Blue Nile for the irrigation of the Gezira is attributed to Sir W. Garstin in 1904. For some years afterwards, the Sudan Irrigation Service studied a project for the same purpose by means of a dam on the Blue Nile and a canal through the Gezira. In 1913, definite plans were put forward and referred by the Sudan Government to the Public Works Ministry in Cairo for consideration and advice. These plans consisted, first, of a dam at Makwar (Sennar), and, secondly, a canal taking off from the above dam for the irrigation of 300,000 feddans in the Gezira. One set of plans was designed by Tottenham, of the Irrigation Service, who investigated the capabilities of the water supply in the river in relation with the area possible to lay under specific crops, and the other set by Captain Kennedy, Director of Works, Sudan (see below).

Accordingly, in 1913 M. MacDonald, Under-Secretary for Public Works in Egypt, on instructions from Lord Kitchener, invited Sir W. Garstin, H. McClure and Sir A. Webb, Advisor to the Egyptian Public Works, to meet him in London for the purpose of examining these plans and giving an opinion regarding them. The estimated costs of these plans was provisionally put at £E. 1,236,000.[53] However, both plans were rejected because, on engineering ground, they failed to deal with the closure of the deep eastern channel of the river, at this point, in a practical or satisfactory manner (Fig. 46). It was recommended that, if an examination of the site showed it possible, this channel be laid dry for the foundations of the dam. This was considered to be of paramount importance and, so far as the actual construction of the dam was concerned, was the key to the whole problem.[54]

However, early in 1914 the three veterans proceeded to the Sudan and examined the proposed site of the dam and, after a careful study of the many difficulties presented (such as space for the construction of the necessary coffer dams, the materials required, limited time for the actual work, boring and other constructional problems) they came to the conclusion that the deep eastern channel could be laid dry if due and sufficient preparations were made previous to the commencement of work on the dam. Preliminary plans and estimates were then prepared by MacDonald, and a sum of £E 1,420,000 was included in the Bill presented to the British Parliament in 1914.[55]

Thus, during the following three years, MacDonald thoroughly investigated the question of discharge, levels, sluice-waterways, construction materials and many other engineering problems which, owing to insufficient data available at the time of the original plans and estimates, may then be taken as final. The plan showed that the Sennar Dam was a work of prime importance and magnitude and could well be compared with the Aswan Dam or rather similar works yet constructed. It had to withstand a pressure of 13 metres of water and pass a discharge of 15,000 cumecs in a river whose serrated gauge diagram showed that it was subject to great and sudden fluctuations (Chapter Two & Fig. 17).

However, apart from the constructional difficulties involved, the following were among the main engineering difficulties to be constructed. (a) The nature of the foundations; (b) Maximum flood levels and discharges; (c) Water-way in the dam sluices and spillways; (d) Profiles of different portions of the dam and their stability; (e) Levels of sills of sluices and spillways; (f) Flanks of the dam, and (g) Minimum discharge of the Blue Nile. Other considerations included, first, the scope of the future scheme which then included 300,000 feddans of land, 100,000 feddans of which were to be under cotton.

Secondly, summer water supply for Egypt (see below). Thirdly, cotton cultivation where it was assumed that the experience gained from the existing experimental station at Tayiba (started in 1911) warranted the confidence that cotton can be continuously and profitably grown in the Gezira.[56]

However, Sennar was not the only place to be chosen for the site of the dam. M.R. Kennedy suggested that the irrigation of the Gezira plain should be on the basin system by means of a canal taking off the Blue Nile above a dam at Roseires. He, therefore, recommended the construction of works to irrigate the southern Gezira in preference to a dam and a canal at Sennar to irrigate the northern Gezira.[57] In fact this idea of a dam at Roseires had in the first place been considered by C. Dupuis and Tottenham.

However, from the earliest days of the study of the problem of irrigating this area, it was recognised that the introduction of perennial irrigation into the northern, and not the southern, Gezira was most likely to produce great development and yield a good return on the large capital sum necessary to invest. The general conditions of northern Gezira, with a large area of good level plain but poorly cultivated under semi-arid conditions and with a comparatively dense population dependent on a very uncertain rainfall, all pointed to the selection of that tract in preference to the southern Gezira, which has a fairly reliable rainfall, (Figrs. 12, 47) and, therefore, would, even if people were there, in any case not be a pressing irrigation problem. It was, however, an unpopulated area without means of transport or other services for the construction of engineering works. Moreover, owing to the rate of development expected, it was a matter of utmost importance, in view of the heavy prime cost of the work, that the most remunerative crops should be gsown - the best class of cotton for choice. This was clearly not possible if the basin system of irrigation was to be adopted, hence the decision to irrigate perennially, seeing that the low stage supply of the Blue Nile would in all but the very lowest years suffice for at least 900,000 feddans, and for not less than 3,000,000 feddans when Lake Tana was brought under control - in which case the dam at Roseires would be superfluous. Only and due to political reasons, when control of water at Tana was impossible, then a dam at Rosseires might become a necessity, but still without invalidating a dam at Sennar. Furthermore, Kennedy's plan did not, it was argued, involve any greater cost than the combined works at Sennar since it was not devised to carry water to the northern region, but this was only calling attention again to one of its worst defects, which was irrigating, and that by a system not the most remunerative, a part of the plain which then did not call for it.[58]

Thus, Kennedy's proposal was rejected in favour of the original plan (of a dam and canal at Sennar) which the B.C.G.A., after a thorough study on the spot by a special commission, recommended to the British Prime Minister in 1913 who in his turn approved to an initial loan for the project. This approval was also strengthened by the unanimous endorsement by an international commission which was especially appointed in 1920 at the request of the Egyptian and British Governments, to study, and give recommendations for, the various projects on the Nile put forward by British and Egyptian engineers to increase water supplies for both Egypt and the Sudan.[59] These projects included: (a) Aswan and Sennar Dams; (b) A dam on the White Nile at Gebel Aulia; (c) An Equatorial Lakes dam and regulators; (d) a dam at Lake Tana, and (e) a dam at the 4th Cataract on the Nile (Fig. 48). The outcome was embodied in two reports: a Majority Report which recommended that Egypt be given the right to use the discharge of the Nile in low season, and the Sudan to use the flood waters for her irrigation needs. All the projects were sanctioned. The Minority Report, drafted because of disagreement among the members of the Commission as to the allocation of water supply, recommended that the vested rights of Egypt, as then existed, should be respected and that the unappropriated surplus supply accruing from the above projects should be divided equally between the two countries.[60]

This was started when in 1914 Kennedy made the startling statement that the hydraulic engineering estimates on which the Gezira Project was based were all wrong. MacDonald, he argued, had counted on an average flow during the months of January and February of respectively 347 and 247 tons of water per second as a minimum, whereas (he claimed) the official record for these months during 1900 and 1914 indicated a flow in the Blue Nile of "only 87 and 64 tons of water per second respectively."[61] That is, the minimum supply of water available had been over-estimated. He also accused MacDonald of under-estimating the needs of the Gezira crops in the period of shortage.

This triggered off a very heated and bitter argument, those who took Kennedy's view arguing that the carrying out of the Gezira

Project would leave Egypt "thirsty", while the others, headed by MacDonald, claimed that there was ample water for all possible needs in both countries. The guarantee by the Sudan Government of water supply to the Sudan Plantations Syndicate which, on the completion of the Sennar Dam, was to administer the irrigated area in the Gezira on behalf of the Government, was claimed by the Kennedy group as being radically unsound.[62]

To solve this tangled problem, the whole matter was referred to the Nile Projects Commission of 1920 which, after a lengthy interrogation of all parties concerned as well as experts, gave its verdict: Kennedy's charges were rejected as having no justification, while W. Willcock's charge that measuring discharge of the Nile by means of sluices at Aswan Dam had resulted in "a grossly inflated values" was also rejected. MacDonald's figures, which started the row, were confirmed with slight modifications, by subsequent commissions.[63]

Nevertheless, the doubts aroused were hard to dispel and the fear of the Egyptians that Britain was conspiring to deprive them from the source of their livelihood was not easy to allay. The Gezira Project, they suspected, was an aim to that end.[64]

VI <u>WATER SUPPLY FOR EGYPT AND SUDAN:</u>

Egypt then, as it is now, was completely dependent on the Nile for all water required for irrigating its land. Economically, it was shown that in Egypt irrigation had been resorted to only when no more cultivation could be done without its aid but that in the Sudan the Sennar Dam, for example, was projected "long before the growing possibilities of the Sudan had been fully exploited".[65] However, before perennial irrigation was introduced in Egypt during the nineteenth century, irrigation was practised only during the flood time. With the building of the Delta Barrage water was increasingly used for growing cash crops, including cotton, and gradually all the natural flow of the Nile became a vested right for Egypt. But because of fluctuations in the natural flow, storing of surplus water for use during times of shortage, necessitated building of a dam at Aswan which was completed in 1902 with a storage capacity of 1 milliard cubic metres (M^3). By later subsequent raisings in 1912 the capacity of the dam was increased to 2.4 milliard M^3, and as a result the area under perennial irrigation increased to 4 million <u>feddans</u>, while that under basin irrigation decreased to 1.3 million <u>feddans.</u>[66]

In the Sudan, perennial irrigation was at first limited by a licence for only 2,500 feddans for experimental schemes, but this area was increased to 10,000 feddans when the Aswan Dam was completed, and a further 10,000 feddans when it was raised in 1912, with an additional open "flood licence" for pump irrigation between July 15 and the end of February.(67)

When the Gezira Project was first proposed by Garstin in 1904, it consisted of a barrage and a diversion canal to irrigate 100,000 feddans. But the exceptionally low Nile of 1913-14 - indeed the lowest on record in 180 years - and increased costs of building materials because of the war, necessitated increasing the area to 300,000 feddans and consequently providing a storage dam instead of a diversion barrage. This, however, raised two questions: (a) What area can the Blue Nile, with another low river like that of 1913-14, irrigate during the low period, and (b) How much area could be irrigated without infringing the rights of Egypt?

Before answering these questions in some detail, a brief account of the natural supply of the Blue Nile will be given (see also Chapter Two), and for this purpose the mean discharges from November -

TABLE 32 BLUE NILE DISCHARGE AT SENNAR IN CUMECS

Month	Mean for 11 years 1906/1907 - 1916/17	1907 - 1908	1913 - 1914
November	1,400	860	325
December	705	440	170
January	425	265	120
February	285	175	75
March	195	110	65
April	155	85	85
May	230	115	75
June	525	400	300
Mean	940	305	150

Source: M. MacDonald (1918), op. cit., p. 8

June are given in Table 32 (see also Tables 37 a,b,c App. 37). Since it is the Blue Nile that makes the flood, the low flood of 1913-14 in the main Nile was also a low one in theformer. The winter supply of the Blue Nile was in the same way the lowest for the same period for, while in the main Nile a low flood might, owing to the intervention of the White Nile, be followed by a winter supply not low in the same proportion, no such assistance could augment the falling waters of the Blue Nile.

The extent to which the Gezira could be irrigated was to be affected by the nature of the crops to be grown at various seasons, the relation of their water requirements to the needs of Egypt, and the amount of storage water that could be provided. The best crop rotation and the supplies it required were determined by experiments at Tayiba and Barakat, the amounts being 5,160 and 11,708 M^3 for lubia and cotton respectively.[68] The rotation adopted was Cotton - Lubia - Fallow, each occupying one-third of the area to be cultivated. The Agricultural Department and the Sudan Plantations Syndicate were in agreement on the volumes said to have been pumped for the experimental stations as Table 33 shows. Based on the discharges and these calculations, it was assumed

TABLE 33 PROPOSED WATER ALLOWANCES AND AMOUNTS ACTUALLY PUMPED, JANUARY 18-APRIL 15 (1913/14 → 1916/17) AT TAYIBA AND BARAKAT EXPERIMENTAL STATIONS (in M^3)

TAYIBA			BARAKAT		
Year	Water Pumped (M^3)	Water Proposed	Year	Water Pumped (M^3)	Water Proposed
1913-14	3,906,680	4,007,000	-	-	-
1914-15	3,630,730	3,871,000	1914-15	5,437,000	6,131,000
1915-16	3,822,255	4,663,000	1915-16	5,480,000	6,790,000
1916-17	4,898,840	5,841,000	1916-17	7,123,000	7,605,000
	16,258,505	18,382,000		18,040,000	19,533,000

Source: Computations, p. 12

Notes: (a) Watering for the bulk of the area ended on February 29, only 60 feddans out of 271 were watered up to March 15.

(b) This was late instead of early because water was only given from September 14 (due to heavy rains).

(c) Watering was continued to April 30 owing to lack of water earlier in the season due to pumping difficulties.

that the extremely low year of 1913-14 had in the critical period - April 1-15 - sufficient water adequately to supply 315,000 feddans, while in the next lowest season, 1907-1908, the total area cultivatable would have been 530,000 feddans (Fig. 49 and Table 37e App. 37).(69) Thus, while these figures represent what the natural unaided river can do, it must be noted that to get the Blue Nile water on to the Gezira Plain entailed the construction of a dam with the consequent double advantage of making available, if it is required, all the water passing between January 1 and April 15, and providing additional storage when necessary. This proposed Sennar Reservoir, MacDonald calculated, could, allowing for evaporation losses, store 487 million M^3 from surplus flood waters which, in addition to the natural flow of the Blue Nile during this period, could irrigate 660,000 feddans in the worst known year, 1913-14, and more than 1,000,000 feddans in the lowest following year, 1907-1908 (Fig. 49 and Table 37 e,f App. 37).(70)

With regard to the question of how much area could be irrigated without detriment to Egypt's interests, MacDonald calculated that in the lowest level recorded, Egypt's shortage would have lasted from February 18 to July 15 at Aswan, which was equivalent to January 18 to June 25 at Sennar. Water would be required by the crop between January 18 to April 15, and, in case of a bad low river, could not be drawn from the natural flow of the river during these years without detriment to Egypt. After April 15 watering of cotton ceased and what the Gezira required was only a small quantity of water for domestic use. Thus, the only water available for the Gezira during the period of January 18 to April 15 would be the amount stored in the Sennar Reservoir, that is 487 million M^3, and the 300,000 feddans, according to the data obtained from the pilot schemes at Tayiba and Barakat, needed 500 million M^3 between these dates as the following table shows.(71) To meet this, there would have been an effective storage of 467 million M^3 - a sufficient quantity for 280,000 feddans. It is therefore obvious that with some restriction of water supply (such as the cessation of waterings for cotton at the end of March), 300,000 feddans could be cultivated from the reservoir alone and Egypt would suffer no diminution of the then Blue Nile supply even up to July 25. It was also assumed that long before the 300,000 feddans were cultivated, the White Nile dam (see below) would have been finished and Egypt by then would possess

TABLE 34 WATER REQUIRED BY THE 300,000 FEDDANS BETWEEN JANUARY 19 AND JUNE 15

Period	Quantity of Water (M^3)
January 19 - 31	59,000,000
February 1 - 28	127,000,000
March 1 - 31	140,000,000
April 1 - 15	68,000,000
April 16 - 30	22,000,000
May 1 - 31	47,000,000
June 1 - 25	38,000,000
Total	501,000,000

Source: M. MacDonald (1918), op. cit., p. 5

at least 4,000 million M^3 of new storage water (Aswan Dam contained normally about 2,400 million M^3). Of this quantity, a portion could be reserved to make up for any gradually increased use of the Blue Nile. To develop the 660,000 feddans in the Gezira, without at all reducing the natural supply in the Nile between January 18 and June 25, 1,100 million M^3 were to be found, of which 40% could be provided independently at Sennar, and the rest - 630 million M^3 - was to come from reducing the storage of the proposed White Nile reservoir or Gebel Aulia Dam.(72)

Thus, the conclusions MacDonald reached can be summarised as follows:

(i) The Blue Nile, with a dam at Sennar, can guarantee 660,000 feddans of irrigation in the Sudan against the lowest recorded Nile, and 1,000,000 feddans in the next lowest year, and much more in years of average flow. Accordingly, ordinary engineering practice, given enough population, would warrant the undertaking of more than 1,000,000 feddans forthwith.

(ii) The only area to be irrigated then in the Gezira was 300,000 feddans, and this could be irrigated from the Sennar storage without in any way affecting Egypt's supply from the Blue Nile. But before this area had all been cultivated, the Gebel Aulia Dam would have been finished, and when it was thought expedient to gradually extend the irrigated area to, say, 660,000 feddans, this could be done, even during the lowest year, without detriment to Egypt, and this by earmarking 20% of the Gebel Aulia Dam storage to compensate the abstraction from the

Blue Nile. In all other years over 1,000,000 feddans could be irrigated without detriment to Egypt once the dam was completed.

(iii) The stages of these developments could overlap in such a way as to produce ample and continuous security of supply. Thus, before the Sudan could deprive Egypt of any of the Blue Nile water, the White Nile storage could be ready with the bulk of its supply for Egypt and with a small percentage, in excess of Egypt's needs for many years, temporarily available as compensation for any abstraction made from the Blue Nile. So also, before Egypt was ready to use up this compensation water herself, either upper Blue Nile or upper White Nile Works (see above) could provide more storage.[73]

In order to preserve good relations between Egypt and the Sudan, MacDonald suggested that the Sudan should undertake that, until the Gebel Aulia Dam was completed, 300,000 feddans should be the maximum area developed in the Gezira; Egypt should agree that, after the completion of the above dam, 20% of its storage would be earmarked as compensation water to allow the Blue Nile to be drawn on to an equivalent amount by the Gezira for a definite period to be agreed upon by the two parties. After this period, this compensation water would be released to Egypt by the provision of other storage on the Blue Nile, or some arrangement would be made for further utilisation of the White Nile.

These proposals were to solve the difficulties of the period of shortage. For the period of surplus - flood time - Egyptians also feared that the draw on flood waters from the Blue Nile by the Gezira Scheme would be to the detriment of basin irrigation in Upper Egypt, but this risk was reduced by building a barrage at Naga Hamadi (Fig. 48).[74]

It was the publication in 1919 of these proposals that resulted in that immense controversy which finally led to arbitration by the Nile Projects Commission of 1920 (see above). However, in 1925 a new commission was set up which recommended that control over the abstraction of water from the river was to be maintained by volumes and seasons rather than by area limitation, and that this control be exercised by an agreed procedure for regulating the Sennar Reservoir. The procedure suggested was based on a "standard" rather than on a "worst" river, with cover for the exceptional by providing that certain minimum criteria of flow on the river should have been reached at certain dates and should be used to control the rate of abstraction. These recommendations thus enabled the Sudan to increase its irrigated area to any extent it liked, without detriment to Egypt, by economies in water usage within a certain total available quantity both for the period of surplus and that of shortage.(75)

For the unlimited pumping permits for flood irrigation up to the end of February, which had been granted some years before for small areas of perennial irrigation, the Commission, thinking that this arrangement would adversely affect Egypt, decided that the natural flow ought not to be drawn upon by the Sudan after December 31 - which in effect meant that crops like cotton would be restricted to the Gezira Scheme only. To get over this problem, the Commission approved of the existing pumping licences until December 31, and allowed for some extension, not by using the natural flow after December 31 which was to go to Egypt, but by releasing some 150 million M^3 of water, which was especially retained behind the Sennar Dam for domestic use in the irrigated area to be used by the pumps during the period of shortage. The domestic water supply was to be provided by the pumps of the pilot stations instead of Sennar Reservoir.

(i) Sennar Dam Reservoir

The recommendations of the Commission of 1925 meant in effect that until further storage works started the problem of supply over again, all water used by the Sudan during the shortage period - January 1 to July 15 inclusive - was to be recorded in a credit-and-debit account. The credits were as follows:

(i)	Computed Capacity of Sennar Reservoir	781 million M^3
(ii)	Allowance for Evaporation Loss from Reservoir	24 million M^3
	Allowance for Gezira from 1 - 18 January	117 million M^3
	Allowance for Pumps previously approved	143 million M^3
	Total Credit	1,065 million M^3

The allowance for pumps was to cover the 22,500 feddans of perennial irrigation and 38,000 feddans of flood irrigation to the end of February for which permits had already been given.

The debits were:

(i) Quantities Actually drawn off in the Gezira

(ii) Quantities Estimated to have been drawn off by Irrigation Pumps anywhere in the Sudan on the Nile or any of its tributaries.

(iii) Actual Evaporation Loss of the Sennar Reservoir.

The debits were by no means to exceed the credits, and as long as this did not happen, the Sudan was allowed to dispose of her water as she thought feasible.

However, in making the various suggestions, the Nile Commission pointed out that they were devising practical arrangements for the present and near future. For the period of surplus - July 16 to December 31 - for example, it was not a question of depriving Egypt but of going fair shares in using the surplus water. For the Sudan, MacDonald suggested a maximum discharge of 84 cumecs in the main canal as sufficient for the first stage of the scheme. The basis of this calculation was reached by considering two factors: (a) The interval between waterings, and (b) The volume of water required per feddan per watering.(76)

The watering interval for cotton in Egypt was 18 days while the volume per feddan per watering was 450 M^3, which amounted to a requirement of 25 M^3 per feddan per day. But in the hotter climate of central Sudan, the interval was found at the Tayiba Pilot Station to be 10 days and the volume per feddan per watering 600 M^3 or 60 M^3 per feddan per day. However, finding this at variance with all known data, MacDonald chose 50 M^3 per feddan per day as an estimated need for cotton, while for other crops an interval of 20 days was chosen, which meant an estimated need of 25 M^3 per feddan per day. Thus, on a 3-course rotation basis, out of the 300,000 feddans, cotton was to occupy 100,000 feddans, other crops (Lubia and dura) another 100,000 feddans, and 100,000 feddans to be left fallow, and this formed the basis for the formula of water requirements for the crops which was as follows:(77)

Cotton:	100,000 feddans X 50 M^3	= 5,000,000 M^3/Day OR 58M^3/second
Other Crops:	100,000 feddans X 25 M^3	= 2,500,000 M^3/Day OR 29M^3/second
	Total	= 7,500,000 M^3/Day OR 87M^3/second

However, this figure of 87 cumecs was for various reasons reduced to 84 cumecs by MacDonald in 1926.(78)

(ii) <u>The White Nile Projects:</u>

The proposed construction of Sennar Dam, whereby the whole summer discharge of the Blue Nile would be finally absorbed, and the actual commencement of works in 1913 on the Bahria and Gharbia Drainage Projects in the Nile Delta, had prominently brought to notice the necessity of increasing the existing summer supply of Egypt.[79]

Means of increasing supply, as recommended by Garstin, was to be carried out in two places (Fig. 48): (a) At Lake Tana to store part of the flood water of the Blue Nile for the benefit of both Egypt and Sudan, but this had to be omitted as not coming within practical consideration then. (b) Since, for the time, nothing further apart from Sennar Dam could be done on the Blue Nile, except possibly for the Sudan, it was necessary to confine the attention to those works on the White Nile which could be safely constructed and completed within a reasonable time. Other long-term works to increase this supply from this river have already been mentioned above (Fig. 48).[80] For immediate use Garstin also proposdd a dam on the White Nile near its mouth which was to control and conserve the early flood waters of this and the Sobat river for Egypt. Another problem which faced Egypt then was the threat of high floods, and as a protection various schemes were put forward but were unsatisfactory.[81] As a solution, a scheme was eventually put forward, and consisted of the following works: (a) A reservoir dam at Gebel Aulia capable of supplying an adequate summer supply to Egypt for many years, and (b) A diversion channel from the Blue Nile above the Sennar Dam for the conveyance of excessive flood water to the reservoir above Gebel Aulia Dam. However, this last project was made unnecessary by the building of more barrages in Egypt and the increased use of water.[82]

But while the Sudan Government went ahead with its part of the programme, the Gezira Scheme, the Egyptian Government, in view of the heavy estimated cost of the Gebel Aulia Dam and complementary works, had to suspend all operations connected with that project in 1921. The dam was completed in 1937.

Thus, with the main problem of the Nile waters solved, the realisation of the Gezira Scheme only waited for finding proper funds to finance it.

VII PROBLEMS OF FINANCING THE GEZIRA SCHEME:

For a country economically disintegrated and financially bankrupt, providing money to finance such a big scheme was utterly impossible. Thus, the necessary fund had to be procured from outside: Egypt and Britain. Egypt was already preoccupied with her own development schemes and was not, in any case, prepared to assist a scheme that she thought would deprive her of her vested rights in the Nile waters. This left only Britain, and here there were strong reasons to ask for a loan: the periodic shortage of cotton supplies that threatened Lancashire, and the urgent need for new and secure sources of supply within the Empire were too strong to be shunned. The ardent support of the B.C.G.A. and influential industrialists and people to the scheme was strong enough to bring pressure on H.M. Government to grant a loan despite some opposition from prominent people and M.Ps.(83)

Thus, after the approval of Lord Kitchner, Wingate, MacDonald, Webb and M'Clure, the scheme was sanctioned and passed by the British Parliament in 1913. It was then considered to be of such urgent importance to start work in the Gezira at once and not wait until the Government had taken the necessary steps to float the loan on the market to obtain the necessary funds to go ahead with the work. In order to enable the men to start at once and avoid all delay it was arranged in 1913 that the Government should be financed to the extent of £500,000 repayable in five years.(84) But the serious consequence of a failure of rains or flood such as was experienced in 1913, demonstrated the vital necessity for the development of a comprehensive system of irrigation not only with the object of increasing the economic resources of the country but also to render the people secure from the danger of famine.

MacDonald put estimates of the dam and main canal at roughly about £2,000,000 and the minor canals, implements, seed, etc. at £840,000, the first cost to be taken out of a loan of £3,000,000 to be guaranteed by the British Treasury. However, after the war a new estimate in 1919 put the cost of the Gezira works at £4,900,000, and in the face of this situation the British Treasury guaranteed the interest on a Sudan Loan of £6,000,000 (5.5% Guaranteed Bonds 1919-59), to replace the £3,000,000 loan promised in 1913 but never floated.(85)

However, some M.Ps, headed by a Mr. Johnston, pressed that the loan should be conditional on an undertaking that "All cotton produced in the Gezira should be offered for sale in the first instance in Gt. Britain" and "... the possibility of fixing a maximum price at which cotton produced in the Gezira should be sold" to prevent the S.P.S. and others "... to effect a corner in long staple cotton".[86] But the British Board of Trade, to whom the Foreign Office referred the matter in 1924, was careful not to accept this proposal as it might irritate other countries because it was against the "open door" policy in international trade, and because such a step would be inconsistent with the settled policy of the Board of Trade and the British Government to encourage in every way possible the development of cotton growing.[(87)]

However, because of the increased cost of material and labour in 1920, there was a need for more funds in order to complete the works which was suspended during the war. But, to the great disappointment of all, the high cotton prices during 1920 and before fell from 45d per lb. in this year to the slump figure of 8.5d in 1921. After hard bargaining and considerable discussion, supported by a thorough report on costs, the British Treasury agreed to guarantee the principal and interest on a further loan of £3,500,000. Moreover, supervision of the work from the Irrigation Service in Egypt was transferred to the Sudan and work continued again. Furthermore, under the Trade Facilities Act of 1924, the amount of £3,500,000 guaranteed in 1922 was increased to £7,000,000 which, together with the £6,000,000 loan of 1919, brought the whole sum to £13,000,000. Of this amount £400,000 was lent to the S.P.S. to erect ginneries, and £700,000 was allocated for railway extension, the cost of the dam and canalisation of the 300,000 <u>feddan</u> area (Fig. 46) amounting to about £11,500,000.[(88)] Thus, the harnessing of the Blue Nile and with it the hopes of thousands of Sudanese for a brighter future came into being.

In this connection, we must remember the smaller chances in those days for raising private capital to temper, as Gaitskell put it, "Nostalgia for the low capital costs of the pre-1914 era ... when enterprise still originated in the audacity of a few friends and private firms willing to risk substantial sums from their pockets on fairly hazardous hopes."[(89)] It was in this form that private capital first participated in the agricultural development of the Sudan, and indeed this development had been so closely linked with the S.P.S. that a brief account of its financial history is deemed necessary.

The formation of the S.P.S. goes back to 1904 when the enterprising American, Leigh Hunt, visited the Sudan and came back impressed with the country's potentialities as a cotton producer (see above). He formed the company with an original capital of £80,000 and received a large concession at Zeidab to grow cotton.[90] But after unsuccessful attempts, he gave up the idea and sold his shares to a group of people who, in order to effect a profit, changed from direct cultivation to a tenancy system (see Chapter Six and Seven). With this new policy, the capital was increased in 1910 to an authorised £25,000, £50,000 shares being issued at a substantial premium of £3, while £68,000 shares of £1 each, destined to be issued at a premium of £4, and £25,000 at £5 per share premium, were held in reserve until the end of 1913. Later the shares of the company were the subject of much speculation, rising at one time to £8, and falling as low as £4 apiece (Table 38 App. 38).[91]

Nevertheless, the issued ordinary shared capital in 1914 stood at £135,000 while the debenture issue amounted to £57,000. The shareholders in 1913 received a distribution at the rate of 12.5% for the second year in succession; for the years 1914 and 1915, however, the dividend distribution was reduced to 5%. But during the war, the high prices of cotton spelled its fortunes, the only fluctuations being caused by low yields (Chapter Seven).

Despite these hazards, the S.P.S. continued, spurred by a strong belief that in the end everything would come alright, and it did for the benefit of the shareholders and the country alike. For it was through their agricultural experience that the Gezira Scheme came into being. Thus, while the S.P.S. attended to vital minor matters, the Government was left with the more important problems, such as the provision of efficient means of transport and handling ports without which the whole scheme would have been futile.

VIII TRANSPORT PROBLEMS AND RAILWAY DEVELOPMENTS 1867-1925 (Fig.50)

In a vast country like the Sudan, with its productive areas scattered widely and loosely linked with each other by the slow and inefficient camel transport, the need for an efficient means of transport can hardly be ignored. The stringent need for quicker means of transport to develop the country economically was first recognised by the Khedive Ismail in the 1870's, and although he failed, his project laid down the essential principles which, during the Condiminium rule, were to govern railway building in the Sudan: to connect Khartoum with Cairo, to provide an outlet to the sea for trade by railway, and to link the productive parts of western Sudan with the rest of the country.

However, difficulties in connection with transport and supply were the main obstacles to the rapid progress of the army during the reconquest campaign in the Sudan (1896-98). Similarly, the absence of facilities for communication stood in the way of developing that portion of the country where peace and order already reigned. "It cannot be doubted that railways constitute perhaps the greatest want of the Soudan. Nevertheless, in this as in other matters it is desirable to proceed with deliberation."(92) Accordingly, the first question to decide was what direction the railways should take, and which, amongst various projects that might be supported by more or less valid arguments, called more urgently for prompt exertion. Thus, from the outset, the importance of railway was stressed.

The first line envisaged by the conquering army, however, was to follow the Nile valley from Halfa to Dongola and then across the Beyuda Desert to Metemma on the Nile opposite Shendi (Fig. 50). But this was rejected after laying down 200 miles because this line, even if improved and re-laid, could never adequately serve as the main artery of communication between the Sudan and Egypt. Again, instead of a line from Suakin to Berber, the best alternative but still half-occupied by the Mahdists and infested by raids, a railway across the Nubian Desert from Abu Hamed, in the bend of the Nile, was chosen. This latter, contrary to the other two, offered no high hills or steep gradients, but was waterless.

Work on this railway was started from Halfa in January 1897, and because of delays in this harsh desert conditions, the line did not reach Abu Hamed until October of the same year. But the cumbersome change of modes of transport between camel, boat and railway between this terminal and Berber, made extension of the line further south a matter of great importance. Thus, by July 1898, the railhead reached Atbara, and the bridge on the river Atbara was completed in August 1899. But before building it, the line crossed the dry bed of the river by a culvert of wooden baulks and piles, and the railway depot with sidings and workshops was established on the south bank. By the summer of 1899 the railway reached Shendi and by the end of December the rails were laid up to the bank of the Blue Nile, and thus Khartoum was put within five days' journey of Cairo. Along the Nile, Kerma was linked with Halfa in the north. However, a big problem still remained: Halfa was 900 miles, and Khartoum 1,500 miles, from the nearest sea port by the

Nile valley route. The development of the resources of the Sudan obviously needed a shorter and better route to the sea.

To this effect, initial steps were taken in 1901 for the examination and selection of a suitable route. The first choice was the Suakin-Berber route which was the subject of consideration during the 1870's and 1880's, and along which some miles of railway had already been laid down when the Mahdists occupied the hinterland. But due to steep gradients and shifting sands along this route, it was rejected in favour of another with gentler gradients. The aim of the surveyors was to find, on the seaward side of the watershed, a route which ran parallel to, and not across, the direction of the main range of the Red Sea Hills. Such a route was provided by the Sinkat valley and after preliminary surveys, work was approved and Suakin was chosen as a base. The choice of Suakin, despite its coral-studded, narrow and tortuous entrance, was because it was known to the shipping community, had a fair supply of water and a market to supply the needs of the works. Thus, work started in 1903 and by September 1904 laying tracks began from Suakin. From the railhead at Atbara, the line was also being laid eastwards, and by October 1905 the two railheads met at a point 120 miles from the Nile, and thus, for the first time in history, the Nile valley was linked with the Red Sea by railway.

However, Suakin soon proved to be too small for modern ships and another port was established 35 miles north of Suakin in an inlet called Sheikh Berghut. Re-named Port Sudan, it was linked by railway with the Nile valley and this was followed by construction of deep sea-quays, warehouses, government buildings, lighthouses, and thus it gradually began to develop into a spacious, well-equipped port.

In the meantime, the Kerma line was dismantled in favour of a new line connecting Dongola Province with Abu Hamed, the village of Kereima being chosen as the railhead (Fig. 50). Thus, Khartoum was connected with its sea port by a direct railway, the line to Halfa gave direct access to Egypt, and the new Kereima line served the needs of Dongola.

South of Khartoum, the White Nile was navigable all the year, while the Blue Nile was for only six months, and so all produce from the Gezira and also Kordofan came by boat to Khartoum. However, for the development of the great resources of these areas, the extension of the railway system south of Khartoum was of first necessity, and in this respect the first task was to build a railway bridge across the

Blue Nile at Khartoum. This was completed in 1909 and the extension of the railway southwards was started later the same year. However, the physical conformation of the northern Gezira is such that the low watershed between the Blue and White Niles lies generally within a few miles of the former. It was, therefore, possible to select a route for the railway on ground immune from the risk of damage by flood and at the same time close to the villages and the fertile land adjoining the river. The line was pushed on from Medani to Sennar, and then south-westwards across the southern Gezira to a village on the White Nile, 200 miles south of Khartoum. After a bridge was built across the river, the line was extended to Kosti, and at the end of 1911 to ElObied in Kordofan to be followed by a great increase in the export of gum arabic and trade in general.

In the Gezira, building of the Sennar Dam was commenced after the war, and the Kassala railway, also suspended because of the war, was started and by 1924 the line reached Kassala town, thus linking the fertile Gash Delta with Port Sudan. The final step in the development of the Sudan railways system was the extension of the Kassala line south to Gadaref and thence across the Blue Nile by the Sennar Dam and northwards to a junction with the main Gezira line from Khartoum.

Thus, the problems of time and distance, which had hindered the trade of the country for centuries, were solved. However, the Sudan had to produce crops of high value per unit of weight in order to establish a footing for such crops in the competitive markets of the outside world. This had already been realised by the authorities who were bent on growing cotton of fine quality that would profitably pay the cost of transport.

The building of this railway system was not, as was common in those days, done for strategic reasons - in which case the mother country (Britain) would have paid the necessary fund - or by private enterprise in return for land concession. Instead, the necessary fund was obtained by appropriations from Egypt - an investment fund or loan repayable without interest. In this respect the building of this railway gives a typical example of the unremunerative level of development without which the remunerative level could not be undertaken, but which a poor and undeveloped country like the Sudan could not finance on bakers' loan.

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21. Asia covers India, Japan and China, and consumption in China is based on private estimates, and in most cases China was only consuming her own native cotton.

22. This would have been greater but for the Bombay strike in 1925. See J. Todd (1924), op. cit., Table 1, p. 35

23. W.H. Himbury, "The Part Played By Our Empire in the Production of Raw Cotton", British Cotton Growing Association, vol. cv (1927), p. 16.

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    Indeed after World War 1, as a result of the growing movement for independence in Egypt, Britain could no longer depend on Egyptian long-staple cotton. Hence the Lancashire Cotton Spinners' Association, in its quest for a dependable source of supply, started a giant plantation near Scott, Mississippi. However, because of the bollweevil their hope of growing long staple cotton was thwarted. (Fortune, March (1939), pp.125 F)

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28. The West Indian Sea Island crop dropped by 1931-32 to about 1,200 bales, and despite the short resurgence during the 1939-46 war because of demand for baloons and parachutes, the production fell to a modest 2,000 bales.

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31. Similarly, the King of Italy initiated the International Institute of Agriculture to deal with all crops of the soil.

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36. "Memorandum on the Control of the Egyptian Cotton", Box 156/1 Sudan Archives (Oriental School Durham). It was known that cotton was being smuggled to Germany via Switzerland and Genoa, and to stop this smuggling, licences were issued to countries importing Egyptian cotton, each country being allotted a certain quantity on ration basis. In 1918/19, U.K. was to import 450,000 bales; U.S.A. 150,000; France 50,000; Italy 50,000; Switzerland 30,000; Japan 30,000; Spain 20,000; Portugal 1,000 and Greece 7,500.

37. Prices were to be fixed in relation to prices for American cotton. For Sakel type a sale price at Alexandria of 48 dollars to the bale was thought to be suitable. (Report to the Board of Trade of B.C.G.A. (1920), p.11)

38. Box 156/2, Sudan Archives (Oriental School, Durham). When the purchase of Sudan cotton of 1918/19 crop was refused by the Egyptian Commission which hitherto was responsible for its marketing, the B.C.G.A. instead passed a proposal for a control to be invested in a local committee appointed by the Sudan Government with powers to purchase all cotton and cotton seed at a price based on delivery at Port Sudan and about 10,000 bales were shipped from Port Sudan instead of from Alexandria.

39. Report to the Board of Trade (1917), Appendix II, Article C, p. 53

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R.R. Anson, "Local Cotton History in the Sudan, 1942-46". ibid, vol. XXIII, No. 2 (1946), p. 80

M.F. Rose, "Cotton Research and the Development of the Commercial Crop in the Sudan", ibid, Vol. 36 (1959), p. 252

51. The reason for this practice is somewhat obscure but undoubtedly it was bound up with the build-up of blackarm in the main propagation areas which necessitated a "refreshing" of seed from outside source. Blackarm, though present in Egypt, is a disease of minor importance, and it can be assumed that seed-borne infection was very light, such importations would thus constitute an indirect method of control.

52. Sakel in fact dates back from about 1907 and is the best, but not the most recent, of a series including Joannovitch, Nubari, Afifi, and others now little more than names. Before the inauguration of the Sennar Dam in 1925, the supply was Deltaic Egypt, i.e. from the Delta, in 1919 in a report to the Egyptian Gocernment on the methods to be employed to maintain the staple of Egyptian cotton, the importation of seed of the short staple types, such as Ashmouni and Zagora, from Upper Egypt into the Dela was forbidden, and the Domains were carefully employed in a direct and very successful effort to maintain the standard of Sakel.

53. "Sudan Irrigation; Part I (1917)", Box 112/4, Sudan Archives (Oriental School. Durham)

54. ibid.

55. P.E. Martin, op. cit., p. 307

56. "Sudan Irrigation, Part II (1917)", Box 112/7, Sudan Archives (Oriental School, Durham)

57. M. MacDonald, "A Note on Colonel Kennedy's Proposal for Irrigation of the Gezira by Means of a Dam at Roseires", Box 112/7, ibid

58. MacDonald's preduction that "It is quite true that in a survey of ultimate future of the Nile there is the possibility of Roseires becoming the site of a dam", came true in 1967 when the Roseires Dam was completed.

M. MacDonald, "A Note on the Blue Nile Weir and the Gezira Scheme", Box 109/4, Sudan Archives (Oriental School, Durham)

59. H.M.S.O., Reports on the Nile Projects Commission (1920), p. 5

60. Cmd. 3348, Treaty Series No. 17 (1929), p. 6

Arthur Ransome, in The Manchester Guardian, 15 May (1925)

61. Matters Relating to Egypt and the Sudan, Bulletin No. 1 in Box 109/8, and Bulletin No. II, in Box 109/9, Sudan Archives (Oriental School, Durham). 1 Ton of Water is 224 gallons = 1 M³. approx.

62. The Morning Post, February 26 (1919)

M. MacDonald, "Nile Control Proposed Works", Box 109/5, Sudan Archives, (Oriental School, Durham)

63. Minutes of Evidence, Nile Projects Commission, Part I and II (1920)

"The Blue Nile Projects", Box 109/7; "Reports on the Method of Taking River Discharges through the Sluices of the Aswan Dam", Box 109/10, Sudan Archives (Oriental School, Durham)

64. L.A. Fabunmi, The Sudan in Anglo-Egyptian Relations, 1800-1956 London (1964), pp. 114-26

Mekki Abbas, The Sudan Question, London (1951) Chapter VII

A. Gaitskell, op. cit., pp. 120-125

65. Arthur Ransome, op. cit.

66. H.G. Lyons,"The Anglo-Egyptian Sudan", Scottish Geogr. Mag. Vol. 27 (1911), pp. 255-6

H.M. Cadell, "The Development of the Nile Valley, Past and Present", Scottish Geographical Magazine, Vol. XIX (1903), pp. 230-38

67. "Sudan Irrigation Report, Part I (1917)," Box 112/6 Sudan Archives, (Oriental School, Durham)

68. M. MacDonald, Computations Relating to the Note on the Water Supply Required and Available for the Sudan Gezira Scheme, Government Press, Cairo (1918), pp. 3-12

69. M. MacDonald, Note on the Water Required, op. cit., p. 3

70. Computations (1918), pp. 43-46

71. M. MacDonald, Note (1918), op. cit., pp. 5-6. The requirements of the 300,000 feddans during this period is 601,000,000 M^3, calculated on the assumption that the rotation, water intervals, crops and amount used per feddan per watering, would be as per data supplied from the pilot schemes. Later experience of economising water together with a changed rotation and greater storage capacity at Sennar, was to show that the reservoir could suffice for a much larger gross area.

72. M. MacDonald, Computations (1918), op. cit., p. 8

73. ————, A Note (1918), op. cit., p. 7

74. ————, The Nile Control, Government Press, Cairo (1919)

75. Nile Commission Report, 1925, Clause 17

76. ibid. Since the volume of water needed to irrigate the Gezira Crops had not yet been determined, it was essential for MacDonald to have some figure upon which to base his work.

77. M. MacDonald, The Nile Control, p. 21

78. In 1936, this figure was increased to 168 cumecs. Over years however, it was found that the average water intervals for cotton need not be as close as every 10 days nor the volume as high as 500 M^3 per feddan per watering. Similar economies applied to other crops and these economies enabled the area to be so greatly extended and the Commission's settlement by volume of water rather than by land area to be so beneficial.

79. "Sudan Irrigation, Part I (1917)", Box 112/9, Sudan Archives, (Oriental School, Durham)

M. MacDonald (1921), op. cit., p. 12

80. W. Garstin, op. cit.

H.E. Hurst (1951), op. cit., p

Board of Trade Committee on the Growth of Cotton in the British Empire. Evidence No. 1 (1917), p. 12

M. MacDonald, "Note on Col. Kennedy's Proposals for Control of the White Nile", Box 122/4, Sudan Archives (Oriental School, Durham)

F. Newhouse, op. cit., pp. 10-14

81. "Sudan Irrigation, Part i (1917)", Box 112/6 Sudan Archives, (Oriental School, Durham)

M. MacDonald, A Note on the Blue Nile Weir and the Gezira Scheme, Ministry of Public Works, Cairo (1915), pp. 1-4

82. M. MacDonald, Note on the Water Required (1918), p. 6

Board of Trade Committee (1917), p. 12

The date and volume schedule in the flood season was modified so that the Gezira should not draw more than 126 cumecs before 1936, in view of further delay in the construction of the Gebel Aulia Dam. By arrangement with Egypt in 1936 the Gezira was to reach its total entitlement of 168 cumecs in 1940. In the event, the final watering of the main canal to take this discharge was only completed in 1956.

83. Cmd. 2171 (1924), p. 3

84. Board of Trade Committee (1919), p. 15

85. Cmd. 1837, p. 4

A. Gaitskell, op. cit., p. 74

86. Cmd. 2171 (1924), Correspondence No. 1

87. ibid. Foreign Office to Board of Trade, Feb. 29 (1924), p.4
Board of Trade to Foreign Office, March 14 (1924), p.4

88. A. Gaitskell, op. cit., p. 93

89. ibid, p. 75

90. P.E. Martin, op. cit., p. 293. Of this total Wehner Beit and Co. took £14,000 shares, Leigh Hunt £19,000, Other Americans £18,000, de Chastillion £10,000, and two Irishmen £1,000

"S.P.S. Memorandum and Afticles of Association", Box 415/7 Sudan Archives (Oriental School, Durham)

91. "S.P.S. Reports and Accounts, 1910 and 1912", Box 415/7 Sudan Archives (Oriental School, Durham)

A. Gaitskell, op. cit., p. 75

Schuster, "Memorandum on the future financial position of the Sudan as it may develop in consequence of a resettlement of political status of the country and its financial relations with Egypt", July (1924)

92. Accounts and Papers, Vol. CXII (1899), pp. 3-5

CHAPTER SIX

DEVELOPMENT OF COTTON GROWING IN THE TWENTIETH CENTURY - II

In the previous chapter we have discussed the motives behind cotton growing in the Sudan, and some of the various problems which had to be solved before embarking upon the main scheme itself. Now we can proceed to discuss the remaining problems, namely, marketing, provision of credit and security, and land settlement, and how each one was tackled.

I MARKETING PROBLEMS

The biggest problem that faces developing countries is to find markets for their home products. For a colony, this problem is solved by the mother country which takes the responsibility for marketing these products either in other world markets or its own home market. With independence, and its complications of nationalism and assertion of economic freedom, the problem is inevitably intensified. The country is not only to find how to get its products accepted at all in trade, but also to find serious competition from those countries which produce similar items and which have already secured a firm footing in the world markets. It has to cut in on the existing organisation of supply, and with a primary commodity in world trade such as cotton, the marketing system is quite often too complex and impregnable for a developing country to easily break through.(1) Thus, it may be quite common that such a country has to depend on local merchants who might lack interest or experience of the crop and would require a middleman's remuneration, and have mutual understandings which are quite often detrimental to the producer's interest.

However, the Sudan was fortunate in this respect. As already stated in the previous chapter, prospects for Sudan cotton were high, and indeed from the beginning the Lancashire merchants showed a profound interest in the development of the Gezira Scheme. Moreover, the B.C.G.A. bought shares in the Sudan Plantations Syndicate and was given a seat on its Board.(2) The B.C.G.A. was also pursuing a similar policy of encouraging cotton cultivation in other parts of the Empire. In the Sudan, besides supplying expert advice and machinery, the B.C.G.A. undertook to act as a marketing agent for the Sudan cotton on a small commission. This was indeed a great advantage since cotton from the Sudan was to be handled by a body of the highest standing and esteem, and introduced to the competitive Liverpool market under its auspices. This was undoubtedly of vital importance since it helped to overcome the natural reluctance of spinners to change from already established connections and to alter their machinery and try new varieties of cotton - an expensive change and adaptation which would have nipped the new scheme in the bud. Thus, to persuade the spinners to take up the Sudan cotton, the B.C.G.A. adopted a technique of having, ready at store in Liverpool, sufficient stocks to enable the spinners to choose lots which suited their particular yarns at times when they wanted them, and the first system of marketing adopted in this case by the S.P.S. was to consign all cotton to Liverpool to the B.C.G.A. for sale on commission.(3)

This system was adopted until the Gezira Scheme was launched in 1925, when the desirability of developing, in addition, sales by auction came up for consideration. Nevertheless, it was agreed that the responsibility for sales management be given to the S.P.S., which had to consult the Government in this matter. However, it seems that Sudan cotton used to be shipped via Alexandria until 1918-19 when, as already mentioned, shipment from Port Sudan started because of the Egyptian Cotton Commission's refusal to purchase Sudan cotton of that season.(4) However, the going was not as easy as it seems, especially before the out-break of the 1914 war.

It was frequently urged that, in view of the undoubted difficulties then (1914-15) attached to the export of dura, and the absence of any prospects for the shipment of wheat in the near future, agricultural effort was to be concentrated on the production of such crops as cotton, which had high value as compared with weight. The position of the Sudan and Egypt in this respect, it was maintained, was unassailable in the market of long-staple cotton other than Sea Island. Unfortunately for this contention, the President of the Fine Cotton Spinners and Doublers' Association, who visited the Sudan in 1913, pointed out that Brazil, Peru, Georgia and several States of America producing long-staple Upland cotton, were then competing on more than equal terms with Afifi, Ashmouni and Sakel cottons of Egypt. He wrote, forwarding samples, that "the J.H.P. Brazil is a dirty kind of cotton but useful, better in every respect, except dirt and waste, than Ashmouni from Upper Egypt. The long-staple American again is in many respects better than Afifi, though also neppy and wasty. The Georgian's compete with Sakel, and the West Indian is of course better than anything grown in Egypt".(5)

In view of this direct and growing competition, the question of relative costs of production and marketing necessarily become of vital interest. These varieties of cotton mentioned above were grown almost exclusively under rain-cultivation, and from this standpoint, the deltaic areas of the Baraka and Gash were alone in a position to complete on equal terms. But, in addition to the handicap of a heavy water bill, the irrigated smaller cotton estates along the main Nile and in the Gezira, had to meet charges for transport which definitely reduced any enterprise to the character of forlorn hope. It should also be remembered that a large proportion of cotton from the main Nile estates was being produced at a loss, while the abandonment of considerable areas was evidenced by the official returns of cotton cultivation.(6)

It may be appropriate in these circumstances to compare the proportion of the value of cotton which went to the producer, the middlemen, the railways and the steamers, in America and the Sudan. Thus, for example, for one cent per lb., many interior towns of North Carolina, as a typical cotton State, could put cotton into the ordinary course of transit, and deliver it through port of shipment in England or on the Continent at the consumer's mill. In shipping cotton to Japan by way of Galveston, the distributor did the work for about 5.3% of the cost to the consumer in Japan, and got 94.7% of the cost to the consumer. At a period of high freight rates on ocean trade, a pound (lb.) of cotton was carried from New Orleans to Chemitz, Saxony, direct to consumers, for the combined expense of 1.25 cents.(7) With this statement may be compared the freight charges on a consignment of cotton shipped from Khartoum to Liverpool, and sold through the agency of a local bank, in 1914. The cost of this consignment to the consumer was £E.837, the producer's share was £E.690, or 82.4%, while 3.7% went to the railway, and a similar share to the steamship company, and no less than 10% to the middleman.(8) This can be attributed partly to the absence of organised markets in the country and the lack of an adequate system of distribution which, in the absence of reputable commercial firms in the Sudan then with a command of capital and a standing on the European markets, constituted serious drawbacks to commercial as well as economic development, particularly rural development.

The problem that faced the Sudan cotton, under these circumstances, was how to be accepted in the world market - to make a name for itself before buyers would give the same price for it that they would readily give for Egyptian cotton of the same grade. Buyers at Alexandria and Liverpool were in 1900-3 to remember handling Sudan cotton of the Turkish period (from the 1870's to 1883). Shaking samples over paper, they used to remark, "Sand! desert sand! I know that sort - comes on camel back across desert", and forthwith drop the sample, though at first glance ready to offer a fair price for it.(9) Moreover, the Joannovitch and American cottons from the Sudan had at that time lost their quality, and in fact the latter could find no market in Alexandria except for mixing with the low grade Upper Egypt cotton for the Continental markets.

Before building the railway line to the Red Sea, Sudan cotton was ginned and marketed in Egypt, and the cost of transport per kantar of 315 lb., sent through an agency to Egypt, was as follows (Table 35).

TABLE 35 TO SHOW COST OF A KANTAR OF 315 LB. TO EGYPT, 1901-2

	Cost (mms.)
Freight from Shendi to Halfa by railway	368
Freight from Halfa to Aswan by boat	96
Freight from Aswan-Beni Suef by Egypt railway	301
Commission and Porterage, Shendi, Halfa, and Aswan	96
Total	861

10 mm. = 1 P.T. = 2½ pence. Source: Accounts and Papers (1902), p51

However, buyers at Suakin were ready to take Sudan cotton as it was taken at Alexandria if the railway line to Suakin was completed which, they argued, would effect an economy of 50 P.T. in carriage. Thus, comparing the financial aspects of cotton growing in Egypt and Sudan, the lack of quality in Sudan cotton, representing a loss of about one to two pounds per feddan, (or about 1½ dollars below Egyptian price for every 4 kantars), was not relatively so important as the cost of carriage and the price of fuel for water-raising purposes.[11]

These conditions, as stated in the previous chapter, were ameliorated with the advent of the railway to Suakin and then to Port Sudan in 1905. But to discern the difference in cost of production, a rough estimate of the cost of cultivating one <u>feddan</u> of cotton in Egypt and the Sudan, and the carriage of its produce - about 4 <u>kantars</u> - in the case of the Sudan to Egypt before and after the extension of the railway to the Red Sea, were worked out as shown in Table 36. The price for carriage is for unginned cotton since no ginning factory had yet been established in the Sudan. However, nothing is included for irrigation in Egypt, though on many estates charges for pumping would amount to £E.1 per <u>feddan</u>, or even more.[12] The estimate of irrigation in the Sudan is based on an oil engine using petrol at 22 P.T. per tin (of 4 gallons) before, and 3½ P.T. per tin after, the

TABLE 36 ESTIMATE OF COST OF CULTIVATING ONE FEDDAN OF COTTON IN EGYPT AND SUDAN, AND CARRIAGE OF PRODUCE AFTER AND BEFORE SUAKIN RAILWAY (1901-3)

Items	Egypt	Sudan, Cost in P.T.	
	Cost in P.T.	Before Railway	After Railway
Labour, cultivation, seed, etc.	250	300	300
Irrigation	-	300	200
Carriage of 4 <u>kantars</u>, unginned	-	350	150
Rent, i.e. interest of capital, value of land	500	50	50
Total	750	1,000	700
Value of 4 <u>kantars</u> at 12½ dollars (Novem. 11, 1902) & 40 P.T. for seed = 290/ <u>kantar</u>	1,160		
Value of 4 <u>kantars</u> at 12½ dollars & 40 P.T. for seed = 265 P.T./kantar		1,060	1,060

Source: <u>Accounts and Papers</u>, 87 (1903), p. 94

projected railway - an equivalent to 5½ and 3½ P.T. per gallon respectively. Railway carriage is to Beni Suef in Egypt as it was the nearest ginning factory then.(13) So, under such conditions, it paid the cultivator better to sell his cotton locally at the price of 150 P.T. per kantar rather than to incur the heavy cost of carriage to Egypt.

With completion of the railway to the Red Sea and the coming in of the S.P.S. as a private enterprise ready to invest money in cotton production, and the ardent support and active participation, of the B.C.G.A., conditions greatly changed as noted above. Nevertheless, unclean picking, lack of strict classification and grading, together with bad handling of cotton in rebaling compounds, practised widely in Tokar before 1915, were to be eliminated before the reputation of Sudan cotton was irreparably tarnished in the eyes of buyers, and also for the cultivators to obtain a more constant price, and, of course, to enhance the value of the crop produced. To help bring this, the need for creating incentives for the producer by assisting him with credit, was considered of paramount importance.

II CREDIT AND SECURITY

It is generally recognised that the small owner or tenant must be able to obtain credit, and that his command of borrowed capital will be determined by the security he may be able to offer. However, a proper assessment of the role of credit is often difficult to make, and there are examples where liberal credit acted as disincentive, and others where development efforts were handicapped by lack of, or access to, credit.(14) But, in general, savings for investment in agriculture can be generated where enough land is available, where ecological conditions are favourable, and where a profitable cash crop can be grown. In other cases this initial saving may be generated from wages or other jobs such as trade; but this investment, in the first place, needs favourable political conditions, which can provide incentive and assurance to the peasant that what he toils to grow will be to his own benefit.

In the Sudan, as already noted in Chapters Three and Four, agricultural conditions during the Turkish and Mahdist period, were so oppresive that many peasants left their lands and took to trade, either as pedlars or assistants to others, who were mainly aliens. The money procured through trade was not invested in agriculture but in any other lucrative trades. Moreover, the attitude of many Sudanese towards agriculture, in general, as an inferior job worthy of slaves has a bearing on this aspect. However, this attitude should not be taken as a deep-seated aversion to agriculture as it is; on the contrary, in the first experimental estate for cotton growing established at Zeidab in 1904, it proved that, given the necessary agricultural means and incentive, the Sudanese, especially of the riverine areas, could be converted into farmers capable of efficiently tilling the land, and of ardently following advice and agricultural help offered by the Government.(15) The fact that the success of cotton as a cash crop was first proved in Berber Province and later in the Gezira, both of which, during the Turkish and Mahdists periods, were depopulated and economically ruined because of excessive taxation and maltreatment, bear evidence to what is said above.

However, the burden of taxation on the development of agricultural holdings is enhanced by the absence then of any adequate loan fund, or the machinery for loan administration. Agricultural credit in the Sudan was very difficult to obtain for the smaller farmer except at an excessive rate of interest.(16) An extension of irrigation farming to areas beyond the range of the primitive saqia, but within the radius of modern pumping machinery, was thought to be determined by the possibility of exploiting freehold title as security for loan capital. But a way of achieving this had to be devised and this was soon found.

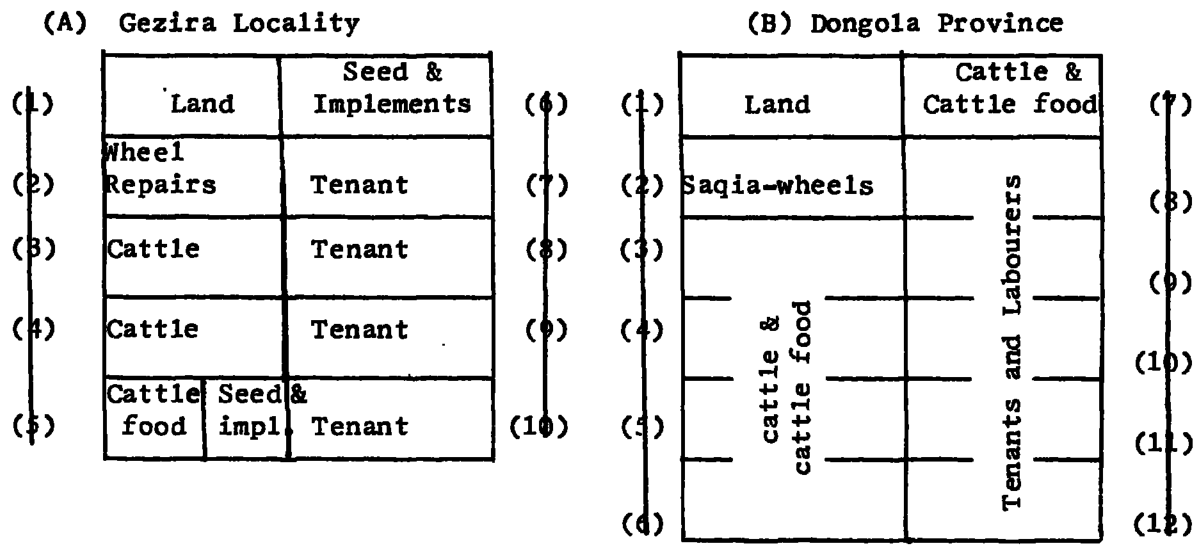
The first lessons on tenancy system were taught at Zeidab in 1909, when deficient water supply, costly transport, shortage of labour, and lack of skill, enterprise and inclination on the part of labourers, made direct cultivation unremunerative. Thus, force of circumstances here compelled the acceptance as leaseholders of cultivators who, in the majority of cases, could offer no quid pro quo for extensive advances on their account. The tenant taking up new land, had to clear it first from bushes and roots for which he obtained a fixed price. He then received oxen and implements in order to level the land or, if the soil was very heavy, it was worked first by the steam plough belonging to the S.P.S. The cultivation was then begun, and the tenants received advances every fortnight in proportion to the quantity and quality of their work. These advances were made on account of the crop to be gathered, and no interest was charged on crop advances. Thus, as the land was let and the water supplied to the tenants without security, and as the latter received, in a majority of cases, cattle, implements, and seed on loan, the incidence of risk was entirely on the S.P.S. (Appendix 44).[17]

This experiment started with 10 Egyptian <u>fellaheen</u> in 1906, and the number of tenants increased to 25 in 1907, and to 102 in 1908. By 1910, out of a total number of 381 tenants, over 200 were Sudanese from the locality, 100 Egyptians, 16 Greeks, 2 Syrians, and one Austrian.[(18)] This system of tenancy association of capital, management, and local cultivator was later to become the basis of the Gezira Scheme. However, in 1908, another method which entailed co-operation with the freeholders, was adopted. In this respect, it was assumed that, with surplus capacity from its pumps, the S.P.S. offered, after encouragement by the Government, to extend its water for a rental charge to natives owning 1,400 <u>feddans</u> nearby along the river bank, in place of their <u>saqias</u>. This was an alternative for more equitable distribution of risks whereby the owner of the <u>saqia</u>-land was furnished with water and facilities for the handling and marketing of his crops in return for fixed payments. Regarded as an effort to introduce an element of co-operation into local agriculture, this system was essentially based on the security afforded by freehold title of water supplied on credit and for such loans as may be needed by the landowner for the development of his holding. But, despite advancement of loans repayable after harvest for clearing the land and digging the new water channels by the Government, and provision of cotton seed free of charge, this system turned out later to be disappointing. A bad crop caused the landowners to lose interest in the system and refusal to pay the S.P.S. for water supplied by its pumps.[(19)] But the experiment was later of great significance in determining the form and kind of partnership that was to govern the Gezira Scheme.

Thus, when the first experimental station was established at Tayiba in the Gezira in 1911, the same rental system practised at Zeidab was introduced here for two years. The rental, which was to cover land, water rates and tax, was experimentally fixed at £E.2 per <u>feddan</u> for the first season (1911/12) and raised to £E.2½ per <u>feddan</u> for the second season (1912/13).[(20)] The loss of £E6,000 incurred by the Government for the two years necessitated a raise in the rent to see what revenue they, and also the tenant, would expect for her future capital investment. At Zeidab, however, the rental system showed no improvement, and the income from rents alone were found out to be far from profitably covering the capital investment despite the higher rental charges, which amounted to £E.4 per feddan for cotton, £E.2½ for wheat and £E.1½ for fodder crops. However, even if the whole 10,000 feddans were let, all rent was estimated to amount to £E.24,000 per annum, while the running costs and depreciation of the station ran as high as £21,000.(21) Coupled with poor yields frequently obtained due to climatic vagaries and plant diseases, the results were discouraging for the peasant, and foreshadowed forlorn prospects for the S.P.S. at the time.

Thus, chances of obtaining beneficial returns under rental system for both the capital investor and the peasant, were remote, and moreover, past experiences of rental schemes in Egypt clearly pointed to the fact that this system would not work in the interest of any of those concerned, particularly the peasants whom the Government was keen to protect.(22) Therefore, an alternative had to be sought, and was found in the customary native practice of dividing the crops into shares among the landlord, owner of the saqia, and the labourer (see Chapter Three). According to this system, the saqia worked, with some differences according to locality, in the following basis: each factor of production getting a definite share of the crops. In the Gezira locality (Diagram A), land got one-tenth of the crop; saqia wheels and repairs one-tenth;

SCHEMATIC DIAGRAM OF CROP SHARE ON 5-FEDDAN SAQIA-HOLDING



cattle two-tenths; cattle food two-thirtieth (i.e. two-thirds of one-tenth) seed and implements one-thirtieth + one-tenth, which together with cattle food were allotted two-tenths of the crops; and tenants, i.e. labourers, four-tenths or 40% of the crop. In Dongola Province (Diagram B), the owner of the land took one-twelfth of the crop as his share, the owner of the saqia-wheels one twelfth, the owner of the cattle, who also provided the cattle food, took five-twelfths, and the tenant labourers five-twelfths, which is equivalent to 41.6% of the crops, and they supplied any seed and implements required.(23)

This system of share-partnership was adopted as a basis for the development of the Gezira Scheme when completed. Meanwhile the pilot station at Tayiba afforded the opportunity for the trial of this co-operative system. Organised with the view to determine the commercial possibilities of the Gezira plain as a cotton area, this station was administered on behalf of the Government by the S.P.S. The Government provided land and water, and received 35% of the proceeds of the crop; the S.P.S. provided the financing, supervision, and management, and received 25%, leaving 40% to the tenants. Thus, the Government supplied the former capital assets under the saqia system, while the working tenants place was taken by the tenant cultivator.

This bold attempt, as Sawyer put it, "to cut the Gordian Knot" of credit, tenure, and administration had the all important merit of simplicity, and pending the education of the tenants in cotton cultivation, their accumulation of a capital reserve and the organisation of a local cotton market, the arrangement may be considered equitable. Moreover, the system was understood by the natives, and provided a mutual bond in adversity or in success for the Government and the peasant, on the one hand, and for the former and the S.P.S. "by passing on some of the Government's share in return for technical management and for relief on some of the capital obligations", on the other hand.(24)

III LAND SETTLEMENT

Land settlement is the systematic recording of plots of land and of the various rights and interests in these plots; its purpose is to guarantee boundaries, give security of title and to facilitate dealings. Here the term 'land-settlement' is used to mean settlement of rights in land followed by registration. In the Sudan, registration of agricultural land was particularly confined to the Northern, Khartoum and Blue Nile Provinces, where most of the narrow bank of alluvial soil, saqia-land, and much, not by no means all, of seluka-land is registered. In addition, particularly all the rainlands of the Gezira, and some further north, have been settled.

When the Sudan was reconquered in 1899, poverty was rife and people, decimated by wars and famines and overburdened by exorbitant taxes, were dislocated from their lands. The riverine people, on whom the whole burden of the Khalifa's, and before him the Turks', injustices fell, were, because of their fixed capital assets like the saqia and oxen, unable to move about freely like the nomads of the central rainlands. As a result, and through generations of occupation, there developed along the Nile the system of individual ownership of land with its vested rights. The new administration embarked upon a land policy taking as its main objective the return of the people to their lands so that cultivation could be resumed. But, without the security of title, the work of rehabilitation would have been futile, and, therefore, land settlement was urgent. However, before going into a discussion of this problem, it would be approporiate to discuss briefly the various types of cultivation practised on different types of land in the Gezira and Northern Province in order to know the nature of claims people produced, since this depended on how long the land was occupied by the claimant.

(i) Cultivation in the Gezira:

In Chapter Three, we discussed the history of peopling of Gazira, and how settlements spread from the rivering banks into the rainlands beyond, first temporarily during the rainy season, and later permanently by digging wells and utilising the various depressions for storing rainwater and cultivating crops. Thus, before the Gezira Scheme was envisaged, this rich tract of flat land was almost completely devoted to growing of dura by rain, and grazing of livestock. But this by any means, or in any way, did not indicate that other crops could not be raised. If cotton as a rain crop was produced in the seventeenth century in sufficient quantity for the appointment of a special officer of customs at Chellga to collect the duties on cotton coming from Sennar to Abyssinia, and if in the beginning of the nineteenth century the cotton manufactories of Sennar played a great part in supplying north-east Africa with articles of dress, it is also evident that cotton as a rain crop could be cultivated in favourably located areas.(25) Moreover, during the Mahdiya, there was a large market for native cotton of which much more was produced in the Gezira than in 1910. The fact that people grew dura was due to a big demand among the people as food for them and forage for their livestock - an insurance against famines and times of dearth.

Broadly speaking, there were two types of land on which crops were raised: riverland and rainland.

(ii) Riverland (Fig. 51B):

In the Blue Nile Province, the heartland of which is the Gezira, riverland had not the same importance as riverland in the Northern Province. There, people relied not on their effort but on the natural flood of the Blue Nile, and while the northerners stuck to their lands during hardships, in the Blue Nile Province, much of the land formerly cultivated by saqias went out of cultigation during the Mahdiya. The reason is due to the possibilities of rain cultivation in the latter, whereas in the north no cultivation can be done outside the narrow strip of alluvial land along the river because of scanty rainfall. In the Gezira, riverland was cultivated as gerf (orriver-bank), river-bugr, and rain bugr, depending upon the distance from the river (Fig. 51B).

The gerf or river-bank is the land which is exposed when the flood recedes, and thus the limit of cultivation depends on the height of the river flood. The inland limits of the land is called Hassa, which is the highest limit of the flood water not carried inland by means of khors, the limit towards the river being the position of the water level at low period. The gerf land was measured lineally by rope and rod, the local rope measurement being 8-10 diraa, and the rod 4 diraa (one diraa = 22½ inches). Usually, the number of these measurements was well-known along the gerf, but was uncertain towards the inland. The Hassa was defined in native documents by the phrase 'well-known from old times', but except in certain clearly defined parts, it was always disputed.(26)

The river-bugr is the land behind the gerf (Fig. 51B), and during high river large areas of this land were flooded by khors and cultivated as river bugr. However, the nature of claim on these lands depended upon the frequency of cultivation, and thus individual claims started where this land was frequently cultivated, but where cultivation was done once in an interval of so many years, it was claimed tribally. Cultivation here was done without terus or earth-banks for holding water, and at first sight it was difficult to determine the boundary between the gerf and river-bugr. From the rainland plateau the land slopes towards the river, the slope being known as Hadab (Fig. 51B) at the foot of which the land was cultivated by means of high earth-banks, which held up the rainwater flowing down from the higher land inland. This cultivation was known as rain-bugr, and was mostly reserved for the cultivation of crops, such as water-melons.[27]

There were great chances of disputes over the riverland. However, along the river bank or gerf there were certain well-known landmarks such as a big khor or a village boundary or a big tree. The total numbers of ropes between such recognised landmarks were also known, but within the limits of these landmarks the boundaries of ownership were constantly disputed. The owners claimed a certain number of ropes but boundaries were not well-defined and, as a result, one owner who claimed over and above his rights caused confusion over a long stretch of the river bank. If there was no land behind the gerf, owners usually claimed as far inland as the mainland, and in such a case, a dispute often arose with the tribe or the representative of a large family. If, on the other hand, there was cultivation behind the gerf, disputes arose between the owners of the gerf and the owners of the bugr land.[28]

As to the river-bugr, where cultivation was frequent, the land has been registered to the owner, but where cultivation depended on an unusually high flood and only happened at long intervals, the land has been registered for the Government with rights of cultivation for those who had been able to prove their claims.[29] The rain-bugr owners always claimed the higher land behind the bugr because cultivation here depended on rain-water flowing from there. This higher land has also been registered for the Government subject to rights of flow of surface rain-water for the owners of cultivation. Beyond the rain-bugr extends the main Gezira Plain where cultivation depended on rainfall.

(iii) Rainland

This was the most important type of land-use in the Gezira. Formerly, the rainland was used as grazing ground by nomads, who also did some cultivation after clearing the land. The method of cultivation was, as already stated in Chapter Three, by constructing terus or earth-banks to hold rainwater for use for the main crop, dura. Some cultivation was also done in which advantage was taken of depressions or natural basins known as ugud, where the rainwater concentrated. Pasture land and, to some extent, land cultivated without terass (sing. of terus) retained its tribal character, but land which was cleared and possessed terus was claimed by the individual. There are certainly some sites of villages and some existing villages of considerable age, but it is difficult to ascertain when cultivation by terass came into practice. It is, however, remarkable that near some old villages there are ugud where cultivation was quite possible without constructing terus.(30) Unlike the river-land, measurement in the rainland was done by gada'a, one gada'a being equal to 5½ acres; cultivation here was done by bilad, terass, ugud, and maiya.

A bilad is an ownership on which terus were made for holding up rainwater. As already briefly described in Chapter One, the main terus were made on the lower end of a slope to hold up water from running into waste, and the minor terus were for directing the flow to selected areas inside the bilad (Fig. 51B). The lower portion of the bilad was known as Hugna, and the higher portion as Sudra. On the fall of sufficient rain, the Sudra was first sown, and afterwards the Hugna, the latter being naturally the more valuable. The cultivation was then divided into small plots of convenient sizes called Sheila, each separated from the other by narrow strips of land. Sowing was done by the digging stick or seluka, and the main crop was dura, but when cotton was grown, terus were made on every side: high on the boundary of Hugna and low on that of Sudra, so that water could be held for a long time.(31)

Ugud, as already said (Chapter One) is a natural basin of low land in which water collects from the surrounding ground, and thus, because of their privileged locations, were cultivated annually except in case of total drought. As a rule, the more water an ugud received, the better the produce became, and cotton thrived well. Cotton was usually grown in the ugud of Managil District, although the Abud District of old days had a great reputation for cotton which was grown in the celebrated uguds nearby. (Fig. 51B.)(32)

Maiya is a big basin of low land in which water accumulates and remains for a long period, and this is its disadvantage, because the grass that grows there is very tough and difficult to eradicate, and because of the hard work this entailed, it was quite often avoided.

Generally, the land far from the river was considered better for cultivation than land near to it, the reason being that the latter, having a tendency to slope, did not hold water easily. Moreover, no uguds were found near the river, where a weed called Buda was more abundant. However, for the cultivation of rain crops, good terus for preventing the waste of water were so essential that if any important terass happened to be in bad repair, the ownership often produced less than a quarter of the possible yield. The main crop was the hardy, quick maturing variety of dura known as Fetereita (see Chapters One & Three). However, the yields fluctuated according to the amount of rainfall and, considering its uncertain character, one can realise why the Gezira, with an area of 5,000,000 feddans, produced so little compared with its area. Before the Gezira Scheme the whole production in the total area amounted to only 130,000 tons of rain-grown dura.[33] This fluctuation in yield according to rainfall can also be discerned from the amount of dura collected as tithe in the Gezira given in Table 39a Appendix 39. But with good land, having good terass receiving good rain and proper cleaning, 15 ardebs of 480 lb. per gada'a (5.5 acres) could be obtained.[34]

Formerly, the work of making and repairing the terass was done by slave labour. After the abolition of slavery, this had to be done by the cultivator himself, but, as the people did not return until the rain began and were then too late to work on the terus, the land was often left without any cultivation at all.[35] Moreover, the effects of sales and mortgage were good insofar as it did check reckless borrowing, limited the lending class to richer neighbours, and kept off the outside money-lenders. It was, however, a hinderance to cultivation more especially since the freeing of slaves, because it was impossible for the owner to raise money by mortgage for his cultivation unless he had land over and above what he was prepared to cultivate.[36]

In Messaltermia District, a typical rain-farming centre in the Gezira, the average area of ownership was about 25 feddans, and it was probable that, according to the method of cultivation practised then, this was the economic holding of the District. Figures relating to sales and mortgage of the rainland, collected since 1898, gave an average value of land of rather more than 50 P.T. the 5-feddan piece (about 2s. 1d. a feddan), while the mortgage value was not much less.[37] The usual custom between the owner and cultivator in the Gezira was for the cultivator to be the tenant for the season either on payment of an agreed rent, or more usually of ushur or a tithe of crop. The problem was that the rainland population was migratory in character; before the rains, it was altogether insufficient for the work of cultivation, but when the rains came, immigration proceeded in proportion to the amount of the rain.

(iv) Riverine Land in Northern Province:

Unlike the saluka-land in the White Nile - which is permanent and usually without saqia-land behind it - that along the main Nile is less permanent (see Chapter Two), and in most cases the sloping bank or gerf, and the adjoining piece in the river bed belong to the owner of the saqia-land above, except in Sukkot and Halfa Districts where the seluka-owners and saqia-owners are distinct. But although there were cases of selling the high land behind the bank without the latter, in people's mind they are considered inseparable because "custom divides the river into rectangular blocks divided in the middle of the river by an imaginary boundary called a mirin which lies in the direction of the flow of the river. The other boundary of the block is at right angles to the river and is called fasil"(38) or divider (Fig. 52B).

After this general discussion on type of cultivation and forms of land tenure in the above two places, it is important to discuss the land policy adopted by the Government in their attempt to develop the agricultural resources of the country to the best advantage of the native cultivator and the country at large.

(v) Land Policy

Unlike other African territories that came under European occupation, particularly in East, South and North Africa, the Sudan, by virtue of its hot claimate and lack of exploitable minerals, did not attract European settlers or large amount of capital which might have created powerful foreign vested rights, as in Egypt.(39) Moreover, the authorities took the interests of the natives to their hearts, and so established a tradition of great competence, and showed a zest and capacity to learn from the mistakes made in other parts of the Empire, and particularly in Egypt.

The main purpose of this land pllicy was, as stated above, to get the people back to the land, and their protection from European and native land speculators. The Egyptian and Indian experiences, which had already engendered a land-hunger there, were not to be repeated in the Sudan.(40) This active land speculation in Egypt spilled over into the Sudan after the reconquest, especially when the railway to the Red Sea was opened in 1905, and rumours of the Gezira irrigation plan were known. But the strong favour among the British officials to create a peasant propriety class rather than land-owners who would certainly be absentees, the caution of the Government and the slowness of the land commissions set up under the Titles to Land Ordinance in 1899 due to staff difficulties, prevented the alienation of the land.(41) Thus, under one of the first proclamations issued by the Government in 1900 it was laid down that contracts for the purchase of land in any province had to be submitted to the Governor of the province for approval. According to further notices published until 1914, it was definitely declared that the consent of the Governor of the province would not be granted to any "sales or dispositions by the natives of the Soudan of lands in the Gezira effected after the 1st of July, 1905, except of such sales to other natives of the same locality as have hitherto been customary and may be deemed by the Governor to be proper."(42)

Title to Land Ordinance of 1899 provided a machinery for the settlement of disputes and laid down the principles to be followed in the settlement. Every person claiming to be entitled to land of which he was not in possession, or to any mortgage or change upon land, was required to submit his claim to the Commission by a fixed date. The Ordinance was based on the principle that persons actually cultivating the land should, as far as possible, be left in possession. Of the rules laid down to guide the Commission, the two most important were: (a) that continuous possession or receipts of rents or profits during the five years preceeding the date of claim created an absolute title as against all persons; and (b) that, in default of any claimant with a superior title, continuous possession since the re-establishment of the Government created a prima facie title.(43)

The Land Ordinance of 1905 also aimed at providing simple machinery for settling the claims of natives over uncultivated lands, and lands which had been cultivated at irregular intervals only, and, when such rights do not amount to the full ownership enabling the Government to proceed to expropriation, if necessary, for the purpose of an irrigation scheme, or any other purpose.(44)

(vi) Land Concessions:

Although very eager to protect the peasants of the Gezira from foreign land speculators, most of the provincial Governors in 1903, because of the lack of Sudanese capital, saw that foreign concessions in places where they did not conflict with natives' interests, would be best for progress in agricultural development. The only place where such concessions could be given at the time was along the main Nile north of Khartoum, particularly in Berber Province, where, away from the narrow strip of land commanded by saqias, lay lands that could only be developed by more efficient irrigation means than saqia, such as pumps and canalisation. But the problem was that in most places where lands were applied for, nothing in the way of cadastral surveys or levelling for irrigation schemes, nor enquiry into native rights, had been done by that time.[45]

However, these variant issues were reconciled by adopting the principle that "development by foreign capital should be looked upon as a problem of stages rather than of final permanent concession."[46] Nevertheless, uncertainty loomed in the mind of both the authorities' and foreign applicants', and although by 1904 the Government offered Government land for sale in freehold blocks of 10,000 feddans and upwards for basin irrigation, many Governors were having second thoughts about future implications of foreign concessions. In Dongola Province, where basin lands were plentiful, the need for future generations, in the face of the rapidly increasing population, had to be considered, and for this purpose 39,000 feddans out of a total of 53,000 feddans surveyed for concession, had to be declared native land.[47] Moreover, the insistance of the Government on full recognition of the existing native rights and full compensation of the people involved in any concession, put off many foreign applicants. The only one foreign concession given was to Leigh Hunt at Zeidab in Berber Province, which was to be a kind of model for others. Future concessions, which were to be made at carefully surveyed places, were made conditional on the provision of an approved plan of development by the concessionnaire on his holding.[48]

The most important obstacle against concessions of this type, however, was the problem of water supply, and without installation of pumping machinery to irrigate these lands, it was futile to waste the so much needed capital on them. But outside the flood season, Egypt could not spare any water and, as already mentioned in Chapter Five, any irrigation project for growing a remunerative cash crop to pay for capital invested, had to depend on water stored from the flood season, and this could only be done by damming of the Blue Nile. Moreover, there was no capital to finance such a big undertaking, neither enough revenue for the various needs of administration. Thus, in the meanwhile and pending a settlement on the Nile waters, the Government turned to the development of the Gash and Baraka Deltas so as to increase returns from native lands.

Here, there was no restriction on water, and the natural flooding did not cost much in capital works, and they were, especially the Baraka, much nearer to the Red Sea. In the Baraka Delta, irrigation and the area cultivated depended, as it does now, on the volume of the flood and direction of flow, both of which were subject to constant fluctuation and changes, and this precluded the development of definite rights of ownership. The first allotments were, therefore, made to the tribes in the area, but because of abuse by strong individuals, the land in 1907 was declared Government land not subject to any rights, whether individual or tribal, but recommendations were made recognising the original actual cultivators as a privileged class. In the Gash Delta, where shiote cultivation had been in practice by individuals and some families from early times, a register of shiote holders was made in 1906. But because of a similar abuse as that of the Baraka Delta, the land was also made Government land which could be allotted to registered shiote holders, with reserving the right to revoke the allotment and terminate the cultivation rights in the shiote.[49]

The success met in the Baraka Delta in this respect was a clear sign that economic development can depend on the natives of the country, and that foreign enterprise was not the only road to progress and development. Yet, the main attention and hope were still attached to the Gezira where land settlement was more urgent.

(vii) Gezira Land Settlement:

The immediate object of land settlement here was to obtain a register of title, and in this it differed from the early settlement schemes in India in which registers were especially interested for revenue purposes.

The work of land settlement in the Gezira was carried on jointly with a cadastral survey, but before this work was commenced, the Director of Survey and his advisors, taking into consideration the level nature of the plain and the local conditions, prepared a scheme for dividing the districts into approximate squares of equal areas, the sides of which were minutes of latitude and longitude. The skeleton survey (Fig. 51C) made under this scheme proved a most admirable work for the later work of detailed cadastral survey, and for the formation of a register of ownership both simple and complete, ".... on a system never previously carried into effect in any country".[50] At every minute of latitude and longitude, iron poles or beacons were erected with cross vanes, on which were stamped the degrees and minutes of latitude and longitude. Twenty five-minute squares, approximately 25 square miles, formed a registration unit or section, and a separate map for each minute square on a scale 1/4000 was produced by the survey party (Fig. 51C).

However, it was arranged that lands in the Districts of Wad Medani, Messallemia and Kamlin should be dealt with first, and accordingly, settlement work was first begun in Messallemia District in 1906, and by 1912 a great part of the settlement was completed. Fig. 52 shows a typical settlement survey map of the Gezira. The initial compilation was reliable, and the laws of the country relating to land tenure and registration were appropriate and faithfully carried out, and in many cases investigations into the various causes of land disputes were thorough and complete. Thus, it is not surprising to find that, since this settlement was carried out, no problem, except for very few and sporadic cases, arose.

The more frequent causes of land disputes were:(51) (a) Claim by heirs that land was part of the inheritance to which they had right;(52) (b) claim that the occupier was in possession as mortgage but not as owner; (c) claims as to boundary of ownership abutting on the common land of the village; (d) claims by women that in the past they had not been given their shares; (e) claims to ownership of land by a tribe having an old document; (f) claims that those in occupation are not owners but cultivators or tenants; (g) boundary disputes, and (h) claims connected with riverlands described above.

In the settlements of these disputes documents of titles were asked to be produced and every effort was made to enable the parties to agree, and now, whatever defects there may be, registration in the Sudan has effectively guaranteed boundaries. Such an achievement is amazing if one remembers that in the early part of this century, the Sudan was poor, and that the classic settlement and survey in Egypt was not yet complete from which many valuable lessons could have been learnt. Even today, with some exceptions, the original survey maps can still fulfil their duty of being accurate and reproducible records of plot boundaries.(53)

Once land settlement was done, the next stage was to allocate the land to the tenants.

(viii) Allocation of Tenancies and Security of Tenure:

Before the Gezira Scheme, cultivation was carried at varying extent each year because of uncertain conditions, physical and political, and individual rights to cultivate various areas had gradually become established by 1900. However, in order to understand the situation properly, it is essential to realise that any picture taken from European ideas of each man living on his land, which he cultivates, is quite mistaken.

The cultivator in the Gezira either lived in villages grouped round wells at some distance from cultivation area, or carried on pursuits in quite other parts, and only came on to the land for the short period of cultivation (Chapter Three). The difficulties of carrying out of the registration of lands were largely increased by the migratory habits of the people. "A man who cultivated his land on the Gezira in the rains might be a merchant or a pedlar at other seasons, or might travel or reside in the far south, or in Kordofan, Berber, Dongola or the Red Sea".(55) The rights to cultivate that were acquired in the manner indicated above were passed by inheritance on death and, as, according to Mohamedan Law, a man's property is divided equally among heirs, and thus becomes split up into innumerable small plots of odd shapes and sizes.

However, as soon as irrigation of the Gezira was considered, it became clear that the odd shapes and boundaries of the individual holdings as they existed, were totally unsuitable to the laying-out of an irrigation scheme. Plots for cultivation under such schemes must be bounded by the water channels, and these must be as straight as possible, while their direction and position is governed by the contours of the land. To get over this difficulty, the Government finally decided that the practical procedure was the following: that the whole of the area should be rented by the Government from its registered owners for a period of 40 years, and at a rent of 2 shillings per <u>feddan</u>, and then re-allotted to the actual owners in the form of cultivating tenancies for plots of regular size of 30 <u>feddans</u> each. The 2 shillings per <u>feddan</u> was fixed as being a generous estimate of the annual value for better land calculated according to the current rates. The owners were to get the tenancies allotted to them in positions lying as near as possible to the positions of their original holdings.(56)

The whole procedure for carrying out those measures were laid out in the Gezira Land Ordinance of 1921 in Appendix 40. The main points of the Ordinance, security of Tenure and right of ownership, are summarised below:

(ix) <u>Security of Tenure</u>:

Under Section 10 of the 1921 Ordinance, owners of land within the irrigated area in the Gezira (the initial 300,000 <u>feddans</u>) were entitled to be granted in yearly cultivating tenancies of such sizes as they themselves were competent to cultivate, this provision being interpreted as follows: no single tenant was regarded as capable of cultivating himself more than a unit of 30 feddans. But if he was the registered owner of a larger area he was given the opportunity of nominating tenants to the excess land. Thus, the registered owner of a total area of, say, 90 feddans, would be entitled to take up one tenancy himself and to nominate cultivating tenants of two other plots of 30 feddans each. These nominees were in many cases the owner's sons or relatives. Such tenants, the Government saw, must have the security of tenure provided they cultivated properly.

In considering this policy in this respect, two main points as regards the previously existing conditions must be remembered. First, in years of good rainfall, the bigger owners could neither cultivate themselves nor find tenants for, the whole of their area, while in years of bad rain, the land had no letting value. Secondly, there was within the 300,000 feddan area, a considerable population who, although not registered landowners, were dependent for generations on renting a portion of land from the owner. The claim of these people to livelihood from the land had, of course, to be considered by the authorities.

The tenancy in each case was a yearly one, but the owner-cultivator was entitled to a renewal of his tenancy from year to year, subject only to his complying with the specified conditions of cultivation. Accordingly, by 1924 every owner of land within the areas already taken up, who applied for it had been allotted a tenancy, but the owner applicants, it was decided, would not exhaust the whole of the area which was then available. After applications had been considered, the Government, or the S.P.S. acting as agent of the Government, was free to consider applications from other would-be tenants. If a man, who was not previously the registered owner of land in the area, was allotted a tenancy, he had not the same absolute right to a renewal of the tenancy from year to year as an owner-tenant.[57]

Thus, on the basis of actual results from the areas already taken up by 1924, it was calculated that over the whole area of 300,000 feddans comprised in the Scheme then - which was divisible into 10,000 tenancies of 30 feddans each - about 7,000 tenancies were taken up by cultivators already residing within the area and the remaining 3,000 by their nominees or people from neighbouring areas.

(x) Rights of Ownership:

Throughout the period of renting, that is 40 years, by the

Government, the native owner was to retain the freehold interests in his land which he could still bequeath or otherwise dispose of and which, on his death, would pass by inheritance to his heirs according to Muslim law of inheritance. Furthermore, when the period of lease was over, the full use of the land with all the benefits of development would revert to the freeholders. Thus, the tenant was encouraged to preserve his holding by this assurance.

However, in order to prevent any kind of land speculation or the alienation of land by the natives to foreigners, and also to protect the cultivator from the native usurer, the Government took certain powers to limit sales of land. In practice, the settled policy of the Government as regards land in the Gezira since 1905 had been to refuse sanction to all transactions except genuine sales in the ordinary course from one native to another. The result of this policy had been that practically the whole of the land in the Gezira remained in native ownership divided into comparatively small holdings so that it may be said that not only has the foreign land speculators been kept out, but also the wealthy native absentee landlord, and the whole of the land remained in the ownership of the actual cultivators that work upon it.[59]

If we consider the economic aspect of land tenure, and try to assess this terurial system in terms of economic effects of its different forms, we must give particular emphasis to three main aspects: relation between supply of capital to agriculture and land tenure, fragmentation, and the economic utilisation of the land.

The supply of capital to agriculture, as already noted in Chapter Three, is necessary for economic efficiency and, for this purpose, the system of land tenure must provide both the incentive to invest and the possibility for the farmer to do so. With regard to the best system to provide this, freehold ownership or peasant proprietorship, it is true that the ownership-occupier can morgage his land as security for a loan, while the system of freehold ownership encourages the farmer to fall into debts, especially in underdeveloped countries in Asia and Africa where there is a strong predisposition to prodigal expenditure on various ceremonies.[60] Relief measures taken under such conditions to protect the peasants include, for example, the Egyptian Five-<u>Feddan</u> Law, and the Punjab Alienation of Land Act of 1900.[61]

In the Sudan, a practice had long existed by which the small cultivator accepted contracts to deliver his cotton to some particular cotton merchants in consideration for money, or more frequently for goods received. The cotton was duly delivered at a fixed, and usually at a low, price, the cultivator receiving no particular benefit from a good year on account of the higher prices ruling, whereas the buyer incurred absolutely no risks. For example, it happened in Tokar in 1911 season when buyers were taking cotton from the cultivator at 40 P.T. per kantar at a time when it was actually selling on the market at 150 P.T. per kantar - a state of affairs that necessitates educating and financially assisting the cultivator so that he does not fall into debt.(62)

However, where owner-occupancy is the rule, this problem of capital can be solved either by (a) agricultural co-operative societies which provide credits to the farmers, and also can mobilise savings and earnings for the same purpose or deal with other needs of the farmer as in Japan;(63) or by (b) state-run co-operatives, which provide seeds, fertilisers, and mechanical cultivation to peasants who, after a certain period, would become full owners of the land, as happened in Egypt in 1952 and in Italy in 1950 to deal with the problems of land redistribution to a poor peasantry;(64) or (c) by the system of triple partnership adopted for the Gezira Scheme, and the company tenancy system of Fiji Islands.(65)

The basis of the triple partnership between the Government, the S.P.S. and the tenant cultivators has already been mentioned above. The inclusion of private management represented by the S.P.S. had the advantage of first applying their prior experience in cotton growing in other parts of the Sudan to the Gezira. Secondly, their management skill was of inestimable benefit in meeting many problems, and, thirdly, their concern that the scheme be a profitable commercial enterprise assured a more practical approach than might otherwise have existed. Furthermore, the fact that the Government received a large share of the proceeds together with the definite termination date set for the private management (1950), undoubtedly, spared the Government complaints that the Scheme was run primarily for the benefit of foreign imperialists and colonial exploiters. Another interesting feature is that the cost of tractor cultivation is equally shared between all tenants, so that, in effect, the farmer with better land and consequently better yields, subsidises the farmer with land of poor quality which needs more attention, and who by himself could not have afforded paying the whole cost. This equal bearing of costs to some extent provides also a kind of insurance each tenant pays against the contingencies of nut-grass or Seid (Cyperus rotundus, L.) infestations, of salinisation of land, or of abnormal insect and disease attacks. Moreover, it could as well result in a wider and more even spread of prosperity, reduce the danger of serious indebtedness, and minimise distress in the less favoured areas.

It is interesting to note that the Egyptian Land Reform of 1952, referred to above, may have been indebted to the example of the Gezira Scheme; which was initiated largely because the administrators did not wish to see the earlier Egyptian experience repeated, in which the Government's introduction of irrigation and drainage schemes had enormously benefited the private land-owner without improving the economic position of the cultivator.(66)

Another important problem is land fragmentation encouraged by the Muslim law of inheritance according to which the land is divided among the heirs, on the death of a father, the widow having one-eighth of the holding, and the rest among the daughters and sons. This is common in the individually-owned lands in the riverine areas of northern Sudan, and indeed matters have reached a stage that ".... a palm tree may be subject to a complex fractional ownership".(67) The results of fragmentation, entailing waste of time and decrease in production, hardly need any comment. Multiple ownership, which is common in the Sudan, also encourages fractionation. The form it takes varies: in the Gezira rainlands, for example, the only division that can be made is of the crop since each plot is an entity which can only be cultivated as a whole; hence division of the land is usually impossible. In Shendi District the shares are registered by frontage and the position of each share is known and recorded in the register. In the Merowe-Dongola reach one finds every variety of fractionation: in seluka plots, it is almost complete, the land is fully divided on the ground, while in the saqia land there may be anything from one to twenty or thirty people cultivating their land in the saqia, each one of whom 'owns' everything from one to a dozen or more patches of land. It is not unusual for a 10-feddan plot saqia to be divided unofficially, but nonetheless effectively, into a 100-sub-plots each one of which is treated by the people as being more or less independently owned. Absentee co-owners draw their rent in kind through a relative. This, however, does not mean that there are absentee landlords because those who live or work outside the district help those at home with cash remittances to pay for seed, taxes, etc.(68)

Thus, the saqia was an example of cooperative society, but the essential difference from a cooperative society in, for instance, England, is that there the man or bank who subscribes to the capital insists on a definite rate of interest, whereas the Dongolawi expected a share in the crop; the former wants more or less certain, if limited, dividends, while the latter gambled on the yield, crop prices or shares, with the cultivator, the full impact of economic forces. Economically, the vital difference is that in Dongola an increase of capital did not automatically imply an increase in the proportion of profits paid out as dividends. Hence additional money could be raised in difficult times without increasing the burden of debt charges.(69)

However, the inefficiency of the saqia proved to be far more great than its economic assets and, as already discussed in Chapter Three, it was thought that the removal of "... incidence to the final stages of production would not only effect an absolute saving of cumulative interest" but to facilitate the substitution of modern pumping machinery and efficient field implements for the primitive native contrivances, of which the saqia was one.(70) For the problem of fragmentation, the tenurial system, while permitting the direction of land-use in the best interest of the area as a whole and providing security of tenure, also prevented the sub-division of land as practised on saqia lands.

IV THE CULTIVATING POPULATION:

Cotton is obviously a labour-demanding crop employing far more labour than is required for grain production. The provision of labour for cotton growing is aggravated by the fact that there are three seasonal peaks in this demand: (a) preparation of land for planting; (b) cleaning and thinning, and (c) picking. Of these three seasons, the last is the most critical because if cotton is not picked when ready, it tends to lose grade and quality deteriorates accordingly.(71)

Formerly, this great demand for labour in agriculture in general, and cotton in particular, was largely met by slaves, as in the U.S.A. and West Indies, and in the Sudan where slave-labour was used largely for the work of cultivation. Undoubtedly, the manumission of salves made the position of the land-owner in the Gezira temporarily difficult.(72) He did not of course appreciate the Government's attitude towards slave-labour, and the dictum of Adam Smith that "the experience of all ages and nations demonstrates that the work done by the slaves, though it appears to cost only their maintenance, is in the end the dearest of any" left the cultivators unconvinced, dissatisfied and cold.(73) It was this social and economic attitude, nurtured by generations of slave-owning society that the Government set out to change and develop into a self-supporting society. The going was not easy; it was difficult for a landowner, whether in the rainlands or along the riverine banks, to adapt himself to a slaveless agriculture, and in this atmosphere of suspicioun, agricultural production unavoidably declined because of more reduced labour supply and disinclination of land-owners to work than of physical causes of droughts and locusts.(74)

Thus, the Government had to choose between almost equally distateful alternatives: the temporary sanction of slavery or the immediate liberation of slaves, the latter being a course which might bring economic ruin upon the country. Liberation would have resulted in the abandonment of most of the cultivation along the river-banks, the loss of flocks and herds of the nomad Arabs, and the death of considerable numbers of individuals who, through no fault of their own, had been brought up under a social system that, although repugnant, was accepted at the time as an indispensable condition of their everyday life. Moreover, to have freed all the slaves would have meant letting loose upon the society thousands of people with no sense of social responsibility, who might have been a menace to public security and morals. Finally, a considerable section of the slave-owners would have risen against what they regarded as a gross injustice, for, after all, they had bought their slaves and paid for them. The Government, therefore, decided to recognise the existence of slavery, but to impose safeguards that would guarantee the slaves against ill-treatment and ensure that, with the passage of time, the system gradually died a natural death. Thus, detailed registers of slaves were compiled, and a proclamation issued that all children should be freed when they were old enough to look after themselves. Meanwhile, slaves were encouraged to remain with their masters so long as they were well-treated.

Furthermore, one of the main objectives of the Gezira Scheme was to gradually change the nomads, semi-nomads and rainland cultivators into tenants - a status which geared him to traditional methods of economic behaviour and eventually accustomed him to definite social and economic relationships wherein respective duties and obligations were historically specified and defined, and thus "the tradition of slave labour for agricultural purposes had been well established for several generations".[75] The economic system on which these relationships were based were, of course, no longer operating, and the strong nomadic background of the people characterised their attitude towards their animals, which were usually kept in unsuited places without fencing, and towards modern agricultural practices and aspects of economic affairs because they wontedly lacked the basic means to receive them. Even today "the patriarchal tradition of flocks and herds as the foundation of social position is still a living reality, and men invest their cotton profits in them regardless of the economics of the situation".[76]

However, besides this dependence on slave-labour and its consequences, there were also other factors which contribute to the inefficiency of this labour, the most important being poor health and ignorance due to lack of education, superstition, and poor diets and diseases, which made men incapable of sustained physical effort. As a result, the number of days a man worked and the hours per day, governed as they were by physical conditions, such as the nature of soil, climate, length of day, location and custom, and by the type of farming, farm size and the crops grown, were small. Moreover, resistance to changes that disturbed existing patterns, fear, suspicion, protracted and complicated efforts at development and progress for some time. The 78 years (1860-1898), of vexatious rule and under the crushing burden of arbitrary taxation, expropriation of land and looting of crops, especially under the Mahdists, implanted fear, mistrust and suspicion in the hearts of the people, and made them not only unreceptive of better methods and innovations, but also conditioned them to view the Government and any undertaking by the Government, in which people were directly involved as in agriculture, as a means of extortion and vexation, and thus they lost almost every incentive to settle down and cultivate.

Thus, when the country was reconquered in 1898, the task before the new Government was formidable. The utter devastation that resulted from Turkish and Mahdists' misrule did more than destroy the economic structure of the country: it destroyed the very foundations on which a new economy could be built. Of the 1,750,000 inhabitants who were believed to have survived, many were old men and women, or young children; tribes that had opposed the Khalifa had been annihilated and their homes destroyed. Along the Dinder and Rahad rivers there was scarcely a trace of the 800 flourishing villages that were reported to have existed there, and when, in 1903, R. Wingate, the Governor-General, visited the once flourishing village of Metemma, to the west of Shendi, he found only 1,300 people, of whome 1,150 were women and children. Other villages, which had at one time been able to put 500 fighting men in the field, could not muster scarecely a tenth of that number.(77)

Indeed, so great was the economic chaos that the question was seriously considered of bringing in Chinese or Negroes from America, as labourers. Egyptians had at first to be attracted by higher wages to come and work in the Sudan. Meanwhile, in order to attract the Sudanese people back to the land and win their confidence in the new regime, they had to be given security of tenure on their lands and taxes - the bone of contention in the previous regimes - were revised and much reduced in amount (see App. 42).(78) The land tax was primarily designed, not to fleece people as in the past, but to induce the natives to cultivate all the land belonging to them, and at the same time to discourage them from bringing forward claims to land to which they had only very doubtful titles, and which they had no intention of cultivating. The system in Dongola was that after two years' warning, a tax on one-quarter of the uncultivated land in private ownership was levied, It was then increased to one-half at the end of the fourth year, then three-quarters on the expiry of the sixth year, and to the whole area eight years after the date at which the warning was given.(79) In Sennar one-fifth instead of one-quarter was levied and the full amount of taxation was to be reached in ten years.(80)

Moreover, they had to create for the peasant new wants in order to provide incentives to work longer, harder, and be receptive to better methods of agticulture, and to achieve this the urgent need for his education and training to increase his efficiency was recognised. The dissemination of knowledge about crops and their environments and about the best cultural techniques of production by highly qualified personnel were, as discussed in Chapter Three, fully imbibed by the authorities. The removal of doubt and fear of exploitation was essential for the proper understanding of the changes proposed for the betterment of the peasant and his economy.

However, these methods took some time to influence the people who, failing to cooperate, adopted the attitude of wait-and-see. Thus, at Zeidab Estate of the S.P.S. initial labour for levelling the land and digging the canals had to be recruited expensively from Egypt, and the Estate initially had to depend also on Egyptian peasants to grow cotton. The 600 natives then available in the area remained content on their saqias. But the good results, and prospects, of cotton as a source of cash increased the number of native cultivators in the Estate from virtually none to over 200 in five years' time. Similarly, at Tayiba Pilot Station in the Gezira, the people were at first averse to change and join in as tenants, and Egyptians from Egypt and Zeidab had to be brought in as first tenants or "starters" to stimulate curiosity, envy and finally imitation of their ways by the locals. The high yield of cotton and plenty of fodder and, most important, the failure of rain outside the irrigated area to produce enough dura crops, brought clearly to the natives the better advantages of irrigation. Thus, when the station was extended for its second season, "... people came from all over the Gezira, offering to deposit money, gold bracelets and all kinds of jewellery in their anxiety to be accepted as tenants".[81] To help them acquire the techniques of cotton growing, the new tenants were "sandwiched" among the skilled Egyptian peasants, and during the second year there was no need to draw upon Zeidab farmers.[82] "It is wonderful to see how these novices at cotton growing have through the influence of their neighbours cultivated their own fields as well as if they had been used to cotton growing all their lives" - this ready way in which the people took to cotton growing and responded to the instructions afforded by the S.P.S. officers indeed disposed of the old idea that the "Arab" could never develop into a good husbandsman, and showed how creation of incentives and cultivation of goodwill and disposition on the part of the Government can change the attitude and to overcome the initial reluctance, of a conservative community and win its confidence.

However, it was all important that when time came for water to be put on to the Gezira plain by means of a canal and a large tract of country was ready, there had to be sufficient native cultivators ready to avail themselves of irrigation and work their land on the most economical system. The exact number of population in the Gezira, or in the whole country, however, was not exactly known, and many contend, rightly though, that by famine and wars the population of the country was drastically reduced, and that the Gezira had suffered a great deal, particularly during the Mahdya, from forced enlistment in the army and punitive campaigns (Tables 25 App. 25 and Fig. 37). The fact that the Gezira offered then a good illustration of how the population of the rainlands migrated according to labour demand, and that good rains always meant more people and more cultivation, and vice versa, made the authorities hopeful that increased demand created by irrigation would cause an increased migration and that the permanent population of the Gezira would increase very rapidly.(84)

The estimated resident population by 1912 in the proper Gezira, north of the railway, consisted of about 79,000 men, 98,300 women and 77,800 children, while to the south of the railway, in the west bank of the White Nile and east bank of the Blue Nile, there were about 100,000 men, 124,300 women and 126,400 children (Table 41 App. 41).(85) In Dongola Province, population is believed to have increased from 121,897 in 1905 to 141,621 in 1913. However, it must be remembered that these estimates were roughly made by provincial Governors, and are only approximates and not the result of a detailed census. But the decrease in the number of men due to conscription in the army is obvious, and it is probable that a large number of the male population consisted of old men. Nevertheless, the number was thought to be sufficient for "a scheme of considerable extent", though it was recognised that this factor might limit subsequent extensions. But the natural increase under the peaceful conditions accorded by the new regime, already obvious in the case of Dongola, was thought to offset the problem of labour as it arose.

However, in this respect one must mention that the Gezira also housed a considerable number of immigrants from Chad and West Africa, who, although Muslims, are predominantly agriculturalists and tillers of the land. For thousands of years there were large movements of people as well as ideas across the large savanna belt that stretches across Africa from the Atlantic to the foothills of the Abyssinian Highlands, and it is contended that the idea of rain-cultivation was probably first introduced into the Sudan from the west by immigrant agricultural peoples about 2,000 B.C., and that the cotton that was cultivated during the Meroitic period (Chapter One) was passed on to West Africa across the same route.(86) Today, there are well-established "western" communities in the Gezira. The motives for emigration from their homelands was first religious+ the pilgrimage to Mecca. However, because of the long journey and perils of the road, many failed to get there and thus settled down in convenient places, and a large number of those who accomplished the journey to Mecca had no inclination to return home, and the only alternative was to settle down in the Sudan.(87) The relatively unoccupied savanna and the scale of agricultural development, with special emphasis on cotton, undertaken by the British, created good opportunities to improve their material condition by working as labourers or even tenants. The reluctance of a large number of Sudanese to take up tenancies undoubtedly gave them opportunity to become tenants by virtue of their efficiency both as farmers and labourers, and thus the part played by them in the initial stages of agricultural development in the Gezira, might have been considerable.(88)

There are, however, physical, social and economic factors associated with labour. With regard to physical factors, it has already been stated that the seasonal regime of cotton cultivation dictates the pattern of demand for labour throughout the year. The farming year in the Gezira began in July and ended in June, and can be divided into:(a) the rainy season (July-October) when crops were established; (b) the winter season (October-December) of regular watering and dura harvested; (c) cotton picking (January-April), and (d) summer season (April-July) when cotton stalks are pulled out and burnt. The demand for labour was not uniform throughout the year but was characterised by two peaks, planting and harvest season. For weeding in the rainy season, and for cotton picking, a family holding of 10 feddans of cotton would have to resort to hired labour.(89)

However, certain human factors also made the problem of labour one of the more serious obstacles facing the development of the area. The size and composition of tenant families are important in calculating the demand for non-family labour, but even if these were adequate to meet most labour demands, there would still remain the need for hired labour. For a complexity of historical, economic and social reasons, and on account of a harsh climate particularly at certain times of the year, there was an active dislike for work in the field. Before the schemes, cultivation only needed a 100 days and consisted, as mentioned earlier, of growing dura on lands owned by landlords and worked by slaves. There developed an outlook among a certain group in which field work became synonymous with slavery. With the irrigation schemes things changed: different farming system, more field work (7 months) which was more physically demanding. The work capacity of the community was still low and inefficient and, furthermore, women, according to Muslim tradition, did not work because of strangers in the field, and there was the tendency of tenant and labourer to supervise than work themselves.

These problems arose not only because of a lack of hard-working agricultural tradition as found amongst the Fellahin and Punjab peasantry, but also because of the agricultural framework adopted. The cultivation, even if the tenant owned the land he worked, operated it on an annual lease renewable indefinitely subject to concurrence with the conditions of the contract. There remained, nevertheless, something less than freehold ownership, and hence less of a personal interest and responsibility for the land. Furthermore, a holding was not always a compact unit but was operated as a number of plots which may or may not be adjacent to one another; the production of crops other than cotton often entailed an interchange in tenants cultivation rights, and in the consequent use of the holding. It was difficult in these circumstances for a tenant to develop a sense of pride in his holding which was vital if efficient agriculture without supervision of the field inspectors of the S.P.S. was even established. Perhaps more serious from the long-term point of view is that there has been little incentive for tenants to invest in farming in the schemes.

However, these problems began to enforce themselves fully of late, and any detailed discussion of them lies outside the scope of this thesis, but suffice it here to say that they arose as a result of the tenurial system and partnership arrangement under which the Gezira Scheme has operated.

After this discussion of the steps taken before the main irrigation scheme could be embarked upon, we can proceed to discuss the main step which was to ascertain by experiment what were the prospects for the successful raising of cotton under artificial irrigation in the Gezira.

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2. A. Gaitskell, op. cit., p. 76. In 1911, the B.C.G.A. took up 5,000 shares in the S.P.S. at a premium of £2, and this was in itself a reassurance of confidence in the S.P.S. and of hopeful prospects after the bad years followed its inception in 1904.

3. ibid, p. 80

4. "Sudan Irrigation Report", Par. II, April-June (1918), Box 152/2 Sudan Archives (Oriental School, Durham)

5. R.E. Sawer, op. cit., pp. 35-36

6. "Sudan Irrigation Report, 1913", Box 112/9, Sudan Archives (Oriental School, Durham)

7. Report of the Industrial Commission, U.S.A. (1914), pp. 15-16

8. R.E. Sawer, op. cit., p. 37

9. Accounts and Papers, vol. 87 (1903), pp. 1050-51

10. ibid, p. 51

11. Accounts and Papers, vol. 88 (1904), pp. 121-22

12. Accounts and Papers, vol, 87 (1903), pp. 1052

13. ibid, p. 1053

14. J.C. deWilde, op. cit., p. 198-99

15. However, it must be admitted that at both Zeidab and later Tayiba, Egyptians were 'brought in as starters', and later the Sudanese joined in, the initial reluctance being due to past experiences in this field.

16. M.W. Wilmington, "Aspects of Money-lending in Northern Sudan", Middle East Journal, vol, IX No. 2 (1955), p. 121

17. Arno Schmidt, op. cit., pp. 51-4

    W. Mather, op. cit., pp. 27-29

18. ibid, p. 27

19. A. Gaitskell, op. cit., p. 66

20. From the Blue Nile Governor to the Director of Agriculture, 9.8.1913. Box 109 Sudan Archives (Oriental School, Durham)

21. A. Gaitskell, _op.cit._, pp. 76-68

22. Lord Kitchener's and R. Wingate's principle was to make paramount the interests of the natives, and their anxiety as to the political and social effects on the country of giving too much power to commercial management was reflected in all their dealings with the S.P.C. See Wingate Papers, letters dated 6.5.1913, _Sudan Archives_ (Oriental School, Durham)

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H. St. G. Peacock, _op. cit._, pp. 10-11

J.L. Burckhardt, _op. cit._, pp. 309-10

26. H. St G. Peacock, _op. cit._, p. 47

27. _ibid_, p. 49

28. A.B. Hiskin, "Land Registration", _Sudan Pamphlets_, vol. 2 (1935), p. 11

J.G. Mather, "Land Customs and Tenure in Singa District", _G.N.R. 1_ vol. IV No. 1 (1921), pp. 1-19

29. H. St G. Peacock, _op. cit._, p. 50

A.R.C. Bolton, "Land Tenure in the Agricultural Land in the Sudan", _Agriculture in the Sudan_ (1948), p. 189

30. Georges Brausch et al., _op. cit._, p. 19

31. H. St G. Peacock, _op. cit._, p. 53

K.M. Barbour (1961), _op. cit._, pp. 184-5

32. M.A. Elias, _Social Outline of Manaqil Southwest Extension,_ Unpublished Manuscript, Khartoum (1964), pp. 16

J.R. Randell, "El Gedid: A Blue Nile Gezira Village", _Sudan Notes and Records,_ vol. XXXIX (1958), pp. 25-40

33. A. Gaitskell, "Advantages of the Gezira Scheme", _Empire Cotton Growing Review_, vol. 21 (1943), pp. 87-88. In 1943, the irrigated area alone produced more than half of this quantity from only one-fifth of the land.

34. Sudan Government, Notes ..... (1926), pp. 51-52

H. St G. Peacock, op. cit., pp. 49-50

35. P.F.K. McLoughlin, "Economic Development and the Heritage of Slavery in the Sudan", Africa, vol. XXXII No. 4 (1962) pp. 355-9

36. ibid, p. 356

37. H. St G. Peacock, op. cit., p. 55

38. A.R.C. Bolton, op. cit., p. 191

39. Mekki Abbas, The Sudan Question, London (1951), pp. 48-54

Earl of Cromer, Modern Egypt, London (1908), Vol.II, pp. 114, 428, 435

40. Charles Issawi, op. cit., p. 497. By 1896, 44% of Egypt's cultivated land was owned by 12,000 land-lords, and consequently a large proportion of the benefits accruing from the irrigation works was going to a small section of the community.

41. Cmd. 20409 Part II (1904), p.3

42. ibid, p.

43. Sudan Government Gazette, April (1904)

44. Accounts and Papers, vol.III (1904), Cmd.2817, p.144

45. Cmd. 2409. Part III (1904)

46. A. Gaitskell (1959), op. cit., p.46

47. Kerma Basin and Dongola Basin Cultivation, Box 112/1, Sudan Archives (Oriental School, Durham).

48. A. Gaitskell (1957), op. cit., p. 47

49. A.R.C. Bolton, op. cit., p. 189

50. H.D. Pearson et al., Notes on the Marking out of the Gezira into Minutes of Latitude and Longitude, London (1907), p.2

51. H. St G. Peacock, op. cit., pp. 19-30

52. Very often this was caused by a sale by one or more of the heirs without the consent of the other entitled, or by one heir claiming land which other heirs claim to have been divided up into special shares.

53. Except in Dongola-Merowe area where the surveyors' demarcation of a plot is very rarely in question, it is usually because the work has been done by an inexperienced person.

54. H.D. Pearson et al., op. cit., p.13

A.B. Hiskin, op. cit., p. 10. There must be no material error in the survey. What this means in practice is a question of fact which can only be judged by the nature and value of the land, both now and after development. Thus, in a featureless plain, it may be enough to be sure of a tribal grazing boundary to 50 or even 100 metres. In Zanzibar where the clove trees are planted 21 ft. apart, it had been decided that the error in the survey should not exceed 3 ft., so that a clove tree, which is the value of the land, could never be assigned to the wrong plot. In Egypt, the mixed commission recommended a limit of ± 25 cm., i.e. that a row of cotton plants, 50 cm. wide, could not on redemarcation be wrongly awarded to a neighbour.

55. H. St G. Peacock, op. cit., pp. 29-30

56. Cmd. 2171 (1924), p.44

57. In practice, however, his position was not much different, and provided only that he cultivated with reasonable efficiency, his tenancy would not in fact be renewed from year to rear.

58. Cmd. 2171 (1924), p.46

59. ibid, p. 46

60. C.K. Meek, Land Laws and Customs in the Colonies, Oxford (1946) Chapter 20

61. Accounts and Papers, vol. 123 (1912), p. 12. By this law, the peasants' last five-feddans, his bullocks and implements were exempt from seizure by foreign usurers who, with the support of Capitulations, lent money to the peasant at rates of 30 to 40%.

Anne Martin, Economics and Agriculture, London (1965), pp.144
The Indian Land Act restricted any seizure on land by non-agriculturalist to a period of 20 years after which the land returned to its owner.
Under the English system, it is the landlord's responsibility to provide and maintain the fixed equipment on the farm, leaving the tenant free to invest his own capital in the running cost of the farm, thus preventing the farmer from going into debt and at the same time ensuring both the supply of capital to the farm and its productive investment.

62. P.F. Martin, op. cit., p. 112. In fact this problem was stopped by following this principle.

63. D. Warriner, The Economics of Peasant Farming, Oxford (1939), p.15
As a result of the Land Reform of 1946 these cooperatives were introduced in Japan and were successful.

64. _ibid_, p. 16

Charles Issawi, _op. cit._, p. 80

65. A. Pim, _Colonial Agricultural Production_, Oxford (1946), pp. 78-9

R. Gerald Ward, _Land Use and Population in Fiji_, H.M.S.O. London (1965), pp. 9-13, 30-34, 118-124.
Fiji provies also an interesting example of a rather similar partnership to that of the Gezira between foreign capital and peasant farming, although here the government plays no part.

66. C. Issawi, _op. cit._, pp. 79-91

D. Warriner, _Land Reform and Development in the Middle East_, London (1957), p. 20

67. V. Liverage, _Land Tenure in Colonies_, Cambridge (1945), pp. 18 and 66
In India, successive generations descending from a common ancestor inherit not only smaller and smaller shares of the land, but inherit that already divided and broken up into smaller and smaller plots. It was to prevent this that the Prevention of Fragmentation and Consolidation of Holding Act of 1947 was made. Other measures were also made in Cyprus, Uganda and Rhodesia.

A. Paul, "Saqia Custom in Shendi District", _Sudan Notes and Records_, vol.19 (1936), pp. 346-

J.G. Mathews, _op. cit._, pp. 15-17

68. The absentee owner participated in the crops by taking his share if he were present in person at the time of harvest, or had a representative present, his share depending on whether or not he contributed his taxes.

69. A.B. Miskin, _op. cit._, p. 15

70. Taxation of the instruments of production, including fuel, by means of custom dues, railways and royalties, had hitherto handicapped irrigation farming in an unsuccessful attempt to compete with areas enjoying relative natural and fiscal advantages.

71. E.W. Zimmermann, _op. cit._, pp. 324-26

72. H.C. Jackson, _op. cit._, pp. 92-6

73. "Memorandum on slavery in the Sudan", Enclosure 3 to Papers Relating to Slavery in the Sudan. _Cmd.2650_ (1926)

M.F. McLoughlin, _op. cit._, pp

74. Report of the Governor-General, 1913, _Accounts and Papers_, vol. 122 (1914), p.112

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77. H.C. Jackson, op. cit., pp. 93

P.M. Martin, op. cit., pp. 151-55

78. Cmd. 2171 (1924), pp. 2-6

79. Accounts and Papers, vol. 137 (1906), p.212

80. ibid, p. 212

81. Arno Schmidt, op. cit., p.22

82. A. Gaitskell, op. cit., p.59

83. Arno Schmidt, op. cit., p. 23

Cmd. 6682 (1912), p.2

84. H. St G. Peacock, op. cit., p.72

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G.P. Hurdock, Africa: Its Peoples and their Culture History, New York (1957), Chapter 12

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88. D.W. Mather, "Migration in the Sudan", in Geographical Essays on British Tropical Africa, R.W. Steel and C.A. Fisher, eds. London (1956), pp.115-

Sam Ibrahim el Khatim, Casual Labour and the Economic Implication in the Sudan Gezira, Unpublished M.Sc in Agriculture, University of Khartoum (1966).
Today in the Gezira Scheme, the westerners hold 4% of the tenancies, provide 25% of labour force in the field, 90% of the labour force employed in the ginning, and 70% in canal maintenance labour.

89. Weeding is done by hand in August and September, and some 0.8 men per holding additional to the tenant's family being required; picking requires some 70% additional man-power, that is, 0.7 men per holding.

CHAPTER SEVEN

PRELUDE TO THE GEZIRA SCHEME: THE PILOT STATIONS, 1904-24

In the early twentieth century, the new administration realised that an important part of the economic future of the Sudan must be with cotton, and accordingly plans were laid to stimulate cotton growing, at first on only a modest scale, but to be succeeded, as soon as law and order had been established, by more comprehensive developments. Thus, at first a few private individuals or syndicates were encouraged to cultivate small areas in a more or less experimental manner, and Berber Province, by virtue of the large and continuous blocks of arable land available there inland of the _saqia_-irrigated lands, was, as already mentioned, among the earliest of the provinces to enter upon such an undertaking. The Government helped in the enterprise, with some reservations, by granting concessions of a liberal nature in regard to land, and the first concessions were given at Shendi and Zeidab (see below).

Thus, cotton growing on a systematic basis was commenced, and by the beginning of 1906, albeit on a small scale, cotton was being grown more or less successfully in the White Nile district of Dueim (where an experiment gave results between 17.5 and 26 _kantars_ to 2 _feddans_), in Khartoum Province, where some 400 _feddans_ were put under cultivation, in Kordofan Province whence 100 different exhibits of produce were sent during the year (1906) to a local cotton show, and in Tokar and Baraka Deltas.(1)

Up to the end of September, 1906, sufficient cultivation had been carried out to enable it to be seen that the country could indeed offer considerable inducement to growers and to the capitalists to perservere with the undertakings notwithstanding the many disappointments occasioned by uncertain rainfall, a low river, and the visitations of swarms of locusts (see Chapter Three). By 1911, however, 31% of Sudan cotton was being grown by flood, about 40% by rain, the remainder being along the main Nile and tributaries, and the heartening feature was that about 91% of this cotton was grown by native cultivators.[2] Moreover, in order to show the natives that efforts on their part to cultivate cotton in a systematic way would be well rewarded, Messrs. Carver Brothers of Alexandria, under the auspices of the B.C.G.A., sent representatives to the Sudan to buy cotton by cash from the growers.[3] At first, indigenous cotton as well as that grown from Egyptian seed was accepted at 40 and 60 P.T. respectively per kantar of 100 lb. delivered at the railway. Secondly, a bonus of 15 mms. per kantar of Egyptian cotton to be divided amongst the village heads near whose villages the cotton was grown. Thirdly, the Government distributed 1,500 ardebs of Egyptian cotton seed in various provinces, the condition being that if the crops were fair, the price of seed was to be recovered from the sale of cotton. Fourthly, a circular in English and Arabic, describing the proper methods of cultivating cotton and of picking, was distributed in all areas. Fifthly, before the cotton season, Carver Brothers wrote offering 55 P.T. per kantar of unginned Egyptian cotton, clean-picked and dry, delivered at the railway. The price was later raised to 60 P.T., and as European gins were being installed at Kassala and the Gordon Memorial College workshops in Khartoum, a price of 185 P.T. per kantar of 100 lb. of ginned cotton was also offered. A further rise to 66 P.T. per kantar unginned, and 200 P.T. per kantar ginned, cotton was also made.[4]

This final encouragement helped many individuals, native and alien, to take up cotton cultivation in many areas in the form of small experimental farms, notably at Shendi, Sennar and in the Gezira, although some were also found along the river north of Khartoum.

I SMALL EXPERIMENTAL COTTON FARMS, 1901-1911 (Fig. 50)

(i) SHENDI FARM

In a report on cotton growing at this farm in 1902-1903, it is stated that the farm was established chiefly with the object of ascertaining whether cotton could be grown successfully on irrigated land in Shendi District.[5] One of the most important investigations carried out was to determine the best time for planting cotton in the Sudan, because this was necessary from the point of view of the allocation of the Nile Waters, which has been discussed in Chapter Five. However, from the first year's results, it appeared that cotton had grown well whether sown in September or October after the flood, in March and April as in Egypt, or in June or July before the full flood. Nevertheless, it was found that, although each period presented certain advantages, a prolonged study was required in order to decide which was the best.

On the cotton varieties tried during the period from August to November (1901), the majority were Egyptian: Ashmouni, Galioubi, Joannovitch, Abbasi, Mit Afifi, and some American varieties which had been successfully tried in Upper Egypt. The Ashmouni cotton gave the most satisfactory results, and the rest yielded small crops, except Galioubi which failed entirely. The cotton from Abbasi and Mit Afifi was of fair staple and quality.(6) During March and April, 1902, the seed of the Abbasi, Afifi and Joannovitch varieties was again tried and satisfactory results were obtained except in the case of the last variety. In another experiment, yields amounted to 400 lb. per feddan in case of Afifi, and ranged from 450 to 500 lb. in the case of Abbasi and Joannovitch although the latter was again unsatisfactory, its fibre being inferior to the former both as regards colour and staple. But the yields obtained with cotton sown in June and July, 1902, were less favourable than had been anticipated, probably on account of a deficiency in water supply.(7)

From these experiments the conclusion was arrived at that cotton of good quality could be grown, and that Abbasi cotton was the variety so far found to be best suited to the Sudan conditions. The Afifi cotton was of fair staple but rather coarse, while Joannovitch crop was of fair length and fineness, but was lacking in strength and inferior to the same cotton from Lower Egypt.

(ii) SENNAR FARM:

In this farm, experiments were conducted on cotton growing by both artificial and rain irrigation. In the case of the former, a cotton plantation was sown with Afifi seed in July, 1903, and the plants were watered occasionally by means of saqias and shadufs. Four crops were obtained, the first of which was gathered in November and the last in December, the average proportion of lint obtained in both cases amounting to 31.2% of the weight of the unginned cotton, and in general the quality was good. Similarly, some samples of cotton were grown on rain-land; the first sample consisted of the type known as Hindi which is said to have been derived from seed imported into the Sudan at a very remote time - probably from India. This cotton was an inferior kind, and indeed introduced a grave difficulty into cotton cultivation in Egypt and later in the Sudan, as its seeds became mixed with that of all good commercial varieties and thus affected their quality. However, the fibre was white but of poor quality, weak and 0.75-1 inch long.(9) The second sample was derived from Egyptian seed which was probably introduced into the Sudan by Mumtaz Pasha in 1871, and this cotton showed evidence of great deterioration, already having lost its colour, and with only a veneer of the general characteristics of Egyptian seed. This cotton, although slightly coarse and 1¼ inches long, it preserved the general properties of Egyptian cotton, and thus, instead of importing fresh seed from Egypt, it was suggested that a system of selection from this sample should be adopted to obtain a variety of cotton acclimatised to this district.(10)

With regards to rain cotton, the varieties known as Mumtaz, Belwa and Abu Hareira were grown without irrigation on the Dinder. The last two were indigenous, and were grown chiefly on the river banks, they lasted for a three years or more, and yielded the best cotton in the third year, while the Mumtaz variety was usually grown on non-irrigated land and was renewed every year (see Chapter One). However, the best districts for cotton growing or non-irrigated land on the Blue Nile is reported to have extended southwards as far as Abu Na'ama, where the average in a good year is said to have amounted to about 360 lb. per feddan of unginned cotton, while in a bad year it fell to almost nothing. On irrigated areas Afifi and Mumtaz did well, and this showed how necessary irrigation was for successful growing of cotton.(11)

(iii) MEDANI AND KAMLIN FARMS:

During the year 1903, an experiment was commenced at Wad Medani with seeds of Afifi variety, which was distributed to the natives. The assistance of an Egyptian expert was obtained, and the leading village heads were brought together and given practical instruction in cultivating cotton by irrigation.

The Kamlin Farm was an area of 150 feddans and was leased to cultivators at about £E.4 per feddan as rent and for water. The policy of the Government in supplying the more worthy cultivator with his land and what he needed to make it productive at the lowest possible price - that is without incurring any financial loss upon the enterprise - proved sound. But unfortunately, the land here was not representative of the Gezira Plain, and the station was situated on the river-bank and not upon the main plain. So it was of little use as a test of the capabilities of the Gezira soil for cotton growing.

(iv) FARMS NORTH OF KHARTOUM

Mention has already been made of the Shendi Farm, and early in 1904, 650 feddans were planted with cotton between Berber and Khartoum, the greater part of the crop being used locally in weaving damour. However, most of these farms were owned by Europeans, and except for one or two, all of them were unsuccessful. Failures were met at such places as Fadlab, Kadaro, and Minani Farm on the Atbara river, chiefly due to a selection of unsatisfactory sites and the planting of crops which, it became known, were altogether unsuitable for the districts (see Chapter Three).

Dongola Province was also considered to be a good place for cotton growing because there exist large basins, such as those of Kerma and Letti, where large irrigation works were undertaken to allow for the flooding of larger areas (Fig. 53), and application for land was accepted and allotted in the manner shown in Table 43 App. 43. The largest new work undertaken was Letti Basin Project (Fig. 54), which allowed for the flooding of 11,000 feddans, and other works were done to provide for the flooding of some further 4,000-6,000 feddans. In Kerma Basin some 26,000 feddans were cultivated as against 3,000 in 1909, thus bringing the total area flooded in Dongola Province to about 40,000 feddans.(13) In 1903, 3,300 feddans were planted with cotton, and when a sample grown from native seed was found to be inferior in quality, trial of Egyptian types was suggested.(14) However, as already mentioned in the previous chapter, the concern for natives' interest made some officers to reconsider giving land concessions here, and indeed cotton growing was not ardently followed here as in other places.

However, in most of the government-owned farms, especially in Dongola and parts of Berber Provinces, stress was made on the production of food crops more than on cotton, while the opposite was true of the privately-owned plantations, such as that of Mr. Neville's at Dar Mali and of the S.P. Syndicate's at Zeidab, in Berber Province (Fig.50). The success at these two places showed that whenever a compact block of good land existed with a sufficient population, it should be possible to install modern pumping machinery in places of the uneconomic saqia. It also showed that taxation of the instruments of production, including fuel, by means of customs dues, railway rates and royalties, had hitherto handicapped irrigation farming in an unsuccessful attempt to compete with areas enjoying relative natural and fiscal advantages. Moreover, in addition to crops grown for sale, it was clearly shown in both places that it was well worthwhile to grow fodder crops, such as lubia and clover, mainly for the purpose of feeding sheep. Of all these farms, however, it was the Zeidab Estate which had far-reaching effect on the development of cotton growing in the Sudan.

II THE MAIN PILOT STATIONS

I THE ZEIDAB ESTATE: (Figrs. 55 & 56)

Mr. Leigh Hunt, an American philanthropist, always attracted by the unpeopled regions of the world, visited the Sudan in 1900 and impressed by the vast tracts of uncultivated cultivable lands, discussed the possibilities of cotton growing with the Governor-General, and made a proposal to take up 10,000 feddans, with a claim to 40,000 feddans in the future, for immediate cultivation as a cotton plantation. The plot he selected was at Zeidab; labour was to be supplied by skilled Negroes from the U.S.A. Thus, he brought over a number of Negroes who had been educated in Agricultural Colleges, with a knowledge of mixed farming, dairying and the growing of various crops; included in the scheme was a small area for growing cotton. Supported by British capitalists in London, Mr. Hunt commenced forthwith to clear the ground and prepare it for cotton planting. Undaunted by several years of hard struggle against difficult conditions and adverse criticism he, assisted by a Mr. Neville, persevered in the enterprise. But his venture was a failure. Like many other pioneers, whether they enter upon land cultivation or mining, he committed initial mistakes which cost him prodigious amount of money; the climate did not suit the American Negroes, and they were shipped back to America. Finally, he sold his interests to a London firm, and a company was formed under the title of Sudan Experimental Plantations Syndicate which acquired the option land from Hunt, with all his rights, interests and obligations. In 1907, a new agreement was signed with the Sudan Government and the title was changed to Sudan Plantations Syndicate (S.P.S.).[15] Thereafter, Zeidab Estate was turned over mainly to the production of Egyptian cotton and the necessary food crops as parts of the crop rotation.

The S.P.S. was granted an option to take up a further large area adjoining its concession, and was also given permission for a period of three years to irrigate from its existing pumping installation some 1,400 feddans of native-owned land with the hope of encouraging private enterprise to take up the idea of providing irrigation facilities for riverine lands owned by the natives. This offer was accepted, and a block of 5,000 feddans was granted. In 1904, an old channel at Fadlab in Berber Province, originally made by the province governor in 1870, was opened and lengthened, and 300 feddans were added to the total of levelled and canalised land, thus bringing about 1,500 feddans under cultivation (Fig. 55).[16]

The initial risks, however, were great due to adverse climatic conditions, and in fact the 70 feddans planted under cotton (the whole area attempted) in the first year were destroyed.[17] Nevertheless, the Zeidab Concession in particular shows that good results may be obtained by careful management. In his report of 1904 Mr. Bonus drew attention to the various many difficulties which beset the landed interest which included deficient water supply, costly transport, shortage of labour, and lack of skill, enterprise and inclination on the part of labourers. "The experience of the managers of the Zeidab Concession make it fairly clear that, for the present, land reclamation rather than actual cultivation is the most promising field for land companies."[18]

(i) Leaseholder and Freeholder:

The question of whether large or small ownership can be cultivated to the greater advantage was undoubtedly determined by the sparsity of population then in favour of peasant proprietorship, and this situation was recognised by the majority of the estates. Elsewhere, attempts to cultivate large areas by the extensive use of hired labour was sooner or later abandoned.

It is to be noted in this connection that the actual banks of the river, comprising the rich silt soil of the new alluvium, were everywhere occupied in freehold by the saqia population, and that the estates in European or Egyptian holding were based, as stated in the previous Chapter, on concessions of karu land lying at a lower level between the flood-bank and the desert plateau, beyond the range of saqia operating from the river (Fig. 55). Any unclaimed land here belonged to the Government, whereas all the hinterland was Government property as part of the desert.[19] The natives had never had any inducement to occupy and settle on the hinterland because they could not irrigate it. Their efforts, from time immemorial had been concentrated on the foreshore of the river whence irrigation could be derived direct by their primitive contrivances. Thus, it is obvious that only the merest strip of land on the river bank was cultivated - measured solely by the amount of food which the natives needed to cultivate, or the extent to which they would suffer hunger and privation rather than endure the exacting labour of irrigation. The problem of finding labour for the development of such estates, however, was solved at Zeidab by granting leases for 30-feddan holdings to tenants drawn from all available sources.[20]

However, owing to the failure of the Egyptian cotton in 1909, exceptionally high prices were paid for the local crop, and the S.P.S. was encouraged to supply water to 1,400 feddans of neighbouring land in native ownership some of which, consisting of islands, had to be cleared by the natives before cropping.[21] As mentioned in Chapter Six, the S.P.S. supplied cotton seed under arrangement with the Government, who advanced money to the natives to buy it, or, under her permission, from the S.P.S. as an advance on terms most advantagous to the tillers of the land (App. 44a). For the water rents, a charge of 250 P.T. was made by the S.P.S. However, this experiment, despite the difficult times and bickerings, showed the fact that the riverine peasant, when working for his own gain, was capable of cultivating in an efficient manner. Nevertheless, the rental system brought serious drawbacks, and the S.P.S's revenue, in face of losses from poor yields, had to be supplemented by small profits on the charge for ginning and on the differential between the price it paid to the tenant and the price at which it subsequently sold the cotton.[22] The idea of a fixed rent, regardless of the crop yields attained, was strange to the local cultivators and consequently the rental system was changed to partnership between the management and the cultivators, as has already been discussed in the previous chapter.

(ii) System and Method of Cultivation:

Of the total area cultivated in 1910, there were 3,000 feddans under cotton, 3,000 under wheat, and 2,500 feddans under leguminous crops. This area was apportioned in plots of varying sizes but generally of 30 feddans each, to tenants who were obliged to conform to the rule that one-third of their land must be under cotton annually, one-third under wheat, and one-third under leguminous crops of ploughed and left fallow, and to other rules as laid out in App. 44b.[23]

When a tenant took up a new land, he cleared it of trees and roots at a price agreed upon. Initial clearing and levelling were expensive because of bushes and scrub, and the unevenness of the land (see Chapter One), and the tenants were assisted by loans of implements and many advances in the manner described in Chapter Six. They were further encouraged by offering £5 as a prize to the tenant who produced the largest yield per feddan.(24)

The annual rent for cotton land charged to the natives varied from 412 P.T. to 512 P.T. according to the quality of the land, for wheat it was 258 P.T., and for leguminous crops 154 P.T. per plot of 10-feddans, including water supply. Moreover, the S.P.S. debitted the tenants 20 P.T. per kantar for ginning and transporting cotton to the railway station on the east bank (Fig. 50). The ginning factory consisted of 10 gins, a sieve for seed, and a 280-ton hydraulic press, each gin had the capacity of 70-80 lb. per hour, and the press could turn out 20 bales of 400 lb. per day.(25) A steam tug and two 25-ton barges connected the plantation with the railway. The transport per ton of 22 kantars of lint, which may be taken as the average yield of 6 feddans, was £E.8.32 to Liverpool, including selling charges (1913). 3.2 tons of seed cotton usually produced 2.2 tons of seed and one ton of lint; the freight and selling charges of the quantity of seed were £E.6.20, making altogether £E.14.52 for transport of lint and seed to Europe. Accordingly, the cost of cotton growing was estimated to be £E.15 to £E.17 per 10 feddans up to the time of picking, including the tenant's own labour, his living expenses, and outside help which he used at times of sowing, hoeing and picking.(26) In 1909/10 season, which was a good one, the approximate average return per feddan was £E.27.5. However, due to damage by boll-worms and cold snaps, yields fluctuated as Fig. 57 shows, and thus the optimistic picture drawn by Mather of high yields of 4,500 lb. of lint per 10 feddans, and consequently of a net profit of £160, was hard to realise as the subsequent years showed.(27)

With regard to the method of cultivation, cotton was sown in May, American cotton in the middle of June, all being ready for picking in February. The land was ploughed twice and ridged by means of a ridging machine, each ridge being 90 cm. apart from the other, and then holes were made 80 cm. apart, with five to eight seeds per hole. The first watering was given immediately after sowing, the second about 20 days after the first, and the third about 15 days later. The field was then hoed, followed immediately by thinning the plant out to two or three per hole, and then irrigation was continued at 15 days' interval. Hoeing, unless the land was baked and weedy, was done twice at least and before the plant was too big.(28)

Picking started by November for the American variety and by December for the Egyptian variety, and all pickings, which must be clean, were spread on a mat in the sun to drive out insects and to dry. The wages for picking ranged from 30 to 40 P.T. per kantar of 315 to 340 lb., and after collecting a few bags of 315 lb. each, they were brought to the stores where cotton was graded by a competent classifier, and the S.P.S. bought from natives at Alexandria prices, less transport and ginning expenses. The tenant was obliged to pay his rent before he was allowed to sell his cotton to any other firm.(29)

With regards to other crops, wheat was sown in November to be harvested by the end of March, and the yield on the average was about 333 lb. per feddan, which was usually sold to the S.P.S. at a price ranging from 125 to 128 P.T. per ardeb. Chopped straw was sold to the army and represented a value of 70 P.T. per feddan. Because the people kept the maize for food, the rent for land on which maize was grown was collected in cash. This crop, which was sown twice in April/May and October/ November, yielded from 2 to 5 ardebs or 333.5 lb. per feddan valued at about £1 per 400 lb. Berseem (clover) was sown in October/November in basins filled with water, and usually gave two cuttings the second of which was threshed out for seed which usually gave three-quarters of an ardeb, valued at £2 per ardeb. Berseem and chopped straw were used extensively for feeding sheep, cattle and camel. Thus, March and April being severe months in the desert, these animals were driven to the cotton fields to graze on leaves and young stems of the cotton plant, for which the nomads paid 150 P.T.(30) Then the residue of the plants were pulled out and burnt. Since no manuring was done except by means of leguminous crops, such as beans and clover, and ploughing in of lubia every third year as a green manure, the animals added some manure during the grazing period. Lubia in most cases was eaten off in the field by the tethered animals, and thus one feddan of lubia gave to the soil about 50 lb. of nitrogen through its roots, and some more from the animals. An entire crop of lubia ploughed in usually gave about 300 lb. of nitrogen.(31)

Irrigation of this area was done by four 30-inch pumps operating at a maximum water-lift of about 8 metres and a minimum of 7.5 metres. They were erected on Zeidab Island at a cost of £42,000, and used wood as fuel (Fig.56). From the island the main canal, which was about 5 m. wide in bed, 8 m. at the level of the land and had a depth of 1.5 m., carried the water to the main-land for about 7.37 km. For the native-owned land through which the canal was built and which was affected by blocking the channel that separated the island from the mainland (Fig. 57) the S.P.S. had to pay an agreed amount to those natives affected as a compensation. The distributory canals were 2m. in bed and 4m. at the level of the land, while the subsidiary canals were 0.5m. in bed and 1.5m. at the level of the land, and from these small canals took off to irrigate 10-feddan blocks (Fig. 55). Subsidiary canals fed 70-feddan blocks, and all in all the whole canalisation cost about £17,000 with a yearly upkeep of £600.[32]

(iii) Cotton Varieties Grown:

As the case with other parts of the Sudan, the varieties first grown here were mostly Egyptian and some American (Table 3). Of the Egyptian varieties, Ashmouni paid best on poor land and generally branched better and carried more bolls, while on good land Sakel and Voltos were remunerative, the latter also ripening earlier, than other varieties. The general experience until 1913, however, had been that when cotton was bad, wheat proved to be an excellent crop, and vice versa.[33]

Nonetheless, these varieties, being more susceptible to diseases, proved to be unsuitable to conditions at Zeidab, and thus a shift was made to the long-staple American variety. However, the reason for the change from Egyptian to American appears to be climatic. At the end of the rainy season, there is a sharp fall in atmospheric humidity and a quick rise in temperature - both of which are more marked as one proceeds northwards towards the Nubian Desert. Cold snaps are sometimes experienced in December, January and February, the mean temperature for these months is 25.6°C and occasional minimum temperature as low as 4.5°C is experienced. Undoubtedly these cold snaps are injurious to cotton, especially so if the weather throughout the day has been warm, as dew deposit takes place during the night which seems to cause a sticky substance, Aphis gossypii, on the leaf causing it, and also young flowers, to drop off. More important also are the very hot desert winds during June and early July which may, in conjunction with water strain, cause shedding of bolls.[34] The result is that with early-sown cotton (April/May), the plant during the rainy season showed great vegetative growth and became possessed of a large area of leaf surface. With the rapid change to a dry and hot atmosphere in October, transpiration through large areas of leaf surface is excessive and the plant tends to shed leaves and bolls in order to establish a balance. On the other hand, on account of the cold snaps in December and January, sowing could not be unneccessarily delayed.[35]

Thus, experience after several years showed that a more quickly maturing variety, such as Americal long-staple cotton, which can be sown from July to early August, is the more suited for this locality. With this late sowing the vegetative growth is less luxuriant and the change to a hot and dry October is less severely felt.

In Chapter One mention has been made of the growing of American varieties in the Sudan prior to 1913, there are also reports in 1913 of traits of Sunflower, Nyasaland Upland, and other types of imported American cottons on pump schemes along the banks of the Nile in Northern Province.(36) In 1914, a Nyasaland Upland type was being grown at Zeidab and in other estates in Berber Province, and by 1924 the strain of Sudan American known as Pump Scheme Strain was well-established, and it appears probable that it was derived mainly from Nyasaland Upland. Thus between 1913 and 1925 various introductions from America continued to be made, but none of these proved as satisfactory as Pump Scheme Strain. The adaptability of this strain may be due to the mixture of varying plant types in the crops which enabled it to settle down in different environments. However, work on the various imported strains showed little promise in breeding a superior yielding type, and gradually the attention of the cotton breeder was devoted to other cottons of higher quality lint or of earlier maturing habit.(37)

The Delta Webber seed was imported from America and was grown on some pump schemes in the Berber area, and a selection of this cotton, Derelect 1, reached the commercial stage but never found great favour. Instead, the Zeidab Estate imported the long-staple Cocker Wilds strain from America, and this later gave place to Wilds No, 16 S.C., which is still grown there and is one of the highest American quality produced in Africa today. Although grown under irrigated conditions, it does not give high yields mainly because of attack by pink bollworm and a capsid. But it has effective length of about 45, a hair weight of about 165, and a high standard count of about 70 and, although susceptible to blackarm, it is fairly fine, giving yarns of appreciably greater strength.(38)

(iv) Cotton Yields and Production:

The first season of Zeidab was almost ruinous, the whole area attempted in 1906, about 70 feddans, being destroyed. But by careful management in 1908-9 good crops were obtained and yields per feddan reached the record figure of 4 kantars from Afifi (Fig. 57). The season of 1911, however, was very unfavourable for Zeidab, the cotton crop had to suffer much from cold weather and from the attacks of bollworm, so that the S.P.S., besides having suffered direct losses, was also suffering from the fact that the natives were not in a position to pay for the water rent, thus making the S.P.S. refuse them water temporarily. The season of 1912, although there is a decrease in area cultivated, was more satisfactory, and the first dividend of 12.5% was paid by the S.P.S.[39] During the following years fluctuations in the yield of cotton coupled with no less marked stability in prices, continued to constitute a problem which was partially solved by the gradual introduction of types of cotton showing greater resistance to unfavourable climatic conditions. The yield over the whole estate during the six years ending 1913, as Fig. 57 shows, ranged from as high as 4 to as low as 1 kantars per feddan. In 1914 crops, especially from the water-tenants' area, were again unsatisfactory, and prices even lower (Fig. 41 and Table 38), and consequently the second dividend was reduced to 2.5% (App. 38).

From Table 3, it will be clear that although the Egyptian varieties, Sakel, Afifi and Ashmouni can give higher yields, they were, as already noted, highly susceptible to odd climatic conditions and to damage by the pink bollworm. The high yields until 1909/10 can be attributed to a higher fertility in the soil and a more or less careful management, but the failure of wheat in 1915, though curiously increasing yield of cotton, showed that its inclusion in the rotation tended to exhaust the soil and effect the yield of cotton when planted in places previously occupied by wheat. So wheat was dropped out of the rotation from 1916/17 season, and with the introduction of Webber throughout the Estate, a marked increase in yield, except for 1916, is noted, particularly from 1921/22 season. The low yield of 1916 is due to a cold winter which affected the whole area as well as the Gezira.[40]

The original area of 10,000 feddans was later extended to the south and north on both Government and native land (Figrs. 55 & 56). The northern extension, called Timerab, was bought from the Government at about £E.1,785.922, and started production of cotton from 1917/18 season. Here, an additional pump was installed to maintain supply from the Zeidab main canal, the native land being irrigated by the old Fadlab canal which was cleared earlier in 1904. However, as Fig. 58 shows, the Timerab yields exhibit a low yield of more or less uniform character, while those of the Water-Tenants show good yields, especially from 1914-19 and 1922-24, which can partly be attributed to the more fertile alluvial soils of the native land. The low yields in between these years were due to cold snaps and attack by asal.[41] However, these yields are averages of many varieties, and to have an idea of the yield of each variety, let us examine the 1916-17 season crop (Table 37):

TABLE 37 ZEIDAB: 1916-17 COTTON CROP, YIELD BY VARIETIES

Variety	Source of Seed	Area in Feddans	Total Yield	Yield/Feddan
			Kantars	Kantars
Ashmouni	Zeidab Seed	1,170	604	.615
-do-	Egypt seed	780	1,054	1.364
Sakel	" "	180	170	.944
Afifi	Barakat "	650	399	.613
American	Zeidab "	370	490	1.325
		3,150	2,717	

Source: Zeidab Group, op. cit.

From this table two things are clear: (1) that Ashmouni seed from Egypt gives better and higher yields than from local seed, which indicates the inferiority of the latter, and (2) that the American, even from local seed, gave almost the same yield as the Ashmouni from Egyptian seed. This fact, coupled with its resistance to severe weather conditions and diseases, proved the American to be the best suited to the area. Thus, although 7% of the crop of 1918-19 season, all of which was American, was infected by bollworm, the yield was still relatively high: 2.71 kantars per feddan.[42]

However, the cause for the spread of disease was thought to be in the native weaving industry. Prior to the introduction into the Sudan of Egyptian and American types of cotton, the only type grown was the poor quality known locally as Baladi. Its cultivation was widely practised both under irrigation and as a rain crop, but more particularly in Dongola, Berber, Khartoum and Blue Nile Provinces. The crop was grown entirely to meet the local demand for cotton, and was used for spinning and weaving it into the native cloth, damour, and sundry other purposes (see Chapter One). When American cotton was introduced into the above-mentioned provinces, it largely took the place of Baladi, but the cultivation of the latter continued as it was considered by the natives to be a better drought-resistant cotton, the lint more suitable for spinning and weaving. However, those notions were dispelled soon: the growing of Baladi cotton in the prescribed cotton areas was prohibited, the main danger to the cotton crop of the damour industry being the storage in native houses of infected seed cotton and cotton seed which, in one way or another, caused the spread of disease to the commercial crop area.[(43)] This prohibition had to be enforced with strictness and rigidity by the management as part of the Government measures and regulations for cotton growing which were embodied in the Sudan Cotton Ordinance of 1921 (App.44).

(v) Management of the Estate:

As laid out in the agreement between the S.P.S. and the Tenant (App. 48b), the tenant was obliged to obey the orders of the officials of the S.P.S. enumerated in the above agreement. The European management initially consisted of one manager and four inspectors, each of them having about 2,000 feddans to look after. The land was fairly undulating and overgrown with shrubs and palms when it was first reclaimed, thus necessitating levelling which cost as much as £10 per feddan in some places, the average cost being £5 per feddan. As the land was rarely perfectly level, as in the Gezira, there was always a difficulty in irrigating the fields, and a great deal of the attention of the inspectors was taken up with its direction. Everyone of the tenants was visited by an inspector at least once a day, and a careful account was kept of his daily work.[(44)]

The Zeidab experience had been more than valuable when Tayiba Station was started in the Gezira in 1911. Sir William Mathers' idea that "... commercial men of the right sort can work both more expeditiously and efficiently than officials however able", found an echo in the hearts and minds of many people, above all in those of the Sudan Government and the B.C.G.A. "The foundation of success has been proved to be the principle of cooperation between native labour and the proprietors of the Estate. The effect on the natives has been to develop self-respect and to inspire them with the ambition to become tenants of the 30-acre plots, each of which one man with his family is competent to cultivate to the best advantage."[(45)]

Zeidab was the first school in which cotton cultivation by irrigation was taught, and success here showed that whenever a compact block of good land existed with sufficient population at hand, it should be possible to instal modern pumping machinery instead of uneconomic saqia. Thus the prospects for Egyptian cotton in the Sudan, which until 1906 seemed dim, were again brilliant. This was because "no great increase can be expected before some irrigation system was introduced", since the Egyptian plant could only be cultivated on saqia land which it occupied for eight months in the year, without producing anything in the way of forage for the saqia cattle.(46) The success of Zeidab experiment proved this point and, although Egyptian cotton was unsuccessful, it also stimulated orientation towards the warmer south - to the Gezira where prospects, particularly for long-staple cotton, were even brighter and more promising. Experiments were necessary to test the suitability of this area for cotton cultivation, and in respect the experiences, both managerial and agricultural, gained at Zeidab proved vital for success as it was shown at Tayiba - the first main pilot station in the Gezira.

II TAYIBA PILOT STATION (Fig. 59)

As mentioned in Chapter Five, Garstin wanted wheat to be grown in the Gezira because it seemed the better crop for the country for being easier to raise (than cotton), involving less labour and cost, and having a market "at the door of the Soudan" in Jedda. A land tax of 50 P.T. per feddan on land grown with wheat and cotton was to cover the costs of irrigation and as revenue.(47)

However, the return which might be expected from a cereal-producing scheme was difficult to estimate, but according to a Government report of the time, "it is worth noting in places where the cultivators of the Sudan are familiar with irrigation, they have frequently expressed their willingness to pay one-third of any crops raised on their lands" for the supply of water (from the pumping stations and otherwise) necessary to mature these crops, and the realisation of any such land in the form of any taxation and water rate "should give a handsome return on the capital invested apart from indirect benefits to the country as a whole".(48) Nevertheless, wheat as the main crop was discarded mainly because of severe competition from other wheat-producing countries, such as the U.S.A., Canada, Australia and South America, and instead opinion in favour of cotton grew stronger and finally won over because of the various reasons enumerated in Chapter Five. However, before the main Gezira Canal Project was embarked upon, the main objective was clearly defined: to ascertain whether cotton could be profitably grown on land coming within the scope of the Project by local cultivators with water which was available during the period of high Nile: 15th July to 30th March. The area chosen for the purpose was 3,000 feddans, which was carefully selected to be as representative as possible of the soil which the Gezira Scheme would eventually irrigate. Tayiba was chosen for this purpose to become the first pilot station in the Gezira (Figts. 50 and 60).

However, it was the Government who started this station, and the S.P.S. was asked by her to take charge of the management of the station - indeed a wise step under the prevailing circumstances. The S.P.S. had highly-experienced agricultural experts who were not only well-versed in the technical affairs of a cotton plantation, but also understood the handling of the natives - a difficult matter for any newcomer to the country. Moreover, the S.P.S., as already stated, was able to induce trained farmers to come from Zeidab Estate to Tayiba, and these Zeidab farmers, among them some natives, taught a small number of the inhabitants of the Gezira the proper way of growing cotton.

(i) The Tayiba Agreement:

When the station was first installed in 1911, the S.P.S., by agreement with the Government, undertook, for a period of four years, to conduct an experimental station of about 3,000 feddans for cotton growing at Tayiba, the intention being, subject to the success of such an experiment, that a large scheme comprising the irrigation of an important portion of the Gezira Plain, should be taken into consideration.[49] The Tayiba Agreement also provided that the experiment should cease if the object had been attained before the period. If, on the other hand, the trial was a success, the Government undertook to grant to the S.P.S. an option to purchase 10,000 feddans of the Government-owned land within the area to be irrigated (Fig. 47), at 20 P.T. per feddan, or 30,000 feddans of the rainland, (i.e. outside the to-be-irrigated area) at 10 P.T. per feddan.[50] But when land settlement revealed that the only large Government-owned land in the Gezira was of very poor soil at the northern tip far beyond the proposed canalisation, the problem of implementing this undertaking and of who was to manage the Gezira Scheme, cropped up. Thus, after much discussion and meetings the principle that development should be a matter of appropriate stages, and not of permanent concession, provided the basis for the first tentative agreement between the Government and the S.P.S.

When the station proved an unqualified success, an agreement was concluded between the two in 1913 defining the rights and duties of both partners regarding the proposed development of a preliminary area of about 100,000 feddans under cotton. The basis of the agreement, besides the proposed main scheme, was a joint undertaking by the Government in partnership with the S.P.S. to develop the cultivation of the area irrigated, and to direct and assist the native cultivators. The agreement was to be in force for a period of ten years from the time water became available, with an option for a further five years, and remuneration of £250,000 by the S.P.S.(51)

As already mentioned in Chapter Six, the Tayiba station was run on the rental system for two years, but afterwards it was put on a partnership basis. This means that everything that came out of the soil in the way of cotton was sold to the best advantage and divided between the three partners on a cooperative basis: 40% to the tenant, 35% to the Government and 25% to the S.P.S. (the management). The green stuff, lubia, which formed (and still forms) one of the rotations was given free to the tenant. For the proportion received, each partner had to carry out certain duties.

Thus, the Government, under this partnership system, supplied land and water, i.e. the dam and the main canalisation and their maintainence, payment of rent to the natives, and amortization. The management (S.P.S.) was to prepare the land, clean and level it, and then let it to the people or tenants, for agriculture, and to make the subsidiary canals, roads, drainage and put up ginning factories and buildings, and to make advances to the tenants (which were repayable without any profit), and to finance the tenants after the work was done every fortnight until the crop was harvested, marketing of the crop and supply, and upkeep, of agricultural implements to the tenants. The tenant was the labourer, working under the supervision and the instruction of the management; his share was to cover cost of labour, seed, agricultural implements, use of tillage animals and his profit.(52)

With respect to this agreement, however, it should be remembered that the Gezira Project, for the irrigation of the Gezira Plain by a dam at Sennar, was initiated and well advanced long before the S.P.S. evinced any interest in the area, and had nothing to do with the S.P. Syndicate's agricultural venture at Zeidab. Survey operations for the Project were started methodically about the year 1905, and a preliminary report on it was presented in April, 1908, by the Inspector-General of Irrigation (Chapter Six). Indeed the Project was so advanced in 1907 that it was the determining factor in the decision as to the route to be followed by the line of railway from Khartoum across the Gezira to El Obied, while in 1906 the Government began a cadastral survey and settlement of the land titles within the area likely to be irrigated. The reports of the Department of Agriculture show that since 1905 one of the main objects of the small-scale experiments conducted by that Department had been to ascertain how far cotton could profitably be grown under the conditions of irrigation imposed by the Egyptian Government (Chapter Five). The Tayiba experimental station itself was started by the Government under the management of its own Department of Agriculture, and the necessary financial provision for carrying on the station was made, and the order for the pump placed, before the agreement was come to with the S.P.S. that they would undertake the management of the station. Moreover, in the agreement with the S.P.S. it was distinctly stated that the station was not to be worked as an experimental farm alone, but mainly as a test station, that is to say, the land was given out to the natives who were to work in the same manner as it would be worked when the Gezira Scheme was in operation. Each tenant was given a 30-<u>feddan</u> plot on a yearly tenancy, and the S.P.S. was to reserve one-tenth of the total area for experiments which they undertook on behalf of the Government.[53]

By adopting this deliberate policy, both externally in their attitude to foreign capital and internally in their attitude to what was equitable for the people - itself an outcome of their refusal to accept the view that a higher standard of living was all that mattered irrespective of how it was obtained or how its benefits were spread - the partners of the future scheme established equitable and practical principles for development than to hasten pace. They rejected the idea that the motive of private profit was alone the best determinant of development, and whatever private capital they accepted was not in any way or by any means to dominate or deflect them from what they thought right: the harmonious evolution of the natives in their own society. This attitude led them to demand, both for the purpose of excercising enough influence on policy and to get more money for the country, a large State share in the provision of capital and profits.

The tenants were to obey the instructions of the S.P.S. inspectors as laid out in the agreement between them and the S.P.S. (App. 49). In case there was disobediance on the part of the tenants, the advances on the crop were withheld. The tenants were, however, entirely free agents as regards the disposal of their produce after having paid their rents. The rent of the first year was fixed at £2 per feddan, but was raised to £2½ in 1912 and again to £3 in 1913, inclusive of water rate.[54]

(ii) Methods of Irrigation and Cultivation:

In Chapter Two, the Blue Nile was shown to exhibit big variations between high and low levels, ranging from 71 to 52 feet respectively. Thus, it is natural that the cost of pumping is an expensive item, and accordingly it was understood at the very commencement that the Barakat test station could be a costly undertaking. The water-lift was the highest along the Nile.[55] The output of the pump was 27.5 cubic metres per minute (c. .46 cumecs), and the prime cost of the pumping station was about £18,000, the fuel, coal briquettes, cost 340 P.T. per ton free Tayiba, and consumption was about 1½ tons per 12 hours. The water horse-power, i.e. lift of one cubic metre of water one foot high per minute, was 123 when the lift was 71 ft. The water was taken by the main canal to the distributory ones which in turn fed the field channels that irrigated the field crops (Fig. 59).[56]

For cultivation, the land was ploughed twice and ridged during May and June, and a few days before the 15th July planting began. In each hole 7-10 seeds were put, the spacing being 60-70 cm. on the ridges. and 90 cm. from plant on the ridges, and irrigation commenced about the 15th July. Weeding was done about 14 days after the first watering; the second watering, as it fell within the rainy season, was given 25 to 30 days after the first, while the other waterings were given as required, about every 15th or 16th day, and hoeing was done three times, sometimes by hand and sometimes by cattle-drawn implements. The thinning out took place after the second watering, leaving two plants in each hole, and during this operation, any exotic variety, particulary Hindi plants, were carefully extracted. The bulk of picking took place in December.[57]

Water was supplied from the 15th July to the end of February, but if extra watering for wheat and cotton was needed, it was given in March at a fixed rate of 20 P.T. per feddan per watering. Important in this respect was to determine the water duty required by various rotation courses, as already discussed in Chapter Five.

The first year's experiments were made on the basis of a 3-year's rotation, the rotations adopted being: cotton, wheat, *dura*, and leguminous crops such as *lubia*, beans etc., and no fallowing was practised. Nevertheless, when the rental system was replaced by partnership during the second year, experiments with 90 *feddans* were made on a 2-year rotation system. The tenancy for the partners was to have as much as possible of the land under the paying crop, cotton, and therefore to adapt the rotation of cotton and leguminous crops alternately. Wheat, which proved to be exhaustive to the soil, had to be eliminated since *dura* could be grown in the summer to provide grain and fodder, and could be followed by *lubia* in winter. The experiment would be:

(i) 2-Course Rotation   Cotton)
                         Dura followed by) 20 *Feddans*
                         Lubia)

However, as regards this 2-course rotation, it was noted that *Buda* *(Striga hermothica)*, a weed parasite on *dura*, was already proving troublesome under the former rotation system, and the trouble was likely to be intensified on the 2-course rotation. Furthermore, the leguminous crop would not receive a good chance on being rushed in when the *dura* was harvested. It will also be seen that during the months of low Nile, water was required for 10 *feddans* cotton and 10 *feddans lubia*.(59) Thus, to turn the above 2-course rotation into a 3-course one, using the same crop, it would be as follows:

(ii) 3-Course Rotation   Cotton)
                          Dura) *30 Feddans*
                          Lubia)

Thus, even if wheat was grown, it was advisable from an agricultural point of view to have the two cereal crops on the same shift. *Dura* however, appeared once in the 3-course rotation, and there was, therefore, a better chance of combating *Buda*; *lubia* could be put in early and thus to receive a fair chance. Moreover, during the months of low supply in this rotation water was required for 10 *feddans* of cotton only. The chief extra cost involved was the small canalisation of 30-*feddans* in place of 20-*feddans* for each tenant. In considering this 3-course rotation in comparison with the 2-course one, the fact should be remembered that land at that time was very cheap and abundant in the Gezira, whilst the total amunt of available water during the months of low Nile was limited (Chapter Five). For the season 1912/13, that is, from 15th July - 21st March, the following table shows the amount of water per feddan per 24 hours over the gross area (Table 38).[60]

TABLE 38 THE AMOUNT OF WATER GIVEN PER FEDDAN PER 24 HOURS, 1912-13

Period	Gross Area in Feddans	Amount of Water/Feddan/ 24 hrs. over Gross area
July 15th - 31st	1,914	22.8 M^3
August	1,914	8.1
September	1,914	15.2
October	1,914	23.0
November	1,914	21.0
December	1,914	22.4
January, 1913	1,914	20.0
February	1,914	24.8
March, 1st - 12th	1,914	16.3, (or 11 M^3 if spread over whole March)

Source: Box 112/3 Sudan Archives

In the two seasons, 1911/12 and 1912/13, the average number of waterings given to cotton was 16 cubic metres, wheat 6, dura 4, and lubia 3-4. However, in the period of maximum demand, that is, October 20th - November 18th, the amount similarly per feddan was 30 cubic metres, but by a little distribution of water, this figure was capable of reduction to 25 cubic metres per feddan per 24 hours over the gross area. It must be noted that these figures apply to the 3-course rotation then in force, that is: 1st year cotton, 2nd year wheat, 3rd year dura and lubia. In comparison a 3-course rotation of: 1st year cotton, 2nd year dura and 3rd year lubia, would mean a large reduction in the period of maximum demand, and likewise a large reduction in the months of low supply or Nile: January, February and March. This will be seen from the following table which shows when the crops would require water (Table 39).

TABLE 39

A			B		
30 Feddan Area			30 Feddan Area		
Cotton	-	July-March	Cotton	-	July-March
Wheat	-	November-March	Dura	-	August-November

Table 39 contd.

		A			B
Dura	-	August-November	Lubia	-	August-December
Lubia	-	November-March			

Source: Box 112/3 Sudan Archives

In 'A', 10 feddans of cotton, 10 feddans of wheat, and 10 feddans of lubia were being irrigated during the months of low supply, January-March, while in 'B' 10 feddans of cotton only were being irrigated in the same period. Moreover, in 'A' the period of maximum demand occurred at the sharaki watering period, that is, October 20th to November 18th, when 10 feddans cotton were under irrigation and 10 feddans lubia ought to be if the recuperating group was to receive a fair chance. In 'B', the period of maximum demand occurred when the rains were available, and further, the seeding could be better spread so far as dura and lubia were concerned, since neither crop need be hurriedly laid down.

However, a problem closely connected with watering was that of subsoil water and drainage. Contrary to the high subsoil water in Egypt, it is interesting to note that even with high water in the Blue Nile the level of the subsoil water in the Gezira is about 4 feet below the surface (Chapter Two). Consequently, there were no field drains in the Tayiba Station, but for sanitary precautions, drains were vital for the success of the scheme and prosperity of the natives. Malaria was almost endemic and mosquitoes bred freely in depressions where rain-water collected. With more water by pumps, control measures were undoubtedly necessary, and the Government insisted that the S.P.S. should comply with all sanitary regulations, and take all proper sanitary precautions in the extension and maintenance of the works required.(61) The S.P.S., which had experienced malarial problems at Zeidab during its first years there, was also keen on precaution for the healthy working of both staff and cultivators, and on the risk of malarial conditions, it was noted:
(i) That under the old conditions of cultivation by rain there was no control of water, and that breeding places for mosquitoes were constantly formed in pools under teras banks or in larger depressions. (ii) That under the new conditions there were to be no teras banks with pools under them, and that the canal banks would very much diminish the amount of water which would flow into depressions. (iii) That generally the whole system was to be under control, and that a controlled system with

adequate staff was far less likely to give trouble than the old state of affairs with no control and no staff. (iv) An organisation was to be established for dealing with malarial conditions and providing treatments for patients. Thus, in each block there was to be a dispensary with an attendant, and a native sanitary inspector when required, all being supervised by the medical inspectors at Wad Medani who would have the assistance of the British sanitary inspector when required. The S.P.S. inspectors would have instructions as to all points likely to produce malarial conditions, and it was part of their duties to be on the look-out for such conditions and to remedy them at once, and to prevent stagnant water on the land so that their tenants remained as well as possible to be able to cultivate and produce efficiently.(62)

(iii) Acreage and Crop Yields (Fig. 61)

Cotton was cultivated on 250 feddans during the first year by 25 tenants, each with 10 feddans under the crop. Besides, the S.P.S. used some feddans to experiment with a variety of Egyptian and American cottons grown from imported as well as local seeds to find out those best suited to the conditions in the Gezira and at the same time gave higher yields. Thus, in the season of 1912/13, returns from varieties sown on an experimental plot of 610 feddans were as follows (Table 40).

TABLE 40 RETURN FROM COTTON VARIETIES SOWN ON EXPERIMENTAL BASIS, TAYIBA, 1912/13

Variety		Area in Feddans	Yield in Kantars of 315 lb.
Afifi	Egyptian seed	460	5.83
Afifi	Tayiba seed	50	5.65
Nubari	Tayiba seed	20	5.20
Nubari	Zeidab seed	10	5.02
Nubari	Egyptian seed	70	4.13

Source: S.P.S. Files, Barakat

Although this table clearly shows the superiority of seeds imported from Egypt, it also shows that seeds from Tayiba are second best. However, one experiment was not conclusive or enough, and in 1915 and 1916, experiments were retried with American and Egyptian varieties, the results of which are given in Table 41 below.

TABLE 41 RESULTS OF COTTON VARIETIES GROWN ON THE EXPERIMENTAL AREA, 1915 and 1916

Variety	Area in Feddans	Yield in Kantars/Feddan
Assili (Egyptian) *	3	3.52
Sunflower (American)	2	3.66
Nyasaland (American)	2	4.04
Makhsous (Egyptian) *	7	4.70
Griffen (American)	3.5	5.01
Allen's Improved (American)	3.5	4.90
Afifi (Egyptian): sown after Oct.	7	3.06

* Attacked by asal

Source: Cotton Yields & Statistics

In 1916/17 20 feddans of basin cotton (10 feddans Egyptian and 10 feddans American) were also tried, and the results were about 1 kantar per feddan (k.p.f.). However, under special watering conditions at an interval of 25 days, another 10 feddans of cotton were sown, but the return was less than 2 k.p.f. Moreover, the Egyptian variety, Makhsous, was again attacked by asal, (see below), and yield only amounted to about 4 k.p.f., while the American did not thrive well, and thus Egyptian varieties were found to be susceptible to asal attacks. The varieties sown under the watering experiment were Nubari and Afifi; each yielding 2.5 k.p.f., and

TABLE 42 ACREAGE, CROP YIELD AND RETURNS, TAYIBA 1911/12 - 1912/13

Season 1911/12					Season 1912/13				
Crops	Area/Feddans		Yield/ Feddan	Average Selling Price PT	Crops	Area/Feddans		Yield/ Feddan	Average Selling Price PT
	Tenant	Experiment				Tenant	Experiment		
Cotton	250	21	5.32K	320/k	Cotton	610	58	5.63K	320/K
Wheat	140	7	4.1Ard	130/Ard	Wheat	520	58	4.5Ard	130/Ard
Dura }	100	28 }	Used as fodder for stock		Dura }	610	58	3.5Ard	100/Ard
Lubia }		}			Lubia }	used as fodder			

Source: Box 112/3, Sudan Archives. Ard. = Ardeb. K = Kantar

King's and Griffen, each yielding 2.17 and 2.74 k.p.f. respectively.(63) In the main commercial area of Tayiba, the areas cultivated by both tenants and on experiment together with returns for the first two seasons are given in Table 42 above.

As seen from this table, the first season at Tayiba was undoubtedly an agricultural success, and heavy yields of both cotton and other crops were obtained, the average yield of cotton being 5,300 lb. (Fig. 61).(64) It is indeed surprising that cotton, despite attacks by flea asal during August, September and October 1912, could thrive and give these high yields. The failure of rain dura outside the irrigated area convinced the formerly reluctant natives of the great advantages of irrigation, and as a result the number of tenants rose to such an extent that there was no need to draw farmers from Zeidab for the next season. In the second season, yields of cotton in both quality and quantity were even higher, the largest yield coming from Afifi grown from both imported and local seed, as the following table shows (Table 43):

TABLE 43 COTTON YIELDS BY VARIETY FROM TENANTS' AREA, TAYIBA, 1912/13

	Variety & Origin of Seed	Area in Feddans	Average Yield in k.p.f.	
Cotton	Afifi : Egyptian Seed	10	Highest	7.5
	Afifi : Egyptian Seed	10	Lowest	3.4
	Nubari: Egyptian Seed	10	Highest	4.5
	Nubari: Egyptian Seed	10	Lowest	3.0
	Afifi : Tayiba Seed	10	Highest	4.4
	Afifi : Tayiba Seed	10	Lowest	3.7
	Nubari: Tayiba Seed	10	Highest	3.7
	Nubari: Tayiba Seed	10	Lowest	3.5

Source: Tayiba Station, S.P.S. Files (Barakat)

Even under various experiments, Egyptian varieties, especially from Egyptian seeds, proved to be well suited and to yield better than the American ones, and accordingly cultivation was confined to four Egyptian varieties. However, from 1919 season onwards, the switch to Sakel was phenomenal as the following table shows (Table 44).

TABLE 44 AREAS UNDER VARIOUS TYPES OF EGYPTIAN COTTON AT TAYIBA, 1916-20

Season	Area in Feddans			
	Sakel	Makhsous	Afifi	Assili
1916/17	340	-	725	830
1917/18	400	520	780	-
1919/20	1,085	642	-	-

Source: Tayiba Station, S.P.S. Files (Barakat)

From the total of 1,085 feddans under sakel in 1919/20 season, only 100 feddans were sown with new seed imported from Egypt, the rest being from Tayiba seed which with time proved to be more suited to the local conditions without losing its high yielding qualities. Thus, besides yielding better than American varieties, the cost of growing one feddan of Egyptian cotton was nearly the same as that of one feddan of American cotton (Table 45) and this, coupled with the higher prices the long-stapled Egyptian cotton commanded (Fig. 41), its finer quality and strength made the latter the obvious choice of the cultivators. If the average price of the Egyptian cotton in 1913 is taken as 10d. and that of the

TABLE 45 COST OF GROWING ONE FEDDAN, OF AMERICAN AND EGYPTIAN, COTTON PRODUCING FIVE KANTARS ON TENANTS SYSTEM, TAYIBA, 1913

Items	American		Egyptian	
	£E.	mms.	£E.	mms.
Rent	2	500	2	500
Two Ploughings		400		400
Ridging		150		150
Making earth-banks		100		100
Three hoeings		950		950
Sowing		060		060
Thinning		050		050
12 Waterings		600		750
Seed		070		150
Picking five kantars at 25 P.T.	1	250	1	250
Five sacks		300		300

Table 45 contd.

Items	American		Egyptian	
	£E.	mms.	£E.	mms.
Cutting Cotton stalks		100		150
	6	350	6	810

Source: A. Schmidt., op. cit., p.44

American as 6¾d per lb., it is clear that this was an enormous difference in favour of Egyptian cotton growing and for the enormously increasing demand for it in the world markets at the time, there was no question as to which crop was to be grown.(65)

With regard to return per holding of 30 feddans based on the prices of crops referred to in Table 46, the following shows the gross return in 1912/13 season:

TABLE 46 GROSS RETURNS PER 30-FEDDAN HOLDING, TAYIBA, 1912/13

			Return £E.
Cotton	10 feddans x 5.6 k.p.f. x £E.	3.25	179
Wheat	10 feddans x 5 ardeb/F x £E.	1.60	80
Dura	10 feddans x 4 ardeb/F x £E.	1.88	43
	Total Gross Receipt		302

Source: Box 109/1, Sudan Archives

However, the prices realised for wheat and dura were high owing to local scarcity of grain, and thus the gross return was abnormally high.

The cost of cultivation to the tenant for the above yields, taking the day wages paid as ½ P.T. for a boy, 2 P.T. for a woman and 3-4 P.T. for a man (the day being reckoned from sunrise to sunset), amounted to about £E.80. If the water rent is fixed at £E.2.50 per feddan, the total cost of cultivation would be £E.155, and this deducted from the total gross receipt, will be:

Gross Receipt	=	£E. 302
Costs of Cultivation	=	£E. 155
Net profit	=	£E. 147

This was under the rental system (see Chapter Six). When this was changed to the partnership system, giving the tenant 40% of the gross profit and thus reducing his profit to about two-fifths of the gross receipt, the tenants had "a feeling of bad faith" after having done so well out of the low rents of the past two seasons (for the rents were increased to £4). The receipts, based on the figures of the previous years given above were:

Two-fifths of Gross Receipts (at £E.302)	=	£E. 121
Deduct Cost of Cultivation	=	£E. 80
Net Profit		41

The tenants, however, were given some compensation, but the Government made it clear that the system of partnership would not be changed, and those who did not wish to continue under the new system were replaced by others.(66)

In assessing the results of the two years' working of the Tayiba Station - where everything was done on a large-scale on tenants' system by which only the success or non-success of the station could be judged - one arrives at the conclusion that the station was a complete success, and undoubtedly surprised even the most optimistic expectations. But, it was hazardous to judge the success of any irrigation scheme on a large-scale in the Gezira by the test of only 2,000 feddans and in two years' time. The safest way to ascertain the suitability of producing cotton over the entire area of the scheme was first to enlarge the Tayiba Station, and establishing additional pumping stations at various places within the area that was to be finally included in the large scheme. The objects of these experimental farms would then be: (i) To ascertain whether the land all over the 500,000 feddans area of the Gezira was quite suitable to cotton producing. (ii) To educate the natives of the Gezira in cotton growing. It was all important that when the time came for water to be put on to the Gezira Plain by means of a canal and a large tract of the country was ready, there must be sufficient native cultivators ready to avail themselves of the irrigation and work their lands on the most commercial system. (iii) To ascertain, through actual experience, the cost of excavating the channels in various parts of the Gezira, and thus enable the Irrigation Department to make the correct calculations as to the cost of the large scheme. The irrigation channels of these test stations were to be used when the dam and the main canal had been constructed.

With these points in mind, a new pilot station was established at Barakat, 12 miles south of Tayiba, in 1914 by the S.P.S. at their own cost, and at the same time Tayiba station was increased to 2,000 feddans (Fig. 61). In the meantime, the original Gezira Project for developing 500,000 feddans was postponed for being too ambitious financially, and instead it was decided to concentrate efforts on 300,000 feddans (100,000 feddans of which were to be under cotton), and the work on the canal was commenced on January, 1914. But the outbreak of the world war suspended all major activities regarding the main scheme, i.e. the dam and works connected with it. At Barakat, however, works on the new station forged ahead.

III BARAKAT PILOT STATION (Figrs. 60 & 61)

The land demarcated comprised, exclusive of site occupied by the pumping station and flume, nearly 9,000 feddans, but the area originally discussed, which was to be irrigated annually, was 2,500 or 3,000 feddans.(67) The station was to be run on the partnership as stated in the 1913 agreement. However, in 1913 it was arranged, again chiefly at Lord Kitchner's instigation, that the S.P.S. should erect a pump and canalise about 6,000 feddans at their own expense and run it as an experimental station until the arrival of gravitation water from Sennar Dam (Fig. 60). Thus, the S.P.S. undertook the Barakat Station as a preliminary to the main Gezira Scheme, and in the expectation that the agreement with them and the Government would be ratified. But they did so entirely of their own accord and on the distinct understanding that the Government was to be put to no expense whatever with regard to this enterprise. The Government undertook to levy no taxes on the crops and the S.P.S. agreed to hand over the whole of the pumping installation to the former free of charge when the land was under the Gezira Scheme.(68)

As a result of experience gained at Tayiba and Barakat, it was possible to settle the main lines for developing the main Scheme. It had become clear that the work of managing the whole business on the agricultural side - training and supervising the tenants, seeing to the digging of the field channels and the clearing of the ground, carrying out of the levelling and ploughing, supervising the sowing and growing of the crops, making advances to the tenants to cover their working expenses during the early part of the year before the proceeds of sale of cotton came in, arranging for the collection, sorting, ginning and marketing of the crop, etc. - required a large and elaborate body. It also required the provision of large sums of money for expenditure on fixed plants and staff, and for financing advances to the tenants. Such a management was beyond the resources of the Government at the time, which already had to undertake the building of the dam and the construction of the main canalisation, and the S.P.S. was accordingly invited to participate as partners in the final scheme. Thus, negotiations were carried from 1913 onwards, and finally a comprehensive concession agreement was settled in 1919, which formed the basis on which the Gezira Scheme was to run.

However, the agreement as it exists today was not completed until 1929, and in both the fear of the Government that the S.P.S. "might allow the tenants to get hopelessly indebted and in its own power", was allayed by a specific clause that the S.P.S. was "to consult the Government on all matters of importance affecting the joint undertaking with reference to the interest of the Government, the Syndicate and the tenants respectively".(69) On matters of loans to tenants, the agreement provided that the S.P.S. should make loans for seed, implements, labour and other agricultural operations, to tenants who reasonably needed them, but the interest charged and the terms of the loan had to comply with regulations agreed with the Government. The gross profits were to be divided as envisaged in the Tayiba Agreement of 1913. To help and protect the genuine cultivator, however, the Government needed to control the use of the land to stop sub-letting, and at the same time retaining the cooperation of the people, the Government issued a notice in 1920 to all land-owners in the area which was later embodied in the Gezira Land Ordinance, 1921 (App. 44).

Thus, the natives' interests were secured, and the main intention of the agreement ".... a joint undertaking in partnership with the S.P.S. to develop the cultivation of the irrigated area and to direct and assist the cultivators", was finally fulfilled. Moreover, according to the experimental rotation originally introduced into Tayiba, the tenant shared all his crops with the other partners, but in 1919 agreement the profit-sharing applied only to the cotton crop. The other crops, dura (which replaced wheat) and lubia belonged to the tenant free of any charge or taxation.

Thus, the Government was assured of its main duty: to keep control of development for the protection, and interest, of the people.

It believed that economic advancement should come "not only as an imposition from outsiders indifferent to the effect on local society which must be fitted in to suit it, but as a process of evolution from the inside, suited to the existing social system of the people".(70) In fact, just as the Government endeavoured to improve the existing native institutions by the addition of consistent elements from more civilised countries, so the planners tried in the Gezira Project to improve the existing native cultivation with the aid of scientific methods without alternation of the normal social development of the community.(71)

However, although the social and economic success was acknowledged, the cost price of cotton growing by the pumps was considered to be higher than was expected from gravitation irrigation.

(i) Cost Price of Cotton Growing and Yields (Fig. 61)

Under the existing conditions at Toyiba and Barakat, with a high water lift and using wood as fuel, it cost, taking a 300 lb. yield per feddan, about 7.3d per lb. to grow cotton. If this yield could not be increased under such conditions, then why not put up more stations and grow more cotton at 7.5d per lb.? This, however, could not be done because the supply of wood which the S.P.S. was able to get for the two stations was limited and if, say, a dozen more stations were put up, "the whole country would be burnt up in a few weeks".(72) The other alternative, importing coal or oil could increase the figure from 7.5d to 9.5d, and in 1915 most of the Gezira cotton was sold at 7.5d per lb.(73) Then, what cotton was going to cost to grow, taking a 300 lb. yield on a basis of 100,000 feddans, the area to be under cotton all the time when the Project came into operation?

Under gravitational irrigation, the cost was estimated to be about 5.5d per lb., and if the area was doubled, i.e. to 200,000 feddans the cost would then be reduced to 5d per lb. What is included roughly in the cost are: irrigation 3.7d., management 1.2d., and labour 2.4d, giving a total of 7.3. 3.7. This, on the basis of 300 lb. yield, is the cost under pump irrigation. If, in the Gezira Scheme, the management and labour would remain the same, then the cost price under gravitational irrigation, 5.5d is thus made up of: irrigation 2.15d, the management 1.2d, and labour 2.4d., the only difference arising in the cost of water, which is undoubtedly cheaper under the latter.(74) Seed, which cost only 2s. per feddan, is not included.

With regard to the population required to cultivate the land on the rotation system of 10 feddans cotton, 10 feddans leguminous and dura and 10 feddans fallow, one person per cotton feddan was estimated to be ample to run the scheme; 3 men and 3 women workers and a couple of youngsters about 10 years of age, were considered to be sufficient to run a block of 10 feddans. Thus, 100,000 feddans of cotton were estimated to need 80,000 workers, although another estimate put the labour required for the total of 300,000 feddans at 100,000, and if the whole adult male population of the area, estimated at about 7,800 at the time were employed, there would still be a shortage of 2,200, which was considered easy to secure, mainly from West African immigrants.(75) The tenants, however, could not do the whole work of the holding; for the ordinary routine work the wife (or wives) and children were sufficient, but as already mentioned in the previous chapter, more labour was needed at weeding, and again at picking, time, for which an additional labour of 7,000-8,000, or 0.7 men per tenancy was needed (Table 48). It so happened that these demands came at a time when the rain dura of the surrounding districts was requiring attention, August and September being the time when dura also required weeding, and January and February when labour was required for harvesting and threshing. The estimate cost of growing a 10-ardeb crop of dura on a 10-feddan fallow plot was about £E. 5 (Table 47), the estimate being based on the assumption that

TABLE 47 ESTIMATED COST OF GROWING A 10-ARDEB CROP OF DURA ON A 10-FEDDAN FALLOW PLOT

Items	Cost		Men Days
	£.E	mms.	
Repairing Canals (Abu Ishrin & Abu Sitta) and field channel	1	500	20
Sowing		400	6
Seed		80	-
First Weeding (Average)		800	12
Second Weeding (Average)		500	6
Cutting		600	8
Transport to threshing floor		150	-
Threshing		500	8
Transport to villages		200	-
	4	730	60

Source: Russell & Martin-Leake, op. cit., p. 38

neither tenant nor his wife did any work on it. Considering the importance of dura as the staple food of the tenants, its labour requirement was more than that grown by rain and thus more costly to grow, but the insurance against failure of the crop provided by irrigation offset this advantage. The main problem was that some operations, especially weeding, coincided with those of cotton, and harvest with that of rain-grown dura. Thus, comparing the cost of work for which payment had to be made, apart from family work, of both cotton and dura (Table 48), it became clear that working a tenancy by family labour only was almost impossible.

With regards to yields, the 1911-14 crops can be considered as bumper for both Tayiba and Barakat (Fig. 61), but while increase in acreage is noticeable for the next years, the decrease in yield is also obvious, especially for 1915/16 crop. The average yield for this season was 330 lb. per feddan on 3,360 feddans while in the previous years the yield was 525 lb. per feddan on 2,960 feddans. In the season 1915/16 the coldest winter temperature was experienced in the country which was the cause of this reduction, but for the 1916/17 season, with an average yield of 320 lb. per feddan, there was a little shortage in water: one of the stations ran up to about 350 lb. yield and the other was pulled down because of shortage of water.[76]

However, the high yields for both stations (5.16 k.p.f. for Tayiba and 5.3 k.p.f. for Barakat) were met with low prices (Table 29 App. 29 & Fig. 41), but when prices rose in 1916, yields dropped badly due to attacks by thrips, aphis and shortage of water. In 1917, yields continued to be low again because of a breakdown in the gear of the pump and the consequent shortage of water, while prices were still high because, since July 1917, the shortage of cotton had become decidedly serious (Table 26 App. 26). Owing in part to the necessity for growing more foodstuffs to meet the needs of war, the cotton crops of the U.S.A. Egypt and India had been curtailed.[77] Moreover, the seasons were unfavourable and the 1919/20 season gave rise to fears that the crops both in the U.S.A. and Egypt would again be deficient. The shortage of cotton was in those finer kinds which constituted the chief requirement of British mills, and consequently the price for Egyptian cotton rose from 6.30d. per lb. in 1914/15 to 9.88 in 1916/17 (Tables 29, 30 App. 29, 30, Figrs. 41 & 42).[78]

In the Sudan, however, the 1919/20 season was another good year (with a yield of 5.25 k.p.f.), and prices were phenomenal. But

TABLE 48 ESTIMATE OF THE NORMAL EXPENSES OF A TENANT OF S.P.S. ON A 30-FEDDAN HOLDING, 10 BEING COTTON AND 20 FALLOW, GEZIRA 1923

Nature of Work	Value of work that can be done by Tenant.	Cost of work for which payment must be paid.	Remarks, time required, etc.
	£E. m/m	£E. m/m	
(1) Ploughing and Ridging	-	11. 000	Machine work done by S.P.S. & charged to tenant
(2) Constructing Field channels & Tagnets	1. 500	-	Tenant alone in 20 days, with Family 10 days
(3) Cost of Seed	-		Provided & charged by S.P.S.
(4) Sowing	0. 350	1. 000	Tenant & Family in 3 days
(5) First Watering 13 other waterings	0. 500 2. 600		Tenant alone in 4 days Tenant alone
(6) First cleaning	0. 550	1. 950	9 men for 4 days, tenant and Family, two men
(7) Resowing	0. 120	-	Tenant himself
(8) Second cleaning	0. 430	1. 070	7 men for 4 days; tenant & Family and 2 men
(9) Third cleaning	0. 500	-	Tenant & son in 4 days
(10) Cleaning of fallow hosha	-	-	Not required of tenant
(11) Bull cultivating 3 times	-	1. 800	A few tenants do this with their own bull
(12) Thinning	0. 500	-	Tenant alone
(13) Making up field channels after bull cultivation (3 times)	0. 900	-	Tenant & Family in 9 days
(14) Picking of 40 kantars	7. 500	5. 100	Based on 3½ pickers for 60 days, 60 lb/day/ picker. 1 m/m paid/votle of seed cotton tenant & Family & two pickers
(15) Transport of 40 kantars to Collecting Stations	-	1. 000	20 camel journeys of 5 miles at 5 P.T/journey. But many tenants own camels
(16) Cutting out and burning stalks	1. 000	-	Tenant & Family in 10 days

Table 48 contd.

Nature of the work	Value of work that can be done by Tenant.	Cost of work for which payment must be made	Remarks, time required, etc.
	£E. m/m	£E. m/m	
(17) Upkeep of tuckle (hut grass)	0. 300	-	Tenant can do it, but cost varies according to distance of wood & grass.
(18) Repair of Abu Ishrin & Abu Sitta for the following season	1. 500		Tenant himself in 15-20 days.
	18. 250	22. 920	
Total	£E. 41. 170		

Source: By Mr. Parr, Produced in Russel & Martin-Leake, op. cit., p. 39

in 1921, the prices of cotton fell from 45d. per lb. in 1920 to 8.5d. in 1921 and, unfortunately, this coincided with lower yields, this time due to cold weather and a boiler burst in February necessitating 40-60 days between watering, and until the dam functioned in 1925/26, the yield from all stations, including Hosh and Wad el Nau, ranged from 2.21 to 3.92 k.p.f. (Fig. 61).[79]

IV HOSH AND WAD EL NAU STATIONS (Fig. 60)

Although the two preliminary stations, Tayiba and Barakat, had given most valuable experience, both the Government and the S.P.S. realised that this was not enough. If the full area of 300,000 feddans was to be brought under cultivation as soon as the dam and canalisation were completed, it was of vital importance to get as many British inspectors and native cultivators as possible trained in advance. The S.P.S., for this purpose, undertook two further large pumping stations with the area. On the first at Hosh (19,000 feddans with 6,500 under cotton) cultivation was started in the season 1921/22, and on the second at Wad el Nau (30,000 feddans with 10,000 under cotton) in the season 1923/24 (Figrs. 62 & 63).[80] In taking these steps, the S.P.S. expended large sums of money on the pumping installations with the knowledge that as soon as the dam and the main canalisation were completed, the pumps would no longer be required, but this bold policy had been amply justified by its results, and clearly illustrates the value of the S.P. Syndicate's cooperation in this matter.[81]

Thus, by 1923 the irrigation of the Gezira by means of four pumping stations was generally carried out for nine months in the year. In 1922, the S.P.S. commenced with the erection of the pump at Wad el Nau about 180 ft. from the river bank, and it was estimated that the amount of water required from this station would be about 52,000 gallons per minute. However, owing to the distance of the pumping station from the main canal running from Sennar Dam at Wat el Nau (Fig. 63), it was found necessary to construct a feeder canal into which the water was pumped from the station through a rising main nearly half a mile long. This determined the head against which the pump had to work. It was further decided, owing to the difficulty of obtaining wood or coal for fuel, that diesel oil engines should be installed for driving the pumps, and that the units should be three in number, each pump to be capable of delivering 26,000 gallons of water per minute, two working together and one set as spare. The duty of each pump was to deliver 2 cumecs against a maximum total head of 836 ft., this head being based on the assumption that the water level in the river did not fall below 1,279 ft. above sea level (at Alexandria), and that in the delivery canal water did not rise to more than 1,349 ft. above the same.[82]

These areas, at the completion of the main scheme in 1925, were to be linked up with the Gezira main canal system, and the water, which would then be deviated from the dam at Sennar, would flow by gravity in their irrigation channels. Thus, the working of these two stations may be taken as fairly typical of the working of the whole scheme, though it must, of course, be remembered that they were a first beginning and that readjustments may be necessary as further experience was gained.

(i) <u>The Working System:</u>

The area at Hosh (or Hag Abdalla) was first cultivated in 1921/22 and the allotment of tenancies for this first season was on a ~~provincial~~ provisional basis as the station was started before the canalisation on the whole area was completed. Levelling of the land started from 1920 and was more or less finished by 1921 (Fig. 62). The first season under normal working conditions was 1922/23 when a total area of 19,000 <u>feddans</u> was ready for cultivation. This was divided into 700 plots which were all taken upon the principle already explained in the previous chapter, mainly to freeholders within the area. At the end of this season, in 41 cases out of a total of 700, tenancies were not, for various reasons, renewed. Of the 41 tenants concerned, only eleven were actual owners or nominees of owners of land within the area, and in fact in all these cases, the owners were again given the right to nominate other representatives. Again for the season 1923/24 there were 700 tenancies and only in one case was the tenancy terminated.(83)

The area of Wad el Nau (Fig. 63), was first cultivated in the season 1923/24; there were 1,153 tenancies, with an area of 11,100 <u>feddans</u> under cotton out of a total of 33,000 <u>feddans</u>, which were all taken up. However, out of these 1,153 tenancies, 14 changes in tenancy were reported, and in two of these cases the tenants concerned owned the land in area.(84) The same practice as regards nominating new tenants was followed as for Hosh.

It will be seen from the above figures that there is a progressive diminution in the number of changes in tenancies at the end of each season. The comparatively large number on the Hosh Station for the season 1922/23 were entirely accounted for by tenants who, having taken up tenancies, showed no interest in carrying out their duties properly. It is not indeed surprising that in the beginning cases of this kind should be found, and the great improvement for the second season gave ground for the hope that the tenants were settling down to the new conditions. The list of 1923/24 season's changes at Wad el Nau is given in App. 46 as an illustration of what happened.(85)

The actual figures as regards allotments of tenancies in Wad el Nau Station may also be of interest in showing how the allotment had in fact been made. The area taken up of about 33,000 <u>feddans</u> was divided among 1,154 tenants of which 600 were owners of land within the area, and 322 were tenants who were neither owners of land themselves nor nominees of owners. Of the 322 in the last-mentioned class, 127 were residents in Wad el Nau area, and 148 resident in the closely adjoining areas, the balance of 47 being resident elsewhere. It will thus be seen that practically the whole of the allotments - 1,107 out of 1,157 - were made either (a) to owners of land within the area and their nominees (in many cases members of their families), or (b) to residents in or on the borders of the area. Moreover, every owner of land who applied for a tenancy was allotted one.'86)

Thus, when the Sennar Dam was completed in July 1925, a fifth of the area to be irrigated was already finished and accustomed to the system before irrigation by gravity commenced over the whole area, which was entirely canalised and cultivated in 1925/26 season (Figrs. 46 & 47). Before this season, however, extension outside the pump area was carried out at the soutwest end of the proposed area west of the main canal, and included Hosh, Remeitab, Ghubshan, Wad Naaman, Wad el Atai and Kumor (Fig. 60). Thus in the first season, the S.P.S. was able to allot tenancies for 240,000 feddans, of which 80,000 feddans were actually sown with cotton and watered, while the tenants had further been allowed to plant up to 40,000 feddans of dura and 40,000 of lubia[87] The maximum area under cotton with the pumping had been 20,000 feddans, and the expansion in one season from this to 80,000 feddans was really a remarkable achievement, which without the pioneer work of the S.P.S., would have been quite difficult. The areas canalised for the pumping stations at Tayiba, Barakat, Hosh and Wad el Nau have been incorporated in the main area (Fig. 46), and as the water flowed by gravity from the reservoir above the dam, the pumps ceased to irrigate.[88]

However, despite this great expansion in acreage, a noticeable feature is the diminution in yields in the last four years from 3.92 kantars in 1921/22 to 3.66, 2.86 and 2.21 in the last three years (Table 49 & Fig.69).

TABLE 49 YIELDS PER FEDDAN IN KANTARS OF 316 FROM THE FOUR FOUR PUMPING STATIONS AND THE FIRST SEASON OF MAIN SCHEME, AND TOTAL YIELD/FEDDAN, 1911/26

Season	Tayiba	Barakat	Hosh	Wad el Nau	Total
1911/12	5.32	-	-		5.32
1912/13	5.62	-	-		5.62
1913/14	3.80	-	-		3.80
1914/15	3.10	5.39	-		5.29
1915/16	3.10	3.48	-		3.32
1916/17	3.47	3.20	-		3.31
1917/18	4.10	2.66	-	-	3.29
1918/19	4.13	3.50	-	-	3.33
1919/20	5.60	4.98	-	-	5.26
1920/21	3.20	3.50	-	-	3.27
1921/22	3.46	3.84	4.23	-	3.92
1922/23	4.30	4.00	3.4	-	3.66
1923/24	2.54	2.87	2.88	2.88	3.86
1924/25	2.338	2.288	2.390	2.046	2.21
1925/26	First Season of Gezira Scheme				4.8

Source: Agricultural Res. Work in the Sudan, Report for the Season 1926/27, p. 6

This was due partly to the extension of cotton growing over a large area, but largely to the increase in the damage done by pests, of which blackarm and thrips were the most formidable, especially for 1924/25 crop. The lower yield at Wad el Nau in 1924/25 than elsewhere was because watering stopped there on March 31st instead of April 15th as in the case of other pumps. Apart from pests and shortage of water, the 1921/22 and 1922/23 seasons experienced abnormally heavy rainfall which necessitated resowing, and this led to unsatisfactory results.(89)

At this point, it will be appropriate to discuss briefly the various factors, apart from water shortage, that affected the yield of cotton during the experimental stage, 1911-25. However, it should be borne in mind that some of these factors, like thrips and blackarm, later assumed serious dimensions which necessitated intensive research into their, and other factors, causal effects on yields, after the Gezira Scheme was launched in 1925. As a result the discussion will necessarily draw upon information obtained from post-1925 research on some of these factors that existed before 1925 and which were later found out to have been the cause for the minor fluctuations in yields that occurred during this period.

V FACTORS AFFECTING COTTON YIELD IN THE GEZIRA, 1911-25:

Writing about the difficulties facing the seven-year old Gezira Scheme, the Egyptian Cotton Year Book, 1932/33 wrote ".... Sudan Sakels will never be competitive to Egyptian Sakels either in price or in terms of delivery, as the cost of production is very much higher in the Gezira than in Egypt, besides which a minimum price must be obtained below which the S.P.S. cannot afford to sell its cotton ...... But the principal reason why Egypt need not fear the competition of Gezira does not lie either in its merits or advantages, but in the uncertainty of its future, as a cotton producing country".(90) The article went on to list the drawbacks of cotton growing in the Gezira, instanced by low yields of the previous decade which were attributed to the nature of the Gezira soil, and quoted doubts which had been expressed earlier by Sir W. Willcocks, mentioning the reluctance of the Sudanese to work really hard, the prevalence of very destructive diseases, like black-arm, leaf-curl, pink bollworm, thrips and locusts.

However, some of these difficulties, such as high costs, were temporary, but pests and diseases constituted a real threat to the whole scheme between 1928-33, although in time they, if not completely overcome, were brought under control.(91) Indeed one of the problems of Sakels and other Egyptian varieties of cotton was their susceptibility to damage by rain during early growth, and the consequent hazards the rain caused to ploughing and weeding operations (see Chapter Three). This problem did arise in a serious form at Barakat during 1913/14 season, and was further complicated by the effect of heavy rains on the young cotton plant. In 1921 rain nearly damaged the whole crop.

(i) <u>Rainfall and Cotton Yield:</u>

During the growing season, the weather is an important factor affecting the cotton crop. Although, the effects of the weather on the cotton plant itself are important, the more important to the crop are the effects of the weather on the pests and diseases which attack it. Germination of seed and growth of plants can only take place if the soil and atmosphere are neither too hot nor too cold. For cotton, the best temperatures in the Gezira are those occurring in the cool rainy season, for if the rainy season is hot, early growth will be slow, and thus cool, moist weather till the end of September gives excellent growth of cotton. Moreoever, hot weather at flowering time does not harm cotton and is thought to improve the quality of the crop, while after flowering, spells of hot weather may cause shedding of bolls and loss of quality. Thus, the best cotton season in the Gezira was found to be the one which is cool and moist at sowing time, gradually getting hotter and drier till the end of October, and then cooling off without any severe hot or cold spells.

Rain after sowing time was found to benefit cotton by cooling and moistening atmosphere, although indirectly it encourages blackarm, and if heavy, causes yellowing of crops by waterlogging. Rain also encourages weeds, and at the same time makes weeding difficult because the land becomes too wet to work on, and thus it delays other operations such as resowing and thinning. Rains after sowing was found to encourage the spread of blackarm disease, especially if it was accompanied by strong wind, but this late rain (September onwards), was found to be beneficial on cotton yields, in the absence of blackarm. However, the depressing effect of heavy rainfall in the year before the crop was sown, was found to hold for many parts of the Gezira. If the harmful effect of such rain on cotton yield primarily through increased weed growth on the fallowed land (which will come under cotton the following year), because of increase in normal rainfall from north-south (Fig. 12), a maximum depression of cotton yield would be expected in the south following heavy previous-year's rain, and a minimum depression in the north. Conversely, the pre-sowing rain has beneficial effect on yield, and the heavier it is the higher the yield and vice versa. Blackarm being under control, the pre-sowing rains improve the fertility and tilth of the soil in two ways. First, it helps to increase the nitrogen salts in the soil and washes some of the harmful salts down away from the root-zone. Secondly, the soil as well as the atmosphere are cooled to ensure a better growth, and by encouraging the germination of weeds before cotton is sown, it allows the tenant to destroy them early so that they do not compete with the young cotton plants.

(ii) Fleabeetles, White Fly, Aphids and Asal:

The first appearance of fleabeetles occurred in several hoshas at Tayiba in July 1912, while asal appeared in August and by October it completely damaged the hoshas affected. Aphids appeared for the first time during the 1916/17 season at Barakat.(93)

The fleabeetles are usually the first pests to attack the cotton crop, and they eat small round holes in cotton leaves, although a large number of them can consume a whole leaf, except the veins. However, they occur throughout the cotton-growing season, but it is only when the cotton is in the seedling stage that they do serious damage by congregating on the few leaves available, and finally killing the plant. Since they also eat other plants, the presence of weeds encourages their attack on cotton, and that is why cotton tends to be more severely attacked in seasons of poor rains where there are fewer weeds to attract these insects. In the same way, early-sown cotton plants are most severely damaged. However, their tendency to gather at the edge of cotton plots, where the plant first appears, make control measures possible, and this is achieved by spraying "gammexane" powder from lorries or by hand-dusters.

Whiteflies are found in large numbers on cotton and lubia crops, and by sucking juice out of the leaves, reduce plant vigour, and thus the severity of the damage they cause depends on the density of their population. When they are numerous, they cause leaf-shedding and even wilting and death of the plant, and they multiply up as the crop grows, and usually reach their greatest density in about November. However, in addition to this direct damage, the flies were later found to play an important part in spreading leaf-curl disease from one infected plant to a healthy one.

Aphids are small green insects which suck the juice out of cotton leaves, and in the process produce, like white flies, a great deal of asal, thus making the infested cotton to be wet and sticky. They are usually found in thick, sheltered parts of the crop where there is shade and a humid atmosphere, and cause loss by reducing the vigour of the plants and can do serious damage if present in large numbers.

Asal, as stated above, is associated with whiteflies and aphids, which suck large amounts of plant juice, extract their food from it, and excrete the rest of juice containing foods such as sugar which they do not require. Asal in itself is not good for the cotton plant, and it often encourages a black fungus to grow on it, which is also harmful to the plant. The cotton plant itself sometimes exudes some of its own juice from spots on the underside of the leaf, but this never makes the leaf sticky all over like the asal from aphids and whiteflies.[94]

(iii) Thrips and Blackarm:

Thrips are very small insects which are just large enough to be seen on the leaf, and they tear small holes in the surface of the leaf, then suck the juice exuding from these holes, such leaves having a silvery appearance with tiny black spots. When severe, the leaves may dry up completely and fall off, and this slows down growth and reduces yield. They usually attack the cotton about October and do most damage to small plants, and resown cotton is most severely attacked, and tends to be heavier in the south end of the Gezira than in the north, because rains are heavier there and there is more vegetation to maintain a large thrips population.

Thrips first appeared in 1918/19 season at both stations. However, before the introduction of pump irrigation into the Gezira, the cultivated land was divided into two distinct classes. The first was the river land and consisted of the land within easy reach of the river, which was irrigated either naturally by flood water, or artificially by means of saqias (Chapter 6). The second was the rainland. From sometime in the past, the cotton thrips had been recognised by the river-land cultivator as a serious enemy of his crops, but little seems to have been known of this pest in the rain-land cultivation prior to the introduction of cotton. From information obtained, it seems more than probable that the thrips were present in the rain-cultivation before the irrigation of cotton was started. The insects no doubt occurred each year, as they do at present, on certain species of weeds which spring up during the rainy season, and in fact they feed on a number of weeds, garden plants and even trees, and keep alive on these during the dead season. Thus since these food plants dried up sometime after the end of the rains, the thrips must have either perished or sought fresh food plants elsewhere, since it is extremely unlikely that they could survive a long period of drought in the soil without food. The river cultivation is known to harbour thrips for the greater part of the year so that it would appear as if it were the original source of these insects.(95)

However, on the introduction of pump irrigation into the Gezira, rainland previously devoted to the cultivation of dura was placed under cotton, and this land happens to be situated at a distance of approximately from half to one mile from the river-cultivation, and it is very probable that towards the end of the rainy season, these insects spread from one place to another and from plant to plant and reached the cotton area.

In the Gezira, adult thrips were first observed towards the end of the rainy season (i.e. in the latter half of September) as the temperature was beginning to rise appreciably and the humidity was falling.(96) There then followed a period of high temperature and continually decreasing humidity, during which thrips bred and increased at a rapid rate causing considerable damage. As soon as cooler weather set in, breeding became slower, and cotton which had been severely attacked showed signs of recovery, and this less active period lasted until the commencement of the warm weather in March, when the insects were again on the increase. From March until the second week of May the temperature was appreciably high and the humidity low, but although the thrips were extremely common, the crop was better able to resist attack than earlier in the season. However, sometime during the second week of May, the insects were observed to be on the increase, and on referring to meteorological data (Table 48 App. 48), it was found that the humidity was noticeably rising. Finally, as the humidity continued to rise with the arrival of the rains, the thrips became more and more difficult to find and remained inconspicuous until the latter part of September.(97)

From these observations, it was found that as the temperature rises, the length of both egg and larval stages of the thrips decreased and vice versa (Table 48b App. 48). It was also invariably found that cotton plants, which were directly exposed to the north wind, were far more liable to attack than any others in the field, while those in the protected central position were seldom affectdd, and it was rare to find them along the southern side of the field after the arrival of the north wind. This peculiarity was attributed to the dryness of the north wind, which by increasing evaporation and decreasing humidity, affected the side least protected from it.(98)

The thrips lay their eggs on the underside of cotton leaves, on which the larvae lives until they are fully grown, when they fall off the leaves and form pupae in the loose surface soil where conditions are cool and moist. After only a few days, adults emerge from the pupae and start a new and larger infestation, and as a result, the thrips can be reduced by heavy watering, as this drowns the pupae resting in the surface soil. Thus, a heavily-watered plot with 600 M^3 of water every 15 days was found to be free from thrips throughout the seasons, while cotton receiving 550M^3 was not attacked until watering had ceased. Similarly, of the two plots receiving 500 M^3 of water, one was not infested until after the cessation of watering, and the other to a small extent. But the 350 M^3 plot was badly infested throughout the season entirely throughout the field.[(99)]

Thrips (Heliothrips Indicus) was recorded from India attacking indigo, onions and berseem in Bengal in 1908-09. In the Gezira, it was first recognised during the cotton season, 1918/19. Prior to this, the typical silvering of the cotton leaves, which is the common symptom of the attack, and defoliation of plant due to the falling of the leaves had been noticed. This symptom was known as "dry asal" owing firstly to slightly sticky nature of the injured leaves, and secondly, to their becoming dried up as the sap was exhausted, and the native cultivator had recognised this "dry asal" as a pest to his crop for some considerable time. But it began to assume a serious scale by 1918, and by November of this year it appeared at Kabushiya, Zeidab and Damer Island first attacking crops other than cotton, and in 1920/21 season cotton was attacked in Berber province at Shendi and Zeidab. Then it spread as far south as Singa, Tayiba and Barakat, and later in Kassala.[(100)]

Blackarm, on the other hand, is a very serious cotton disease which is caused by a germ which infects the leaves, stems and bolls of the plant, and usually enters the leaf when it has been moistened by rain or dew. First, small angular greasy spots appear on the leaf where the infection starts, and they soon become black and spread, especially if the weather is moist. Severely attacked leaves always fall off, so that badly infected plants may lose nearly all their leaves except a small bunch of growing leaves at the top. The stems can be affected from infected leaves or buds, and both defoliation and damage to the stems and branches cause a loss in yield, and badly infected plants carry only one or two bolls at the top of the plant, and the lint is sometimes stained. Since infected plants produce infected seed and that infection is spread from the debris of fallen leaves, bolls and infected stems, the best measures to control this disease has been by disinfecting the seed with a poisonous powder called "Abavit B", and pulling out of cotton stalks and debris and burned.[(101)]

However, blackarm began to assume disastrous scales from 1929-33, when yields were reduced to 1 and 2 kantars per feddan, and it became the main research problem in the years about 1933, and was controlled by 1934. During the experimental stage, the effect was minor, and consequently no serious step was taken to suppress it until after 1930. Other insects include stemborers, termites, and pink bollworm, either of which was of serious consequence to call for immediate worry, and during the period under consideration, 1911-25, the only serious pest was thrips.

(iv) Rotation Experiments, 1911-25:

Rotation of crops is based in most countries upon the accumulated experience of past years; experiments testing the relative merits of various rotations are rarely resorted to unless some serious disturbance arises, such as the inclusion of new crops. But in the Gezira the need for rotation experiments was urgent, since growing cotton by artificial irrigation was a recent introduction and, moreover, the soil was known to be intractable (Chapter Two). Any improvement in rotation which would allay seasonal fluctuations in yield and raise the general level of production would greatly add to the prosperity of the area.

As already noted, the first crop of irrigated cotton was grown in 1911/12 on an area of 250 feddans at Tayiba, and in 1913/14 at Barakat. The original Tayiba and Barakat pump schemes were experimental, and accordingly various crops were tried, with cotton as the principal one. Tayiba was mainly on a 3-course rotation: Cotton, Lubia, Fallow (C-L-F), while Barakat was on a Cotton-Resting-Resting rotation, lubia not having proved beneficial. No manure of any kind was used. Crops, such as wheat and dura were also grown, though wheat was dropped in later experiments. El Hosh and Wad el Nau introduced the 3-course rotation which persisted until the change to the 8-course rotation in 1932/33. The 3-course rotation was as follows: 10-feddans cotton, 10-feddans dura and lubia (5 feddans each), and 10-feddans resting.[102]

However, since dura was the staple diet of the people, it was decided that, to attract people, every rotation should include dura. Because of the assured water supply a given bulk of dura could be grown on a smaller area than under rain cultivation, thereby freeing land for other crops that might be included in the rotation. Moreover, irrigated dura was an insurance against famines.

Numerous trials were also made on the suitability of crops other than cotton and dura, but so far only lubia was found both useful and easily grown. Lubia supplied food for both man and animal and, as a legume, benefited any rotation in which it was included because it contains in its nodules the nitrogen-fixing bacteria. Fallowing was not practised for two seasons at Tayiba, but the acreage of lubia greatly increased. Fallowing, however, was only included in the rotation from 1914/15 season following marked decrease in cotton yields; wheat was also excluded by the same season, and dura slowly took up its place (Table 50).[104]

TABLE 50 CROPPING AND FALLOW SYSTEM AT TAYIBA, 1912-17 (IN FEDDANS)

Season	Cotton	Wheat	Lubia	Fallow
1912/13	610	520	610 (of this 520 F. after dura)	None
1913/14	668 (174 F. of which were experimental)	575	668 (57 F. after dura)	None
1914/15	993 (17 F. experimental)	-	973 (252 F. after dura)	1,264
1915/16	1,378	-	1,430	621 (+ 240 excluded as too high)
1916/17	1,795	-	1,430	246 (+ 180 excluded as too high)

Source: Bin 3/12 S.P.S. Files (Barakat)

However, it was found that cotton could not maintain its yield if grown continuously or even in alternate years in the same land under irrigation. As the following table shows, continuous cropping of cotton and yield by rotation practised at Barakat are compared (Table 51).

TABLE 51 CONTINUOUS COTTON CROPPING COMPARED WITH ROTATIONAL COTTON CROPPING

Season	Yield of Continuous Cotton (Kantar/Feddan)	Average Barakat Yield (Kantar/Feddan)	Continuous %-age of Barakat
1918-19	3.60 (virgin soil)	4.23 (virgin soil)	85
1919-20	2.22	4.98	45
1920-21	2.10	3.51	60
1921-22	1.61	3.91	41
1922-23	1.51	4.00	38

Source: Bins 3/12 S.P.S. Files (Barakat)

There were variations from these means on individual plots in each area, but they were less than might have been expected. The highest yields were invariably obtained on new land; and by no treatment had they been subsequently reproduced, though the system Fallow-Fallow-Cotton (F-F-C) came as near as was yet possible. It was recognised however, that a system of fallow and cropping without manure could not be permanent, and that some manuring must be given.

Five rotations were included in the 3-course rotation experiments: (a) C-F-F, (b) C-D-F, (c) C-D-D, (d) C-L-F, (e) C-D-D. The rotation ranged from continuous cropping to one crop in three years, and from intensive cereal cropping to rotation without cereal. The results were as follows: (Table 52).

TABLE 52 AVERAGE YIELD OF FIVE ROTATIONS (KANTARS PER FEDDAN

C-L-F	C-F-F	C-D-L	C-D-F	C-D-D
4.5	4.07	3.84	3.84	2.96

Source: T.N. Jewitt (1945), op. cit., p. 265

It is clear from this table that inclusion of dura in the rotation invariably reduces cotton yields. Least harm is done when dura immediately follows cotton, with at least one fallow year before cotton recurs, while lubia was in no case markedly superior to follow, although it may prove slightly more beneficial than fallow when included in a short rotation: follow cotton or dura. On the other hand, if grown after fallow, lubia decreased the cotton yield. Thus, in view of the large increases regularly obtained from nitrogenous fertilisers, the benefit of lubia is surprisingly small and that of fallow surprisingly great.(105)

Frequent fallows were found necessary in any rotation, and for medium yields cotton should be sown not more than once in three years, and between cotton crops at least a year's fallow was considered to be essential, and that the longer the fallow, the greater the benefit.

So far as nitrate level in the soil, and its relationship with the type of rotation are concerned, the following table is of interest (Table 53).

Rotation C-F-F differs from others in showing a marked maximum level during August - September, due to washing down of nitrates by early rain and irrigation. Other rotations show the reduction in nitrates during

TABLE 53 MEAN NITRATE LEVELS DURING AUGUST-NOVEMBER WITH CORRESPONDING COTTON YIELD

Rotation	Mean Nitrate-Nitrogen (p.p.m)	Yield in seed cotton (lb/Feddan)
C-F-F	8.1	1,499
C-D-F	10.1	1,418
C-D-D	4.9	990
C-L-F	13.7	1,703
C-D-L	10.8	1,496

Source: Same as Table 52 above

these months - notably C-D-F rotation. The two rotations cropped annually C-D-D and C-D-L show their fall from October onwards, and the other three where cotton follows a fallow, show it from November onwards, this decline being due to uptake by plants (Fig. 21).[106]

Although Zeidab and the pilot stations had direct bearing on the evolution of the Gezira Scheme - indeed the latter were the very basis of this scheme - there were other cotton-producing areas which contributed more or less to the development of cotton growing in the Sudan in the way of experience, tenant education, and management. There were government pump schemes along the main Nile in Berber and Dongola Provinces, which were started during the war for the purpose of producing food crops, but when grain prices subsequently became unremunerative after the war because of fall in prices, the schemes switched to cotton production. There were also the Baraka and Gash Deltas, where cultivation of cotton started long before the Nile schemes were started, thus bringing in the much-needed revenue to the Government (Fig. 67), when it was still groping for a remunerative way of utilising and developing the Nile lands for cotton growing.[107] Thus, it is worthwhile to discuss briefly cotton cultivation in these areas before 1925, beginning with two Government schemes.

III GOVERNMENT PUMP SCHEMES

In these schemes, as at Zeidab, Egyptian cotton was formerly grown, but due to the various reasons mentioned above, there was a shift to the long-stapled American Upland, which was originally derived from Nyasaland. Zeidab Estate provided the seed.

V GANDETTO (Table 54)

The area lies on the eastern bank of the Nile to the south of

Shendi (Fig. 50), forming a narrow belt of light, easy working river alluvium or island soil lying between the flood area of the river-bank and the karu, which forms the edge of the desert. In 1923/24 season, 3,100 feddans were canalised. The land, however, was not taken over by the Government, but remained in the hands of the owners who paid a rent for the water amounting to: (a) Half the net sale price in case of cotton; (b) £E.4 per feddan in case of wheat; (c) £E.3 in case of beans, summer dura and maize; (d) £E.2 per feddan in case of lubia.[108]

These charges were fixed on the basis of the tenant's power to pay and not on the respective amount of water consumed by the crops. The cotton crop was ginned and sold by the Government and the costs of these operations were deducted from the total receipts in order to arrive at the net sale price.[109]

In general the cultivator adopted a 4-course rotation: Cotton-Fallow or Lubia-Food Crop-Fallow. The food crop consisted mainly of maize with some wheat, but very little dura. Thus, the striking difference from the practice in the Gezira pilot stations was the fallow; in the Gezira the fallows were bare, while at Gandetto they were covered with vegetation excepting only when the whole block was left and there had been much grazing. The difference lay in the water-table levels and the nature of the soil: in the Gezira the water table was much further below the surface and the soil too heavy to allow of ready movement of moisture. As a result vegetation died on the unwatered land shortly after the rainy season ended, except in depressions. At Gandetto, the water-table was only about 20 ft. down, and it rose even nearer the surface in flood time, while the lighter nature of the soil allowed of better water movement; plants therefore, continued to grow on the fallow.[110] As a result, this vegetation was not only troublesome and costly to remove, but also harboured insects and pests dangerous to cotton.

Cultivation also was somewhat different from the Gezira. First, the land was ploughed, then cross-ploughed and ploughed again, and then levelled and set out in square basins of about 10-metre sides for the purpose of watering, but not ridged, all done by native implements. Sowing of cotton began about mid-June, and ended about July 20th. The rate of seeding was about 12lb/feddan; the seed was put in with a hoe, a shallow hole being made into which the seeds were dropped. The spacing between the plants was 80 cm. by a metre on the island soil, but only 50 cm. by 50 cm. on the karu soil, because growth here was less thriving and with less branching than on island soil. The first watering was given immediately after sowing, there was an interval, made as long as possible, so as to allow of roots growth, after which more water was given at 15 to 18 days' period till about the end of March. The amount of water given per feddan was 450 cubic metres.(111)

TABLE 54 AREAS AND YIELDS OF COTTON AT GANDETTO AND BAUGO SCHEMES

Season	Gandetto Scheme			Bauga Scheme		
	Area in Feddans	Yield in Kantars of 315 lb.	Yield k.p.f.	Area in Feddans	Yield in Kantars of 315 lb.	Yield k.p.f.
1918/19	187.2	823.7	4.45	-	-	-
1919/20	598.0	2686.5	4.59	-	-	-
1920/21	811.4	2260.4	2.78	-	-	-
1921/22	527.7	1641.8	3.11	170	850	5.0
1922/23	617.6	1656.9	2.68	400	1,780	4.45
1923/24	-	-	-	744	-	-

Source: Russel & Martin-Leake, op. cit., pp. 43, 51

With regards to yield, they compare with those of the water-tenants of Zeidab, and were much higher than those from the Zeidab Estate, mainly because of absence of bollworms and the rich alluvial soil. For costs of growing, the following table gives some idea (Table 55). This is for a

TABLE 55 ESTIMATE OF THE COST OF CULTIVATION FOR ONE FEDDAN OF COTTON UNDER PUMP IRRIGATION AT GANDETTO, NATIVE IMPLEMENTS BEING USED

Items	Costs	
	£E.	mms.
Ploughing (done twice)	0	400
Preparing basins, water channels, etc. 6 men/day	0	300
Seed and sowing	0	150
Hoeing three times: 5 men one day each time	0	750
Watering 14 times at 7 P.T. (labour)	0	980
14 Waterings at 46 P.T. per watering	0	440
Cutting and burning stalks	0	220

Table 55 contd.

Items	Costs £E.	Costs mms.
Picking 5 kantars of 315 lb. each at 0.15 P.T./lb.	2	300
Land Tax	0	300
Total	11	880

Source: Russell & Martin-Leake, op. cit., p. 49

5 kantars crop which at a normal price of 14d. per lb. in Liverpool, would be valued locally at £E.22,500. In years when grazing was poor the nomad Arabs used to cut and burn cotton stalks free in return for the right to run their cattle in them, and in really bad years they, in addition to this, paid an extra 20 P.T. per feddan.(112)

VI BAUGA SCHEME (Table 54)

This is situated on the west bank of the Nile, and was the most northerly of all schemes (Fig. 50), and the irrigated area extended about 15-16 kilometres from north to south and about 1.5-2 kilometres deep. It covered some 3,000 feddans in all, of which about 1,600 feddans were Government land, formerly part of the desert, and 1,400 native-owned land. As at Zeidab, the native holdings were as far as possible left intact, and a water rent equal in amount to that of Gandetto, was charged. The Government land was divided into holdings, each 10 feddans, of which 2.5 feddans were cotton.(113)

In addition to the water rent, there was a land tax which varied from 5 to 50 P.T. according to the quality of the land. As at Gandetto, there was a 4-course rotation, one-fourth of each holding being in cotton, one-quarter under food crops, and half of the holding left fallow. Watering system was the same as at Gandetto, cotton receiving 12 waterings in all, and other crops 6-7 waterings. As usual anywhere, the native tended to take too much water, and here the area was organised for the purpose into five sectors, each of which was in charge of a policeman who controlled the distribution of water. The only difference from Gandetto was the sowing date which took place in mid-August, and watering was at 14 days' interval until winter, when longer intervals were allowed.(114)

However, a special feature at Bauga was that the cotton plant was topped some 60 or 80 days after sowing to make it branch. Picking began in December, 100-120 days after sowing, the last watering was given in mid-April and picking ceased in mid-May, when plants were cut off. The return to the natives was indeed handsome: in 1922/23 cotton was sold at Port Sudan at £E.6 per kantar, the net price was £E.4.5, and the total realised for the 2.5 feddans was £E.47.3 of which the cultivator's share amounted to £E.23.65.(115)

Generally speaking, the noticeable feature of cotton growing north of Khartoum was the wide difference in the dates of sowing between the various schemes. At Khartoum North (Shambat) Experimental Station, we find cotton sown in May alongside cotton sown in July; at Gandetto from mid-June to mid-July; at Bauga sowing did not take place until mid-August, while at Zeidab sowing occurred as early as April-May. These differences are too divergent to be solely the result of climatic differences in a relatively uniform tract; it may be attributed to the fact that in some schemes, such as Khartoum North, experiments were still being carried out to find the optimum date, and in others to avoid cold spells and attack by bollworms and other pests, made favourable by the absence of a completely dead season.

IV COTTON GROWING IN THE EASTERN DELTAS

VII THE BARAKA (OR TOKAR) DELTA (Fig. 64)

The physical conditions of the Delta has already been discussed in Chapter Two, and land settlement in the previous one. Thus, all land being Government property, an allotment was made to the cultivators who were bound to carry out certain conditions. These conditions first put forward in 1909 and later embodied in the Sudan Cotton Ordinance of 1921, (App. 51), were: (a) Only cotton seed supplied by the Government may be sown (the seed being bought at Alexandria and imported fresh into Tokar, the amount of seed required being 1 kilo/feddan). The seed was given to the tenants on loan and up to 1917/18, the variety supplied was Afifi and Assili in 1918-20, and Sakel in 1921-22.) (b) All Hindi and extraneous varieties appearing in the resulting crop must be destroyed. (c) All cotton must be picked clean. All cotton must be brought to Tokar market to be weighed and classified under Government supervision, and (d) Instructions given by Government officials regarding methods of sowing, clearing of land etc., must be carried out.(117) Should the cultivator fail to comply with these conditions, his allotment could be reduced officially, and moreover, there was an allotment tax which, including rental, was collected as follows (Table 56) from both local people and those from outside the area:

TABLE 56 TAX LEVIED ON TYPES OF LAND, TOKAR DELTA

Holders	1st Class Land	2nd Class Land	3rd Class Land
On Local Men	60 P.T./*feddan*	50 P.T./*feddan*	30 P.T./*feddan*
On Outsiders	80 P.T./*feddan*	60 P.T./*feddan*	40 P.T./*feddan*

Source: P.E. Martin, *op. cit.*, p. 346

The amount of tax was chiefly decided by the nature of the flooding which the particular areas have received, and taxes were entirely remitted upon areas which had failed through want of water, or reduced upon areas which had been insufficiently watered. However, in 1917/18 season, the Government took as tax one-sixth of the cotton crop, and from 1919/20 one-fifth of the cotton crop marketed was taken as tax (Fig. 67).(118)

Allotment of land was preliminarily done previous to the flood in May-July, and a re-allotment was carried out after the flood had subsided in October when those cultivators, who had received land which was not watered, were given an equivalent plot in an area which had been flooded, provided that such land had not already been allotted. This indeed was quite common because of the fluctuations in the area watered each year (Fig. 19). To make allotments easier, the whole Delta was demarcated as Fig.64 shows. The system of demarcation, adopted for ease of assessment, was carried out in 1912, and subsequently additional areas were added until by 1920 an area of 155,840 *feddans* was completed. The largest unit is called basin, the size of which varies from 2,880 to 10,400 *feddans*, each basin being divided up into a series of squares representing 160 *feddans*, each measuring 840 x 800 metres. The boundary of a basin consists of iron rails embedded in the ground to which are attached boards giving the name of basin on each side.

(i) *Experimental and Flood-Control Works* (Fig. 64)

Although cotton growing in the Delta was an old, but disorganised, practice, the Government started to experiment with various types of cotton to select the most remunerative and best suited to the local conditions. Thus, in 1911 several plots, each 75 *feddans*, were experimentally cultivated under the direct supervision of the Department of Agriculture, the objects of which were: (1) To demonstrate to the native cultivators the effect of improved cultivation, and (2) To acquire data on the following: (a) A comparison of Afifi with other Egyptian varieties, such as Assili, Nubari, and Abbasi, and also with long-staple American varieties, to find the variety most suited for the Delta; (b) The effect of improved tillage on the conservation of water and on the crop yields; (c) General experimental work regarding the best dates for sowing, distances for planting, methods of planting, and the effect of pruning; (d) To determine whether Afifi deteriorated on continued growth at Tokar, and (e) To carry on seed collection and thus obtain a strain of Afifi, or any other variety, acclimatised to Tokar.[119]

The experience gained from these plots had in fact been immense, especially to the natives. The effect of tillage in advance was proved to have a marked effect on yield; likewise increased tillage subsequent to the flood also proved advantageous, and that the average yields which may be expected with good cultivation were as follows: (see also Table 2).

On lightly-irrigated land	400 - 600 lb. seed cotton
On Moderately-irrigated Land	700 - 900 lb. seed cotton
On Well-irrigated Land	1000 - 1200 lb. seed cotton

Much higher yields were obtained on well-watered land over limited areas. Finally, it was proved that Afifi - if not the best - was nevertheless suited to Tokar, and indeed it was found to be superior to Abbasi, and to a less extent, to Nubari. Assili, which was really an improved Afifi, was still being tried, and the long-stapled American varieties proved that they could be successfully grown. Afifi, on continued growth, did not deteriorate but tended to improve through acclimitisation.[120]

However, the repeated changes by the Baraka river of its course within a few years and the large amount of silt it carried constituted a great hazard to the effective use of its waters, and for this purpose a series of banks were constructed in the past (prior to 1923). These banks were of two kinds: (a) Banks constructed across the main channel or at the point of bifurcation, and (b) Banks running approximately east-west across the Delta in the neighbourhood of Tokar town.[121]

Banks under heading (a) generally consisted of sandy soil with a crest width of 5 m. and were protected on their upstream side by brushwood revetment only. They were built with the view of directing the water on to the good land (in most years to deflect water to the west because the tendency of flow was to the east) and were in this way instrumental in increasing the yield and, to a certain extent, in preventing the waste of water. This use, however, was particularly apparent in years of small flood. The land on the west, being flooded almost annually, had fresh deposits of silt laid down, it was kept comparatively clean, and was almost continually under cultivation. Meanwhile, the land on the east side remained either covered with sand dunes, or was scoured by wind to such an extent that almost the entire area was unsuitable for cultivation (Fig. 64). Thus, the eastern side had become eroded by wind, while the western side had become raised by successive deposits of silt, thus rendering greater every year the difference in levels between the two sides. The annually constructed banks appear to have caused the main channel to silt more and more until, in 1919, serious anxiety was felt lest the Baraka should abandon its course.(122)

The banks under heading (b) were constructed to arrest the tendency of the water to escape by khors to the low salty land on the north towards the sea, and at the same time to concentrate it and obtain a more even flooding. In the vicinity of Tokar town, these khors created terraces, the difference in level between the upstream and downstream sides of the banks being about one metre in 1923.(123) In 1923, the Sheddin Bank was constructed, the object being to confine the Baraka to a single channel, and so to prevent the scouring action which was taking place downstream. Other sites for proposed control works are shown in Fig. 64. The main aim for these control works was to prevent (a) Loss of water flooding land too lightly to produce satisfactory crops; (b) Waste in allowing water to escape to the marshes in the north and thence to the sea; (c) Drowning out of land already well-flooded and sown by late flushes of August and September and (d) to render certain the area to be flooded in the ensuing year in order to facilitate allotment.(124)

Langley in 1893 suggested a dam on the eastern channel to direct water into its formerly western channel, and the suggestions of others were similar methods for the same purpose, although sites were different. However, in 1912 the Baraka broke to the east, and a bank was built to divert water to Khor Sharaiet, together with a cut into Khor Tamrin. In 1915 another bank was constructed for the same purpose, but was washed away in 1916 thus necessitating building a new one to bring water directly into Khor Tamrin, and again it was washed away. In 1918 yet another one was constructed for the same purpose, and this was partially successful, for after some distance water deflected to Sharaiet again. Finally, in 1919, the Merchant Bank was built across Sharaiet to divert water to the high land to the west, but was carried away in 1920.(125)

(ii) Methods of Cultivation

The cotton season lasted from the end of August to the middle of May, and cultivation prior to the flood, though good, was risky because the course of the river was so erratic that a man may carefully cultivate his land in anticipation. Sowing took place in August, September and October according to how the land dried; with late floods, a considerable resowing was necessary. Sowing was done by a seluka which was inserted into the freshly deposited silt and a block was removed, and another hole was then made in the soil below, a few seeds dropped in and was covered up. Seeds were, however, sown in irregular lines approximately one metre apart. Generally speaking, cotton was sown on the best soil which had also received the best flooding; the poorer sandy soils were reserved for millet. Picking commenced about the end of December and continued until early May, and cotton was then weighed and carefully classified, and sold at public auction. Then it was transported to Suakin for ginning, and all these operations were done under Government supervision.(126)

Fig. 66 shows the total area planted with cotton and other crops (which consisted mainly of millets) from 1900-1918, the figures for other crops for the last five years being unavailable, and total cotton production from 1900-1923. Cotton area taxed between 1910-16, before obtaining tax in kind is shown in Fig. 67. In the early years, there was an evident stress on the production of millets, and only after 1909 that the increase in area under cotton is obvious. This can be attributed, besides good cultivation and more remunerative returns, to the control works which, despite their weaknesses, could divert water to a larger area and thus make it available for cotton. Moreover, if best watered areas were allotted to cotton, the variation in such areas is clear, and this can serve as an index to the volume of flood and the quantity of cotton produced - the slight variations being due to effect of control works and damage done by locusts. However, if we look at Fig. 69 the predominance of Tokar's position as a cotton producer is very obvious, this mainly representing quantities produced in Government-sponsored schemes. Indeed from 1905-1911, Tokar seems to have produced all cotton destined for export and thus giving revenue to the Government, and although the Gezira pilot stations, Gash Delta, and Government pump schemes along the main Nile appear in the subsequent years, Tokar's position remains unchallenged until 1922 when the Gezira slowly takes up the lead which it has maintained ever since.

VIII THE GASH DELTA (Fig. 65)

Like the Baraka river, the Gash is also notorious, though to a lesser degree, for its changes of course and the amount of the silt it carries, which makes control works difficult. In 1904, the Gash river divided into two distinct channels known as the Eastern and Western Gash, and it seems probable that both ran out from the spill area below Kassala which became numerous as one proceeded downstream.[127] The large circular basin, suggested by C. Dupuis in 1904, to enclose the tract around the apex of the Delta to trap the silt and let clear water through regulators in the containing bank, was found impossible because of the large amount of silt carried by the river.[128] In 1905, a diversion weir across the Gash was built with a canal taking off on the right hand to irrigate rather inferior land between Kassala and the gebels behind it. (Figrs. 8 & 65). The weir was designed to pass a discharge of 300 cumecs - a grave under-estimation of possible Gash flows and the extent to which its bed degrades during a spate (Fig. 20). Consequently, the weir was destroyed by 1906 flood, but was reconstructed and strengthened in 1907 to be removed again in 1921.[129]

In 1911, Gulosit Basin Project was undertaken by building a strong retaining bank across the Western Gash in such a way as to make a basin, but after some successful years, the land was so raised inside the basin by silt that the flow of the Western Gash was completely blocked. In 1918, the entire flow of the Gash was diverted down to the Eastern Gash. However, there were two bifurcations: the first at Futa where the Western Gash silted up in 1917. Thereafter, there was a bifurcation at Tukruf into eastern and western branches of the Eastern Gash, but the western branch silted up in about 1925. In fact it was the old main Gash which took off to the left there, and Khor Kurmuta which went straight on northwards (Fig. 8).[130]

In 1913, Gharbel Gash Canal was dug taking off the Gash about 2.5 km. below the weir on the west side and, depending on the vagaries of the river, watered an area behind the village of Gharb el Gash. In 1920 a canal was cut taking off the east side of the Gash, some 8 km. upstream of the weir to water some 2,000 feddans in a depression lying in the angle formed by the Gash, Khor Aby Alaga south of Gebel Kassala (Fig. 8), called Wad Sherifai Scheme. In 1922, Ankora Canal was opened, taking off the west bank of the Gash, and running northwards to water land lying to the north of saqia area, but the supply was unreliable and sometimes failed completely because of the instability of the reach where the canal took off.[131]

Thus there was a constant struggle against adverse conditions to control the water and direct it to the desired areas, and although a considerable number of canals, cuts and embankments have been built of late, the control is not complete, and the area cultivated still fluctuates as Fig. 20 shows. Here although the area watered is apparently dependent on the volume of the flood, the fact remains that only in well-watered areas that cotton is grown. That is why there is a discrepancy - indeed a complete reversal of the statement above - in Fig. 68 between discharge and area under cotton. Another factor is how the spates arrive: if they were sudden and intermittent, the difficulty of controlling them was increased, and it happened that most of the water passed uncontrolled to unwanted areas. But if the flow was even and continuous, the chances of controlling and directing it to larger areas of rich soil, were greater.

In the same way and for similar purposes as the Baraka Delta the Gash Delta is also demarcated, but the units are larger in size, the basin, or hod, containing 4,000 feddans of 4,200 square metres each, the numbering starting from the apex of the Delta (Fig. 65). The basin is sub-divided into 25 squares, or Moraba'as, each one containing 160 feddans, and with their corners marked by beacons carrying the numbers. Each square is again sub-divided into 16 smaller ones of 204.9 m. side, each containing 10 feddans and known as plots or gittas, which is the basic unit of land distribution. However, they are not permanently worked out in any way, and are re-chained when necessary.(132)

(i) Method of Cultivation

In 1923, the Delta was handed over to the Kassala Cotton Company, a body closely allied to the S.P.S., which was to develop it on somewhat the same lines at the Gezira. The tenants were to carry out the stipulated cultivation and keep up the feeder channels, and in turn were to receive half the net proceeds of the sale of the cotton crop, the remainder being equally divided between the Government and the Company.(133)

Although the Shiote system is no longer practised, cultivation has not changed much except for more cuts, canals and banks that ensure some even spread of the flood waters. The land, having been cleared of its previous cotton crop, if any, by mid-May, was left bare and exposed to the baking effect of the fierce summer sun till the arrival of the flood. There was no ploughing or cultivation of any sort; sowing began in August or September as soon as the water had drained off, and was done by the seluka, the holes being made, after the slab of silt was removed, and spaced about 2 m. by 1 m. Resowing continued until the end of September, and the grass that came up was cut, and clearing went on until picking began from mid-February to May. Provided the grass could be kept down there was apparently nothing to prevent cotton being grown on the same land year after year, but excessive grass growth is a clear indication of over-cropping. Moreover, both soil and water are almost wholly free from salt, so that this problem seems unlikely to happen, and the physical composition of the soil is such that is can apparently be flooded every year without harmful results. The position is thus different from the Gezira (see Chapter Two).

However, despite these good conditions for crop production, yields until 1924 were low (Fig. 68), the main reasons being: (a) Failure to get water on to the land at the earliest opportunity after the flood. The result was a diminished water supply to the germinating seed which checked, and may actually have stopped, the root in its pursuit after the receding moisture, slow as that withdrawal appeared to be. The best solution was by better control of the flood which would allow certain areas to be released before the natural flow ceased and these could be sown while the flood was turned on to other land. (b) Failure to obtain a plant, thus necessitating subsequent sowings; (c) Distance between plants. In many cases plants were obviously too far apart, a distance of as much as 3 metres sometimes separating adjacent lines. It is very questionable too whether the best results could be obtained when 6, 10 or even more plants were left in one hole. Moreover, the duty of water applied needed studying so as to ensure that the limited supply was distributed over the largest area of the land. The small plots useful elsewhere for this purpose may not serve here. The purpose of the added water was not to supply by itself the whole quantity required during the plant's life; it was to re-establish a moisture condition throughout the entire depth of the soil, so that the plant's roots could strike into the permenantly damp zone below. From the nature of the problem it appears that records of watering and of results taken over the whole 10-feddan blocks could give more useful information than detailed observation on small plots.

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CONCLUSION

This thesis has been divided into two parts, and in all comprises seven chapters. It remains now to attempt a synthesis or overview.

Chapters One and Two were concerned with the historical and physical background to cotton growing in the Sudan. A discussion of the origins of cotton concluded that in the Sudan certain exotic forms had been grafted on to indigenous stock. In order to achieve a basic understanding of the plant and its habitat the origin, distribution, characteristics and classifications of world cottons were briefly examined and the varieties and the cultivation techniques introduced into the Sudan before 1925 established, this being followed by a review of the physical parameters involved.

Chapter Three considered the traditional economy of the Gezira in the context of problems of agricultural development. This discussion established the importance of cheapness in the production of competitive crops like cotton. Moreover, the vital importance of science in this field and the education of the supervisory staff to deal with the peasant cultivators, was stressed.

Chapter Four discussed commercial cotton growing by the Turks from 1850 giving the reasons for the introduction of the crop, the general agricultural conditions in the Sudan then and the approach to cotton growing at that time, emphasising the various factors which led to the failure of this untimely and ill-starred venture, in particular lack of scientific approach, of cheap means of transport and the exploitationary attitude of the government. Chapters Five, Six and Seven dealt with commercial cotton development from 1900-1925. The first two chapters discussed reasons for introducing cotton and the various problems facing this development and how they were solved, while chapter Seven was concerned with the various experimental and pilot stations that in the end made possible the success of the Gezira Scheme, and thus laid the foundation of cotton growing in the Sudan.

This contrast between Turkish and British schemes brings us to the case of the thesis: the failure of the Turks and the success of the British. In analysing the causes for failure or success, the main argument of the thesis emerges: the need for pilot studies before undertaking any scheme for agricultural development, particularly when introducing a new crop in a new area. To the modern mind this is now self-evident. Furthermore any attempt to assess more precisely the causes for failure or success of cotton growing in the Sudan during the periods 1860-1897 and 1900-1925 must consider two points: first, were there similarities in incentives for, and approaches to, cotton growing in the two periods? Secondly, did conditions, whether economic, political, social or physical, exist that encouraged the introduction of a new cash crop?

With regard to the reasons for the introduction of cotton in the Sudan in 1860 and 1900, they are seen to be almost identical and in both cases were the result of external factors: the acute shortages in the supply of American raw cotton for that vital Lancashire industry, and the attempt on the part of the British Government to find sources of supply other than those of America. Moreover, the preliminary steps taken by both Turkish and British authorities to encourage people to grow cotton, were more or less similar and ranged from free distribution of cotton seed and reduction of taxes on land to the introduction of Egyptian peasants as "starters" to teach the Sudanese natives proper methods of cotton cultivation. In each period there were attempts to survey and improve irrigation techniques.

Furthermore, in each period a situation existed where productivity could be raised through irrigation, improved farming practices, or introduction of a new cash crop. Trade, which was the backbone of the economy of the country, was in each case subject to harsh taxation and high custom duties, and threatened by tribal raids and pillage, which hindered its progress. Agricultural development was hampered by excessive taxation on land and produce, and indeed between 1888-98 the Khalifa's misrule almost destroyed the economic foundation of the country. The lack of efficient means of transport to carry the crop cheaply to the market posed a serious economic problem. Socially, the expropriation of land from tribes, forced enlistment in the army and punitive campaigns and excessive taxation drove the peasantry, especially the young folk, from the land and disrupted family and tribal organisation. As a result people were weary of harsh economic conditions and wars and longed for peace. Physically, agricultural production, which was mainly subsistence, was subject to great fluctuations resulting from unreliable rainfall and the varying level of the Nile; consequently the people were susceptible to times of dearth and severe famine resulting from crop failure. Moreover, the natives, although destitute and poverty-stricken, had evolved certain agricultural traditions and customs which could have been (and indeed were) of great help in easing the impact of change which resulted from the introduction of new farming practices.

Thus, although there were similarities in some of the initial steps to encourage people to grow cotton, and despite the need for increased agricultural productivity through the introduction of new crops, the end result of the two ventures were very different. This difference lay not only in the fundamental attitudes of the two governments to the practical problems of cotton production, but also in the distinction between development purely for the purposes of exploitation and development linked with agrarian reform and the diffusion of the benefits throughout a whole society. To elaborate on this, we can proceed to discuss and analyse more fully the causes of failure and success.

The foundations of modern agricultural development have generally been laid either by pioneer farmers or planters in regions suitable for white settlers, or by agricultural services of the different administrators in territories where agriculture was chiefly or entirely a native industry. In both cases, there had generally been a basis of native agriculture to work upon. Whereas, however, such native agriculture generally catered for local requirements only, and interest was confined to those food and other products necessary for the family or the tribe, more intensive development of the agricultural resources of these areas was usually linked with the production of some commodity for export. In some cases the extension of cultivation had been connected with products already grown by natives, in others, and more generally, it had been associated with some crop new to the area or which had previously been an unimportant factor in local agriculture, as was cotton in the Sudan. Thus, there was every opportunity for agricultural expansion there.

However, while the Turks blindly seized upon this opportunity to make as much profit as they could from the high prices created by the American Civil War (1861-64), the British were more genuine and cautious in developing these resources. From the start they recognised that they were working against various difficulties and problems and that time was needed if a venture of this kind was to be successful. Indeed the position for the British was more difficult in 1900 because 40 years of misrule had wrecked the foundations on which a new economy could be built.

The peasants who are usually conservative, especially with regards to innovations, were inevitably suspicious of advice given by foreigners. However, realising that alien practices would increase this suspicion, the British started to look for what the native agricultural customs could offer, and at Zeidab they started to experiment with different forms of partnership between the natives and the Sudan Plantations Syndicate (S.P.S). When the rental system failed because of the lack of cooperation from the natives, an alternative was found in the customary native practice of dividing the crop into shares among the landlord, owner of the saqia, and the labourer. Thus, the problems of credit, tenure and management were solved in a very simple way that was derived from existing conditions and hence understood by the tenants and which, moreover, provided a mutual bond in adversity or in success for the government and the tenants on the one hand, and for the former and the S.P.S. on the other. This also helped very much in bringing the tenants to the idea of cultivating cotton annually pending their education in cotton cultivation, their accumulation of a capital reserve and the organisation of a local cotton market. Moreover, the government by controlling the land use could direct it in the best interest of the country as a whole and thus to bring the advantage of large-scale management to a peasant society without creating the hardships that are apt to occur in such a change, to the peasant.

Failure in such circumstances not only discredited the agricultural technicians and government departments in the eyes of the peasants but also emphasised that suspicion of new ideas, once doubt had been aroused, is always difficult to allay. Certainly, if the peasant sees, or is convinced, that a new idea is worth trying, he will willingly do so. But they would very naturally resent advice to take up something which, generally speaking, they did not yet understand because of the weight of tradition, the lack of education and the lack of a real conviction that change was necessary. It is also essential to remember that a different approach is required with different people in different places. Thus, when the Turks first introduced cotton into the Sudan, they imposed a new system of agricultural practice onto the existing pattern which was mainly a subsistence peasant economy. Peasants were forced to cultivate the new crops, cotton, indigo and sugar-cane, on the limited saqia land at the expense of their food crops. Cotton to the Turks was an ideal crop for monopoly and an article for which there was a ready market in Europe, and accordingly was preferred to other crops. However, by retaining the returns for the sale of cotton to itself, the Government deprived the peasant from any benefit and a breach of faith was an inevitable outcome of this short-sighted policy. Moreover, the system of taxation was alien to the Sudanese, and cotton cultivation could not be fitted into the existing pattern of agricultural administration. It would have been worthwhile to study the effect of increased cotton production on the food resources of the country at the time. There was an undoubted need for a cash crop to replace dura, the main food and cash crop, because yields of this crop were subject to wide fluctuations. The Turks, by forcing people to cultivate cotton instead of dura and by keeping the return from its sale to themselves, made the economic position of the native in the rainlands even more precarious. The British, on the other hand, recognised this weakness and exploited it fully in their propaganda for cotton growing with very successful results.

However, if at the stage when cotton is being introduced into an area, low prices result in great diminution in the return to the cultivator, such a situation will put to a severe test the possibilities of cotton growing in that region, and might put an end to the cultivation altogether in some marginal districts. The high prices during the American Civil War rendered it comparatively easy to make profit from where cotton plant could grow and fruit just reasonably well. The Turks, encouraged by these high prices and spurred by gaudy and imaginative reports on the fertility of the Sudan, blindly went ahead planting the wrong type of cotton in the wrong place. When prices went down at the end of the war, cultivation virtually stopped almost everywhere. As the type of cotton they introduced could successfully be grown only by irrigation, a reliable water supply was necessary for this purpose, and this the saqia could not provide because of its limited irrigation capacity.

For the British, however, the saqia was a cumbersome contrivance that should be replaced by pumps. Along the main Nile the land commanded by the saqias was narrow and owned by the natives, but beyond this were large blocks of cultivable land which, because of their distance from the river and elevation, could only be commanded by pumps. Thus, by demonstrating the efficiency and superiority of pump irrigation, without directly interfering with native institutions, the British successfully managed to bring the natives to the idea of becoming leaseholders. In the Gezira, the fact was recognised from the start that rainfall here was unreliable and that perennial irrigation was necessary if the long-staple Egyptian cotton was to be successfully raised.

The provision of transport and other facilities call for a large capital expenditure, and it is only after the facilities have been provided, and therefore the capital expended, that the crop can be grown on a large scale. The opening and development of such an area must of necessity be of the nature of a venture and every reasonable precaution should be taken to ensure the success of the venture. In the Sudan the crying need, among other things, was for efficient and modern means of transport to connect the productive areas together and to link them with the outside world. Indeed, it was futile to introduce any cash crop without first providing an efficient means to transport it to world markets at a rate cheap enough to stand competition, and this the slow and cumbersome camel transport could not provide. This fact was recognised by the British from the start, and in building the railway line to the coast long before the Gezira project paid its way, they gave a typical example of the unremunerative level of development without which the remunerative level could not be embarked upon, but which a poor country like the Sudan could not finance on banker's loan.

The Turks, on the other hand, by monopolising trade and imposing heavy taxes on all aspects of economic life, created an atmosphere which was too risky for private investment, and thus they destroyed any chance of devising suitable forms of mutual insurance and some kind of agreed investment statute, which are so vital in attracting private investors. Conversely, the inclusion of private management by the British in the pilot stations, and later in the Gezira Scheme, had, beside providing capital so much needed at the time, the advantages of applying their prior experience and managerial skill in cotton production to the Gezira, plus providing a more practical approach by their concern that the scheme be a profitable commercial enterprise.

Finally, as in most other forms of human activity, the application of scientific knowledge and the direction of scientific research to the solution of agricultural problems require very careful planning and such planning must be done with full knowledge of all the circumstances and clear perception of the real issues at stake if the desired results are to be obtained and grave disappointment and consequent reaction avoided. The British approach generally, though not always, followed these points. This is evident from the detailed topographic, soil and cadastral surveys, experimental farms and pilot stations, seed farms designed to select varieties best suited to the Sudanese conditions, the adoption of various rotations to improve quality and yield of cotton, and the establishment of research farms to carry on agronomic research and maintain the quality of cotton. The Turks, on the other hand, adopted quite an opposite approach: cotton seed imported from Egypt and planted along the northern riverine areas of Berber and Dongola provinces did not thrive well and of course failed in the rainlands to produce good quality fibre. Failing to maintain the quality by cross-breeding and selection and pure supplies of seeds adapted to Sudan conditions, the cotton plant quickly deteriorated.

However, one can argue that the interval of 40 years that separates the two periods could mean a lot in terms of scientific development and achievements, and that by 1900 big strides must have been made, for example, in plant genetics, heredity, cross-breeding, and so on. This is true. But the fact that Mohamed Ali and his successors, with their all limitations and indulgences, were more concerned about the success of cotton as a cash crop in Egypt, by employing foreign experts to teach the Egyptian peasants every aspect of cotton production, provision of money and seed for the peasant, and, more important, giving time to experiment and liberal advances of money for research to improve cotton quality and yield, and the fact that the modern long-staple Egyptian cotton evolved in 1830's by cross-breeding Jumel cotton by Sea Island, all indicate that the Turks, if not scientific in the modern sense, were at least very much more practical in their approach to cotton growing in Egypt than in the Sudan, where indifference, casualness, corruption and profit motiveness did more harm than good to the people and industry alike.

In assessing the success of an agricultural scheme, the common method is to compare conditions, that is, economic conditions of the area and its people before and after the scheme in order to bring out the material change or improvement that has accrued from the development. But important as the economic factors are, the emphasis can also be laid on geographical factors, that is, on the appraisal of the landscape that has resulted from this transformation, and how is it different from the pre-scheme one. In attempting to apply this last method to the conditions in the Gezira, it must be borne in mind that the full impact of the schemes on people and landscape was not fully grasped or felt until long after 1925, and that the part of the Gezira which was brought under irrigation by 1924 was a little more than one-quarter of the total area to be irrigated when the dam functioned. In such a small area any evaluation of advantages of these stations will again be economic, but one thing is to be recognised, and that is, that the process of change in, and transformation of, the landscape, which had later to assume greater magnitude, was already set apace by these pilot pump stations started between 1911-23.

Thus, before these schemes (as well as outside the irrigated area) the characteristic feature of the Gezira was the enormous flat, dark plain, uniform in its bleakness, the absolute monotony of which was broken here and there by a village or an occasional clump of trees, mostly situated either on sites of cemet~~a~~ries and old villages which had long ago c disappeared, leaving only mounds and depressions in the sandy soils or low-lying land. The people lived in settled villages and grew <u>dura</u> as the main food crop on the flat plain by raising large earth banks to retain the water from an uncertain rainfall between 10-25 inches per annum, and occurring from July to early October. Some cotton was raised in low-lying depressions with a minimum of effort, and food crops were secured for three years in five, but the threat of famines and death was always there. In winter when the grasses had withered and trees lost their leaves, the menfolk moved south to better grazing grounds, and the remaining population led a harsh existence from November to late June, hauling water day and night from very deep hand-dug wells to water themselves and the goats which grazed on the low thorn bushes covering the plain. Some of these villages maintained contact with riverine villages whence they originally came, and when rains failed in the interior they eked out a living from cultivation along the rivers. Apart from this subsistence cultivation, the Gezira plain was an area of extensive livestock raising. Pastoralism and cultivation were not mutually exclusive, and indeed were carried out by the same person. The value of animals in this mixed system of pastoralism and cultivation lay in the security they provided in an environment which was marginal for sedentary agriculture. When crops failed animals could be sold, as a last resort, to buy grain and to permit another crop to be sown.

With the establishment of the pilot schemes, ample water supply was made available for crop and human consumption, and thus the precarious position of the individual owing to the uncertainty of rainfall was removed. He was ensured of a permanent supply of his food crop, and in a year of bad rains the production was far greater than in the past, and thus he was insured against famines. The animals were provided with more fodder from <u>lubia</u> and <u>dura</u> stalks, but to the great disadvantage of the scheme they were not integrated into the farming system itself. Instead of the desultory way of life he used to lead, the peasant was busy most of the time cleaning his plot after rains, digging minor irrigation channels, making ridges and field channels across them to irrigate the cotton, and scores of jobs he never dreamt of before. He was relieved of roaming about with his animals searching for pasture, and this time gained had to be put to the benefit of other tasks. He was no longer his own master: there was a horde of inspectors to tell him what to do and when to do it, and he had to follow their advice and carry out their orders and instructions to the last word, otherwise he was liable to eviction.

The bushes and clumps of trees that were occasionally met and provided a precarious grazing for the hungry goats had to be removed lest they should harbour insects or diseases that may harm the precious cotton plant, and the various depressions which previously provided the best sites for dura and cotton had to be levelled, first to prevent mosquitoes breeding in rain-water that accumulated there during the rainy season, and secondly to render the land level for irrigation and laying out of canals and fields. Villages had to be rearranged and made accessible by roads, and gradually man's activity created a new cultural landscape: the network of irrigation canals that criss-crossed the land, the neat bungalows and houses of the British staff, the telephone and railway lines, the bare landscape devoid of trees, except (depending on the season) cotton plant and dura stalks, or bare and ploughed up or cracked ground, all indicated the transformation which the Gezira plain, after centuries of almost dormancy, was undergoing, and has been undergoing ever since.

Today, the total area brought under irrigation in the Gezira-Manaqil area is about 1,870,000 feddans of which 58% is irrigated each year by the main canal and branch canal and major distributaries totalling over 600 miles, and by minor distributary canals totalling some 2,000 miles in length, in the main Gezira only. Sudan produces only about 1.5% of the world's cotton, but accounts for 30% of its extra-long-staple output, and the Gezira cotton accounts for 65.4% of the country's export by value. Since the inception of the Gezira Scheme in 1925 there have been some changes: the original amount of land allocated to each tenant was changed from 30 feddans to 40, and with this a change in the rotation from the original 6 to the present wider 8 course rotation in the battle against diseases and pests. The distribution of gross profits among the partners has been changed to as follows: tenants 46%, of which 2% is transferred to the Tenants Reserve Fund; the Government 40%; the Sudan Gezira Board (which replaced the Syndicate in 1950) 10%; local government councils 2%; and the Social Development 2%.

GLOSSARY

Abu Sitta and Abu Ishrin:	watering-channels in the Gezira. Lit. The father of six, and of twenty, piastres paid per unit of excavation.
Ardeb:	A measure of capacity for agricultural produce.
Asal:	Literally honey, but also applied to aphids that exude a sticky substance.
Balag:	Areas in the Gash Delta used for silt deposition prior to use of water for irrigation. Land flooded by natural flow.
Bamia:	Okra or Hibiscus esculentus Linn.
Bersim:	Lucerne or alfalfa, Medicago sativa Linn.
Bilad:	Village periphery lands on which cultivation is perennial, without resting period.
Buda:	The parasitic weed Striga hermonthica Benth, that attacks dura.
Bugr:	Land in Khartoum Province lying behind the 'saqia' land and cultivated only rarely when rains have been good or the flood exceptionally high.
Burma:	An earthenware jar.
Dom:	Hyphaene thebaica Mort.
Dukhn:	Pennisetum typhoideum (Burm) Stapf and Hubbard, the main grain crop in sandy areas.
Dura:	Sorghum vulgare Pers.
Fasil:	Lit. dividing-line, the boundary line of a block of 'gerf' land running at right angles to the river.
Gerf:	The sloping land of a river-bank or small pockets of silt land cultivated by 'seluka' as the waters subside after the annual flood.
Hababai:	The winter trade winds, particularly of the Tokar Delta area. They are easterly to north-easterly and persist until the onset of the winter rains.
Haboob:	To blow violently, locally a strong wind usually accompanied by thick dust.
Hafir:	Locally a pool usually man-made.
Hod:	Basin or trough: (a) A compartment of irrigated land (b) In the Tokar Delta, a 'hod' is a basin or unit of 15-56 'muraba', each of which is a square of 160 feddans.

Hod: (c) In the Gash Delta a 'hod' is a large area of 4,000 feddans.

Howash or Hosha: A holding of land; in the Gezira means a tenancy of 10 feddans.

Kantar: A unit of weight.

Karu: Land in Shendi district lying behind the 'saqia' land, cultivable only when the Nile is exceptionally high or when the accident of a good rain has occurred.

Kerrib: Land consisting of eroded water channels cutting from plain to valley along the Atbara and Blue Nile rivers.

Lebad: A stretch of fine alluvial silt land in the Gash Delta.

Lubia: The bean Dolichos lablah Linn, grown for human food, but mostly for forage, in the northern Sudan and a most important crop.

Matara: A Persian water-wheel or 'saqia' working from a well.

Matmura: Burial in the soil; pits for storing grain, particularly dura.

Mulukhiya: Corchorus olitorius Linn., cooked as a vegetable.

Millieme (mm): A unit of money.

Mirin: An imaginary boundary in the river used for demarcating 'gerf' land. This boundary lies parallel with the river.

Misqa: From Ar. word meaning to irrigate, locally a branch canal in the Gash irrigation scheme.

Muraba: Square; in the Tokar Delta a division of land of 160 feddans measuring 800 x 840 metres; in the Gash Delta the sides of a 'muraba' measure 820 metres.

Piastre (P.T): A unit of money.

Kism: Lit. portion or division of land, locally an area of land about the size of a political district.

Qitta (Gitta): Portion, a unit of land in the Gash Delta of 10 feddans.

Qoz: Sand-dune; 'qoz' country means any part of that vast area of billowy continental sand occurring in Darfur and Kordofan Provinces.

Rotle: A measure of weight.

Saliba: Earthen cross-banks to control basin irrigation in the Northern Province.

Samad: A village representative responsible for the agricultural management of the tenancies.

Saqia: Persian water-wheel.

Seluka:	A digging stick with foot-rest; also applied to land cultivated by 'seluka'.
Shaduf:	A hand-operated water-lifting device suited for watering plots of vegetables. It is on the see-saw model with the water container counterbalanced with a lump of clay.
Shiot:	Areas of land in the Gash habitually cultivated by particular families or individuals. Also an area of land in the Gash irrigated by a cut from a 'balag'.
Sunt:	Acacia arabica Willd.
Tamam rai:	Lit. complete irrigation, locally a good irrigation level particularly used in connection with Northern Province basins.
Teras: (pl. Terus)	A small earth bund built with hand tools for impounding rain-water (or rainwater cultivation).
Tob:	A garment; locally a winding cloth worn by women.
Usher:	One-tenth; locally an indigenous land-tax amounting to one-tenth of the total yield of crops.

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12.	British Cotton Growing Association	Bin 12/3

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15.	Tayiba Station	Bin 16/2
16.	Tayiba Tafteesh	Bin 17/2
17.	Tayiba Tafteesh Tenancies	Bin 17/2
18.	Tayiba Extension of Area	Bin 17/2
19.	Tayiba Tafteesh Reports	Bin 17/2
20.	Barakat Station Concession	Bin 1/1
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23.	Barakat Tafteesh Tenancies	Bin 1/1
24.	Barakat Tafteesh Model Farm	Bin 1/1
25.	Barakat Training Farm	Bin 1/1
26.	Major Extension of Areas	Bin 1/1
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28.	Hosh Tafteesh - General	Bin 4/5
29.	Hosh Tafteesh Tenancies	Bin 4/5
30.	Hosh: Abandoned and Flooded Hoshas	Bin 4/5
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37.	Report on the Complete Drainage Scheme for Gezira	Bin 4/4
38.	Temperature and Rainfall Records	Bin 4/4
39.	Temperature Records	Bin 4/4
40.	Ploughing Programme	Bin 7/4
41.	Areas and Annual Division Between Crops	Bin 1/9
42.	Lubia Growing in the Gezira	Bin 7/9
43.	Cotton Stations	Bin 11/9
44.	Cotton Yields and Rainfall	Bin 2/12
45.	Rainfall Theory and Estimates	Bin 2/12
46.	Crop Statistics	Bin 2/12
47.	Average Yield per Feddan	Bin 2/12
48.	Old Tayiba Cotton Yields and the 2-year Rotation	Bin 3/12
49.	Barakat Crop Statistics	Bin 3/12

50.	Gezira Final Yields: Season 1911/12	Bin 3/12
51.	Gezira Cotton Yields	Bin 3/12
52.	Cotton Yields: Yield by Tenants	Bin 4/14
53.	Cotton Yields: Yield by Rotation	Bin 4/14
54.	Cotton Yields: Yield by Hosha	Bin 4/14

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APPENDICES

APPENDICES

APPENDIX 1

TABLE 1 MEAN GEZIRA RAINFALL, 1906-33, in mm. PER ANNUM

(A) Individual Stations: Actual Means and Means Calculated from position.

	Station	Lat.	Long.	Early Rainfall		Total Rainfall		Standard Deviation	
				Ac.Mean	Cal.M	Ac.	Calc.	Early	Total
(1)	Medani	14°24	33°31	47	51	386	365	32	105
(2)	Manaqil	14°13	32°58	44	43	362	336	32	116
(3)	Rufaa	14°48	33°19	34	38	323	304	28	109
(4)	Hàsahuia	14°38	33°18	34	41	292	321	27	118
(5)	Kamlin	15°4	33°11	28	29	241	264	28	81
(6)	Sennar	13°33	33°38	82	72	456	466	43	87
(7)	Dueim	13°59	32°19	30	34	302	301	22	99
(8)	Geteina	14°52	32°23	16	16	196	214	17	97
(9)	Khartoum	15°40	32°34	11	2	160	145	12	94

(B) Five Central Stations (1 - 5)

	Early	Middle	Late	Total
General Mean	38	222	61	321
St. Dev. of mean of 5 stations	23	67	37	82
St. Dev. per station	30	89	41	107
St. Dev. per station (eliminating seasonal mean)	20	64	32	76

(C) All Stations

	Early	Middle	Late	Total
General Mean	36	210	55	302
St. Dev. for 9 stations	18	57	27	71
St. Dev. per station	28	85	40	101
St. Dev. per station (eliminating seasonal mean)	22	67	32	76

(D) Regression on position (all stations)

	Early	Middle	Late	Total
mm/degree of latitude	- 22	- 58	- 26	- 100
mm/degree of longitude	22	50	16	90
As %age of mean/deg. of Latitude	- 16	- 28	- 47	- 37
As %age of mean/deg. of longitude	60	24	30	30

APPENDIX 2

TABLE 2 AVERAGE DISCHARGE OF THE NILE AND TRIBUTARIES, 1912-47 (Means in millions of m^3/day
Totals in millions of m^3)

		J	F	M	A	M	J	J	A	S	O	N	D	Year
Main Nile at Aswan	Mean	118	88	68	55	48	57	138	561	696	476	257	161	228
Natural River (1)	Total	3,650	2,480	2,110	1,650	1,500	1,720	4,270	17,400	20,900	14,800	7,720	1,990	83,100
Atbara	Mean	-	-	-	-	-	3	55	176	117	27	6	2	32
	Total	-	-	-	-	-	94	1,700	5,460	3,520	827	183	53	11,800
Blue Nile at	Mean	25	16	13	11	16	40	178	507	486	252	89	44	141
Khartoum	Total	762	459	339	492	1,200	5,530	15,700	14,600	7,830	2,680	1,350		51,400
White Nile at	Mean	76	63	54	49	47	54	46	49	90	113	99	90	69
Khartoum	Total	2,340	1,770	1,670	1,470	1,450	1,610	1,420	1,510	2,690	3,500	2,960	2,780	25,200
Sobat	Mean	26	13	8	7	13	29	42	52	59	63	66	54	36
	Total	822	371	258	216	417	872	1,300	1,610	1,780	2,010	1,990	1,690	13,300
White Nile below	Mean	41	41	40	38	37	36	37	39	40	41	39	39	39
Swamps	Total	1,280	1,160	1,220	1,140	1,150	1,090	1,150	1,200	1,210	1,260	1,170	1,210	14,240
Bahrel Gebel at	Mean	62	58	57	60	73	72	78	89	90	84	77	69	72
Mongola	Total	1,930	1,650	1,760	1,810	2,270	2,170	2,410	2,760	2,690	2,600	2,310	2,130	26,500

TABLE 2 continued

		J	F	M	A	M	J	J	A	S	O	N	D	Year
Bahrel Gebel at exit from L. Albert	Mean	56	62	59	58	59	60	61	63	65	67	69	61	63
	Total	2,020	1,740	1,820	1,730	1,840	1,800	1,880	1,940	1,930	2,090	2,080	2,140	23,000
Victoria Nile at exit from L. Victoria	Mean	52	52	54	58	65	65	60	58	56	54	53	54	57
	Total	1,620	1,440	1,660	1,730	2,010	1,960	1,910	1,800	1,660	1,610	1,590	1,670	20,700

(1) The natural river at Aswan is calculated from the actual discharge at Aswan by allowing for the water taken by the Main Gezira Canal and for the regulation of the Aswan and Sennar reservoirs. No allowance for Gebel Aulia Reservoir.

From: H.E. Hurst, (1941) App. 1

APPENDIX 3

ANNUAL BALANCE SHEETS

RIVER KAGIRA

Annual inflow:

From Tributaries	16 milliards
From Rainfall on Lake	98 milliards
Total	114 milliards

Annual outflow:

By Victoria Nile	21 milliards
Difference	93 milliards

Evaporation: 1.4 m. per year or 3.8 mm. per day

LAKE KIOGA

Annual outflow:

From Victoria Nile	20.6 milliard
By tributaries	3.5 milliard
Rain on Lake and Swamps	8.0 milliard
Total	32.1 milliard

Annual Outflow:

By Victoria Nile	19.7 milliard
Difference (Evapotranspiration 2.2 m. per year, or 6 mm. per day)	12.4 milliard

LAKE ALBERT

Annual Inflow:

From Semliki	3.6 milliards
Estimated amount from other tributaries	1.7 milliards
From Victoria Nile	19.7 milliards
From rain on lake	4.6 milliards
Total	29.6 milliards

Annual Outflow:

By Bahrel Gebel	22.0 milliards
Difference (by Evaporation at 1.4 m per year or 3.9 mm. per day)	7.6 milliards

LAKE GEORGE AND EDWARD

Annual Inflow:

From tributaries	2.2 milliards
Rainfall on Lakes	3.4 milliards
Total	5.6 milliards

Annual Outflow:

By Semliki	2.0 milliards
Difference (Evaporation at 1.44 m. per year or 3.9 mm. per day)	3.6 milliards

Appendix 3 contd.

AVERAGE EVAPORATION IN MM/DAY

	Piche	Open Water
Mediterranean Coast	6.1	3.0
Nile Delta	4.6	2.3
Cairo and neighbourhood	5.5	2.8
Fayum	7.9	4.0
Oases	13.0	6.5
Upper Egypt	9.0	4.5
Northern Sudan - Halfa - Atbara	15.1	7.6
Khartoum and neighbourhood	15.3	7.8
Central Sudan: Dueim - Roseires	12.6	6.3
Southern Sudan: Malakal and South outside swamp	6.8	3.4
Lake Albert		3.9
Lake Edward		3.9
Lake Victoria		3.8

Source: H.E. Hurst (1957), op. cit., pp. 247-51, 254

APPENDIX 4

TABLE 4 COMPOSITION OF IRRIGATION WATER: ANALYSIS OF THE NILE WATERS (1906) SHAMBAT (JUST BELOW THE CONFLUENCE OF BLUE & WHITE NILES)

Items	Blue Nile (Parts/million)		White Nile (Parts/million)	
	January	August	January	August
Solids in suspension	7.9	1,964.0	61.5	167.27
Solids in solution	166.10	135.2	191.00	161.8
Free NH_3	-	0.034	-	0.020
Albuminoid ammonia	-	2.256	-	0.345
NO_3 (Nitrates	-	0.707	-	0.285
NO (Nitrates	-	Nil	-	Nil
cl (Chloride	1.7	1.89	5.48	4.34
SO_4 (Sulphates	5.06	11.52	Nil	5.43
CO_2 (Carbon dioxide	44.93	54.54	56.16	62.21

Appendix 4 contd.

Items	Blue Nile (Parts/million)		White Nile (Parts/million)	
	January	August	January	August
Ca (Calcium	16.15	25.82	11.68	21.06
Mg (Magnesium	5.81	7.7	6.43	8.48
K (Potassium	2.19	2.02	9.56	4.59
Na (Sodium	9.61	7.7	25.32	12.48
SiO	22.3	16.8	20.4	6.40
Oxygen absorbed in 10 min. at 100°C	1.75	56.00	5.49	9.77

Source: Pump Irrigation in Northern Sudan (1915), p. 69

MATTER IN SOLUTION IN THE NILE

	Parts per million
Lake Victoria	80
Victoria Nile below Lake Kioga	100
Lake Edward	670
Lake Albert	590
Lake Tana	170
Bahrel Gebel below Lake Albert	160
Blue Nile at Khartoum	140
White Nile at Khartoum	130
Atbara	200
Nile at	170

Source: H.E. Hurst (1957), *op. cit.*, p. 279

APPENDIX 5

TABLE 5 AMOUNT OF SILT CARRIED IN SUSPENSION BY

(a) KHOR LANGEB (50 km. upstream of Junction)

Date	vol of water	vol of silt	Wt. of water oz.	Wt. of silt oz.	% in bulk	% in wt.
July 19,1920	0.000320	0.000013	10	½	4.0	5.0
July 23	0.000320	0.000012	10	7/16	3.0	4.0

Appendix 5 contd.

Table 5 contd (a) Khor Langeb (50 km. upstream of Junction)

Date	vol of water	vol of silt	Wt. of water oz.	Wt. of silt oz.	% in bulk	% in weight
July 25, 1920	0.000320	0.000032	10	$1^1/8$	10.0	11.0
July 26	0.000320	0.000013	10	½	4.0	5.0
July 31	0.000320	0.000035	10	1¼	10.1	12.5
August 6	0.000320	0.000012	10	7/16	3.7	4.4
(b) KHOR BARAKA (BARAKA RIVER)						
July 20	0.000460	0.000061	20	$2^1/8$	9.5	10.6
July 26	0.000460	0.000040	20	$1^5/16$	6.2	6.5
August 3	0.000460	0.000058	20	2	8.5	10.0
August 12	0.000460	0.000056	20	$1^7/8$	9.0	9.35
August 20	0.000460	0.000061	20	$2^1/8$	9.5	10.6

Source: Richards, op. cit., App. V

APPENDIX 6

TABLE 6a MECHANICAL ANALYSIS OF THE GEZIRA SOIL

(1) PLOT 61 GEZIRA RESEARCH FARM

Components	1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
S.G.%	1.2	0.6	1.8	1.3	0.2	0.1
C.S.%	6.8	6.6	9.3	4.6	4.7	4.8
F.S.%	9.1	19.6	18.4	11.3	11.3	20.4
Silt %	13.3	13.6	19.8	20.0	21.4	13.1
Clay %	59.5	59.6	50.7	63.0	62.6	61.6

TABLE 6b MECHANICAL ANALYSIS CONTD.

PLOT 67 G.R.F.

Components	1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
S.G.%	1.5	1.8	2.1	1.5	2.6	2.4
C.S.%	5.7	6.7	5.9	5.3	4.5	3.7
F.S.%	16.0	17.1	18.5	17.0	18.3	18.0
Silt	16.0	16.0	13.0	17.0	15.6	19.0
Clay	60.6	58.5	60.4	59.2	59.0	56.9

APPENDIX 6

TABLE 6c MECHANICAL ANALYSIS CONTD.

PLOT 73 G.R.F.

Components	1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
S.G.%	4.2	3.9	3.3	1.4	1.0	5.6
C.S.%	8.8	8.1	6.0	5.1	4.6	2.0
F.S.%	13.6	13.3	12.6	14.0	16.3	13.6
Silt	18.6	18.0	19.0	17.7	18.4	22.4
Clay	54.9	56.8	59.0	61.1	59.6	56.2

S.G. = Stones and Gravels : Larger than 2 mm
C.S. = Coarse Sand : 0.2 mm - 2 mm
F.S. = Fine Sand : 0.02 mm - 0.2 mm
Silt : 0.002 mm - 0.02 mm
Clay : smaller than 0.002 mm

Source: T.N. Jewitt (1954) op. cit., pp. 39-40

APPENDIX 7

TABLE 7 CORRELATION DATA OF THE RELATION BETWEEN COTTON YIELD AND CLAY AND Na CONTENT (GEZIRA)

Area	Simple Correlation			Partial Correlation		Multiple Correlation
	ry^1(%)	r^2y^2(%)	$r^2$12(%)	$r_{y1.2}$	$r_{y2.1}$	$Ry^2$12(%)
1 Dueim Pump Sch.	68 xxx	(-)36.0xxx	(-)26.8xx	0,755xxx	-0.357x	72.5xxx
2 Gezira 33 blocks	38.3xxx	+ 5.2NS	(-) 1.0NS	0.663xxx	+0.371	46.8xxx
3 Gezira 48 blocks	33.9xxx	(-) 1.7NS	(-)20.9xx	0.593xxx	+0.189NXS	36.2xxx
4 Gezira Productivity Study	86.9xxx	(-)66.5xxx	(-)74.4xxx	0.778xxx	-0.064NS	86.9xxx

Variables: Y,re (cotton yield in % (mean of several seasons, actual yield approximately 0.4-14/ha.Lint));
X_1 (=1), clay content per thousand
X_2 (=2), content of soluble plus exchange Na/thousand

Datea of areas 1,2,3,4 refer to the 0-90 cm. layer, those of area 4 to the 0-33 cm. layer
The (-) sign indicates negative correlation

Source: A. Finck & Ochtman, op. cit., p

APPENDIX 8

TABLE 8a SALT DISTRIBUTION IN THE G.R. FARM

Step	202	206	209	211	212	213
1	0.084%	0.127%	0.066%	0.063%	0.079%	0.083%
2	0.072	0.112	0.088	0.088	0.107	0.097
3	0.090	0.136	0.101	0.104	0.137	0.140
4	0.097	0.136	0.114	0.109	0.117	0.162
5	0.106	0.143	0.147	0.134	0.110	0.223
6	0.118	0.160	0.269	0.275	0.121	0.284
7	0.178	0.240	0.475	0.347	0.219	0.461
8	0.314	0.539	0.508	0.540	0.303	0.562
9	0.411	0.603	0.688	0.666	0.418	0.600
10	0.406	0.754	0.926	0.819	0.588	0.633
11	0.386	0.994	0.051	0.840	0.803	0.818
12	0.485	0.925	0.047	0.904	0.924	1.002

Source: T.N. Jewit (1955), op. cit., p. 13

TABLE 8b DISTRIBUTION OF SALTS IN 3 GROUPS OF HOLES WITH DIFFERENT TOTAL SALT CONTENTS

	A	B	C
Depth (inches)	% of total	% of total	% of total
0 - 6	2.06	1.25	1.82
6 - 12	3.23	2.71	4.19
12 - 18	5.06	6.03	7.65
18 - 24	9.10	10.27	11.13
24 - 30	13.20	12.31	11.83
30 - 36	12.81	12.23	11.15
36 - 42	12.23	11.81	10.29
42 - 48	11.42	10.98	9.62
48 - 54	9.49	9.82	9.32
54 - 60	7.98	8.55	8.30
60 - 66	6.94	7.36	7.62
66 - 72	6.52	6.71	6.94

A Holes with mean salt content 0.31 - 0.40%
B Holes with mean salt content 0.51 - 0.60%
C Holes with mean salt content 0.61 - 0.70%

APPENDIX 9

TABLE 9a TOTAL ANALYSIS OF SEPARATED FRACTION OF GEZIRA SOIL

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	MnO	CaO %	MgO %	Org. %	CO_2 %	K_2O %	Na_2O
S.G.	7.69	5.67	1.23	0.57	2.32	46.36	0.29	-	36.33	-	-
C.S.	10.38	6.49	1.32	0.50	1.18	44.86	0.62	-	34.65	-	-
F.S.	75.62	6.34	7.98	2.30	0.50	4.49	0.76	0.79	0.56	0.03	0.50
Silt	33.67	12.76	10.32	5.95	-	6.25	2.31	6.42	1.52	0.21	0.36
Clay	46.70	20.32	12.44	2.03	-	1.10	1.59	15.16	-	0.54	0.48

Source: T.N. Jewitt (1954), *op. cit.*, p. 41

TABLE 9b MOISTURE PERCENT AFTER FLOODING: G.R.F.

Foot	Before Flooding	After 3 days' Flooding	After 14 days' Flooding
1	13.8	35.6	33.5
2	17.9	32.2	33.4
3	18.8	26.0	32.0
4	21.6	23.1	26.2
5	22.2	22.2	22.0
6	21.3	21.4	21.1

Source: T.N. Jewitt (1954), op. cit., p. 41

APPENDIX 10

TABLE 10 INCREASE IN CLAY PERCENTAGE IN THE GEZIRA SOIL WITH MOVEMENT TO THE SOUTH

Latitude	Average % Clay	Latitude	Place	Average % Clay
15° 05' N	43.6	13° 34' N	Sennar	62.5
14 55	44.9	13 19	Abdin	71.7
14 45	48.5	12 44	Abu Naama	62.8
14 35	53.2	12 00	Bahriat	74.2
14 25	52.0	11 15	Khor el Dunia	64.8

Source: W. Beam (1911), p.182 Source: A.F. Joseph (1921), p. 217

APPENDIX 11

TABLE 11a ESTIMATES OF FERTILITY AND LAB. DATA (AVERAGE TO 3 ft DEPTH FOR 12 IRRIGATED PLOTS AT BAUGA'

	Crop Observation				Soil Data				
Plot	Cotton	Wheat	Peanuts	Sorghum	S & G	Clay	pH	Salts	Na Value
					%			%	
1	Good	Good	Good		-	26	8.4	0.04	2
2	Good	Good	Good		-	32	8.4	0.04	2
3	Good	Fair	Good	Fair	-	37	8.5	0.04	2
4	Fair	Good	Poor	Fair	-	37	8.6	0.04	3
5	Fair	Good	Good	Fair	-	48	8.9	0.07	8
6	Poor	Good	Fair	Fair	-	40	9.2	0.07	11
7	Poor	Fair	Poor	Fair	1	13	9.6	0.07	44
8	Fair	Fair	Poor	Fair	[illegible]	36	9.3	0.78	43
9	Poor	Fair	Poor	Fair	3	40	9.0	0.49	46
10	Poor	Good	Fair	Fair	7	42	8.9	1.28	85
11	Fair	Good	Good	Fair	2	48	8.9	1.02	71
12	Nil	Poor	Poor	Nil	8	37	9.3	1.83	145

TABLE 11b YIELD LEVELS INDICATED BY ABOVE INFORMATION (ROUGH ESTIMATE), IN LBS. PER FEDDAN

Crop	Good Yield	Poor Yield
Seed Cotton (American Type)	1,400	700
Wheat	1,600	700
Peanuts	-	-
Sorghum	1,700	700

Source: J.N. Jewitt (1954), *op. cit.*, p

TABLE 11c SOIL SUCCESSION FROM NILE NEAR ATBARA (IN 3 UPPER FEET)

Step	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt %
1	0	4	41	24	32	0.06
2	6	6	35	13	40	1.84
3	1	6	37	15	40	1.29
4	4	11	30	10	45	1.48

TABLE 11c Contd

Step	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt %
5	8	3	25	22	45	
6	3	21	38	5	32	
7		Very	Stony			
8	16	16	32	6	30	
9	1	39	28	5	26	
10	2	23	32	5	38	

TABLE 11d KERMA BASIN

Depth in in.	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt %	pH
0 - 6	0	1	56	19	23	0.06	8.0
6 - 12	0	0	32	28	41	0.05	8.1
12 - 18	0	1	15	34	51	0.06	8.2
18 - 24	0	0	12	30	58	0.05	8.4
24 - 30	1	58	33	4	4	0.03	9.0
30 - 36						0.33	8.9
36 - 42	0	9	76	10	5	0.03	8.9
42 - 48						0.03	8.9
48 - 54						0.03	9.1
54 - 60						0.05	9.3
60 - 66	0	4	52	25	20	0.20	8.7
66 - 72						0.05	9.3

APPENDIX 12

TABLE 12a MECHANICAL ANALYSIS OF ZEIDAB SOIL PROFILE

Depth in in.	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt	pH
0 - 12	1	2	34	10	53	.09 .09	9.1 9.2
12 - 24	0	2	30	14	54	.11 .15	9.4 9.4
24 - 36	0	2	28	14	55	.19 .25	9.3 9.2
36 - 48	0	1	43	12	44	1.02 1.15	8.1 8.0
48 - 60	0	2	28	16	54	1.12 1.07	8.0 8.0

TABLE 12a contd

Depth in in.	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt	pH
60 - 72	0	1	41	14	44	1.77 1.51	8.5 9.1
72 - 78	0	1	40	14	45	.36	9.4

TABLE 12b ZEIDAB SODIUM VALUES AND FERTILITY

Hole (Profile)	Salts %	Sodium Value	Clay	Fertility
1	0.34	34	46	Medium
2	0.17	22	43	-
3	0.76	34	58	Medium
4	0.11	22	38	Medium
5	0.15	20	54	Medium
6	0.52	41	45	Bad
7	0.09	3	47	Very Good
8	0.48	21	47	Poor
9	0.05	04	22	Medium
10	0.05	04	33	Medium
11	0.06	17	18	Medium
12	0.13	29	36	Medium
13	0.15	26	39	Above Medium
14	0.08	12	47	Good
15	0.06	7	46	Medium

Source: T.N. Jewitt, Soils of the Sudan, p. 16

APPENDIX 13

TABLE 13 MECHANICAL ANALYSIS OF TOKAR SOIL

(1) At Krimbit

Depth in in.	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt %	pH %	C %
0 - 6.5	0	2	84	9	5	0.02	8.95	0.09
6.5 - 7	0	0	12	20	68	0.12	8.25	1.50
7 - 20	0	1	87	7	5	0.02	8.90	0.25
20 - 26	0	6	66	14	14	0.03	8.70	0.36
26 - 31	0	0	71	19	11	0.03	8.80	0.19

TABLE 13 contd.

(1) At Krimbit contd.

Depth in in.	S.G. %	C.S. %	F.S. %	Silt %	Clay %	Salt %	pH %	C %
31 - 36	0	7	71	11	12	0.03	8.80	0.24
36 - 48	0	2	86	32	20	0.05	8.75	1.33
48 - 63	0	2	69	15	13	0.05	8.85	0.17
63 - 68	0	1	55	32	12	0.03	8.80	0.13
68 - 82	0	24	40	14	22	0.03	8.70	0.17
82 - 96	0	0	55	15	30	0.04	8.05	0.36
96 - 105	0	3	64	13	20	0.03	8.75	0.13
105 - 117	0	0	46	25	29	0.04	8.65	0.22
(2) At Illibilli								
0 - 6	0	0	18	29	53	0.78	8.05	-
6 - 12	0	0	44	29	27	0.38	8.10	-
12 - 18	0	0	70	16	14	0.21	8.40	-
18 - 24	0	0	40	43	17	0.45	8.20	-
24 - 30	0	0	24	46	30	0.65	8.15	-
30 - 36	0	0	12	45	43	0.80	8.10	-
36 - 42	0	0	7	37	46	0.73	8.15	-
42 - 48	0	0	23	28	50	0.74	7.90	-
48 - 54	0	0	41	30	27	0.72	8.05	-
54 - 60	0	0	51	25	24	0.91	7.95	-
(3) At Tonak								
0 - 14	0	0	25	24	51	0.04	8.20	0.76
14 - 17	0	0	17	32	51	0.27	7.95	0.48
32 - 36	0	0	13	35	52	0.27	8.50	0.49
41 - 49	0	0	14	36	56	0.10	8.45	0.48

Source: T.N. Jewitt. Soils of the Sudan, pp. 14-15

APPENDIX 14

TABLE 14a TOKAR ALLUVIUM (LAT. 18°26'N, LONG. 37°44'E)

PROFILE 1

Depth (in)	Salts %	pH	C%	N%
0 - 7	0.05	8.10	1.27	0.105
7 - 16	0.03	8.50	0.25	0.025
16 - 21	0.07	8.40	0.45	0.055

TABLE 14a contd.

Depth (in)	Salts %	pH	C%	N%
21 - 23	0.04	8.70	0.23	0.017
34 - 38	0.07	8.40	0.38	0.045
38 - 47	0.09	8.45	0.56	0.064
47 - 55	0.14	8.25	0.37	0.041

TABLE 14b PROFILE 2 (TOWARDS THE SEAWARD SIDE OF THE DELTA (Not flooded in the year of sampling))

Depth (in)	Salts %	pH	C%	N%
0 - 6	0.78	8.05	0.79	0.060
6 - 12	0.38	8.10	0.36	0.034
12 - 18	0.21	8.40	0.12	0.017
18 - 24	0.45	8.20	0.20	0.020
24 - 30	0.65	8.15	0.48	0.030
30 - 36	0.80	8.10	0.60	0.064
36 - 42	0.73	8.15	0.64	0.066
42 - 48	0;74	7.90	0.47	0.053
48 - 54	0.72	8.05	0.33	0.026

Source: T.N. Jewitt (1952), op. cit., p. 65

TABLE 14c ANALYSIS OF TOKAR SOIL

Depth in inches	Salts %	Exchangeable Na Mge %	pH	NO_3-N p.p.m	$CaCO_3$	N p.p.m	C%
0 - 14	0.04	0.9	8.20	4	1.1	760	0.76
14 - 17	0.27	4.1	7.95	4	1.8	480	0.40
17 - 24	0.06	1.4	8.55	2	1.9	530	0.43
24 - 32	0.07	1.7	8.55	2	1.7	510	0.47
32 - 36	0.07	2.1	8.50	2	1.6	550	0.49
36 - 41	0.05	1.4	8.60	2	1.6	290	0.20
41 - 49	0.10	2.7	8.45	2	1.7	600	0.48
49 - 61	0.57	2.5	8.35	31	1,8	340	0.27

Source: T.N. Jewitt, (1954), op. cit., p. 16

APPENDIX 15

TABLE 15 MECHANICAL ANALYSIS OF GASH PROFILES

Hole No.	Foot	SG %	CS %	FS %	Silt %	Clay %	Salt %
K 1	1	0	0	15	37	48	0.05
	2	0	0	19	40	41	0.03
	3	0	0	24	42	34	0.03
	4	0	0	42	41	17	0.04
	5	0	0	29	40	30	0.05
	6	0	0	62	24	14	0.04
K 2	1	0	0	8	32	60	.03
	2	0	0	11	34	54	.03
	3	0	0	11	37	52	.04
	4	0	0	16	37	47	.07
	5	0	5	59	16	23	.04
	6	0	6	74	11	9	.03
K 8	1	0	1	23	44	32	.03
	2	0	1	34	38	27	.03
	3	0	1	47	27	25	.04
	4	0	2	60	19	20	.05
	5	0	2	37	31	30	.04
	6	0	1	65	20	14	.03
K 9	1	0	1	59	20	18	.04
	2	0	2	22	36	40	.02
	3	0	1	20	37	42	.03
	4	0	0	26	42	32	.04
	5	0	0	13	44	43	.04
	6	0	1	29	36	34	.04

Source: T.N. Jewitt, Soils of the Sudan, p. 53

APPENDIX 16

TABLE 16a MOISTURE IN DRY GASH SOIL AND IN IRRIGATED GASH SOIL (PERCENT ON OVEN-DRY SOIL)

	Moisture in Dry Gash Soil				Moisture in Irrigated Gash Soil			
	Area				Area			
6" Step	1	2	3	4	1	2	3	4
1	4.2	5.5	4.4	2.7	27.6	20.4	18.8	16.1
2	8.4	8.5	6.9	4.0	28.6	24.7	22.4	21.0
3	11.2	11.4	9.9	3.6	31.0	24.9	23.8	22.1
4	11.3	14.8	12.6	4.1	28.1	28.4	26.0	23.4
5	12.3	12.6	13.6	4.5	23.6	24.5	23.4	20.2
6	10.1	13.0	14.2	4.2	26.5	27.3	22.1	21.3
7	8.5	12.8	11.8	3.4	28.8	24.2	25.8	22.2
8	11.9	11.9	14.1	3.8	27.3	25.2	24.7	22.4
9	9.9	11.1	13.8	4.0	26.4	28.7	25.0	25.0
10	8.6	8.9	13.2	4.5	21.4	27.5	19.2	22.5
11	9.6	8.8	12.0	5.4	22.3	27.3	18.8	25.3
12	8.0	9.0	13.7	4.6	19.7	27.9	21.5	29.6

Source: T.N. Jewitt (1954), op. cit., pp. 54-5

TABLE 16b PERCENT OF TOTAL OF EXCHANGEABLE AND WATER SOLUBLE BASES IN SOME SUDAN SOILS

Bases	Dueim Bad	Shambat	Gezira Average	Dueim Medium	Dueim Good	Gash
Ca	21	13	15	35	18	43
Mag	0	0	0	4	0	0
Na	77	84	80	60	71	50
K	2	2	5	1	70	7
Ca/Na	0.3	0.15	0.2	6.6	0.25	0.85

APPENDIX 17

TABLE 17 TYPES OF COTTON AND THEIR USES

Type	Typical Material	End Use
Strict Middling, $1^1/8$ in.	Sateens	Men's topcoat or over-coat lining
Strict Middling, $1^1/8$ in.	Brassiere fabrics	Women's brassieres or bandeaux
Strict Middling, $1^1/8$ in.	Lawn, print	Blouses, waists, skirts
Middling, $1^1/16$ in.	Prints, broadcloth	Men's handkerchiefs
Middling, $1^1/16$ in.	Broadcloth, poplin	Men's dress shirts
Middling, $1^1/16$ in.	Broadcloth, print	Pyjamas, nightshirts
Middling, 1 in.	Knit 80/2 to 120/2	Women's full-fashioned hosiery
Middling, 1 in.	Bed ticking, jacquard	Bed ticking (mattresses)
Middling, 1 in.	Terry Towelling	Turkish and terry towels
Middling, $^7/8$ in.	Knit 12s to 14s	Men's athletic socks
Middling, $^7/8$ in.	Knit 26s.	Shirts and drawers
Middling, $^7/8$ in.	Knit 12s.	Union suits
Strict Low Middling, 1 in.	Flannel	Work Gloves
Strict Low Middling, 1 in.	Seersucker, garbardine	Suits
Strict Low Middling, 1 in.	Flannel, Terrycloth	Women's bathrobes
Strict Low Middling, $^{15}/16$ in.	Denim drill	Overalls, jackets
Strict Low Middling, $^{15}/16$ in.	Outing flannel, broadcloth	Children's pyjamas
Low Middling, 1 in.	Seersucker, pique	Women's suits, ensembles
Low Middling, $^{15}/16$ in.	Whipcord	Riding, hunting, & camp trousers
Low Middling, $^{15}/16$ in	Corduroy, gabardine	Women's coats and jackets
Low Middling, 15/16 in	Birdseye	Infants' diapers
Low Middling, 15/16 in.	Woven	Blankets
Low Middling, 15/16 in	Sheeting	Oiled rainwear garments
Low Middling, $^7/8$ in	Chenille, tufted	Bath mats
Strict good ordinary, $^7/8$ in.	Osnaburgs	Fertilizer bags

Table 17 contd.

Type	Typical Material	End Use
Good Ordinary, 13/16 in.	8/3 carded yarn	Rugs, carpets (warp yarn)
Good Ordinary, 13/16 in.	Cotton batts	Thermal insulation

Source: E.W. Zimmermann, op. cit., p. 341

APPENDIX 18

TABLE 18 EGYPTIAN COTTON PRODUCTION, VOLUME 1866-7 - 1893-9, AREA

Year	Production in Kantars	Area in Feddans
1866-7	1,127,895	
1867-8	1,207,402	
1868-9	1,306,156	
1869-70	1,362,514	
1870-71	1,970,717	
1871-2	2,044,254	
1872-3	2,298,942	
1873-4	2,538,351	
1874-5	2,106,699	
1875-6	2,928,498	
1876-7	2,773,258	
1877-8	2.593,670	
1878-9	1,683,749	
1879-80	3,198,800	
1880-81	2,276,000	
1881-2	2,912,000	
1882-3	2,284,000	693,000
1883-4	2,694,000	778,000
1884-5	3,616,000	869,000

Table 18 contd.

Year	Production in Kantars	Area in Feddans
1885-6	2,792,000	874,465
1886-7	2,872,000	865,526
1887-8	2,996,000	1,021,250 (sic)
1888-9	2,723,000	
1889-90	3,238,000	
1890-91	4,159,000	
1891-2	4,765,000	
1892-3	5,221,000	
1893-4	5,033,000	965,545
1894-5	4,619,000	999,735
1895-6	5,276,000	1,050,749
1896-7	5,879,000	1,128,151
1897-8	6,544,000	1,121,262
1898-9	5,588,000	1,153,307

Source: Owens, op. cit., p.

APPENDIX 19

TABLE 19

DISTRIBUTION OF AMERICAN COTTON

(IN THOUSANDS OF BALES OF 500 lbs.)

Season	Total Commercial Crop	Exports: To Britain	Exports: Total Exports	Percentage of crop taken by U.S. Mills
1836-41	1,670	984	1,402	16
1841-46	2,161	1,230	1,771	18
1846-51	2,330	1,244	1,781	24
1851-56	3,219	1,696	2,498	22
1856-61	3,780	2,020	2,953	22
1861-65	Civil War - No record of Cotton Movement			
1865-70	2,532	1,234	1,679	33
1870-75	3,831	1,889	2,657	31

Table 19 contd

Season	Total Commercial Crop	Exports		Percentage of crop taken by U.S. Mills
		To Britain	Total Exports	
1875-80	4,943	2,131	3,389	33
1880-85	6,086	2,585	4,135	32
1885-90	6,871	2,749	4,610	32
1890-91	6,874	3,345	5,791	30
1891-92	9,018	3,317	5,858	32
1892-93	6,664	2,301	4,390	36
1893-94	7,532	2,861	5,232	30
1894-95	9,837	3,449	6,726	29
1895-96	7,147	2,299	4,627	35
1896-97	8,706	3,022	5,979	32
1897-98	11,216	3,544	7,540	31
1898-99	11,256	3,529	7,313	32

Source: "Cotton Facts" 1918, Annual Statement of American Cotton Crop published by the Liverpool Cotton Association Ltd.

APPENDIX 20

TABLE 20 MOVEMENT OF COTTON PRICES, 1820-1899

Year	American Upland Cents/lb.	Egyptian in Alex. Dollars/Kantar	Egyptian in Liverpool. Dollars/Kantar	Brazilian in Liverpool Dollars/Kantar
1820	14.3	16.00	-	-
1821	14.3	15.50	-	-
1822	11.4	15.50	-	-
1823	14.7	17.00	-	-
1824	18.6	13.00	21.89	23.14
1825	12.2	13.00	34.97	34.97
1826	9.3	13.00	17.60	21.63
1827	10.3	13.00	15.33	19.11
1828	9.9	12.00	15.85	16.86
1829	10.0	12.00	14.47	14.97
1830	19.7	10.50	16.60	16.86

Table 20 contd.

Year	American Upland Cents/lb.	Egyptian in Alex. Dollars/Kantar	Egyptian in Liverpool. Dollars/Kantar	Brazilian in Liverpool. Dollars/Kantar
1831	9.4	15.00	16.60	15.59
1832	12.3	25.00	16.60	17.99
1833	12.9	30.75	-	-
1834	17.4	25.25	-	- -
1835	16.5	18.50	-	-
1836	13.2	13.00	-	-
1837	10.1	15.00	22.13	19.62
1838	13.4	18.25	30.18	18.61
1839	9.9	13.00	23.38	20.12
1840	9.5	13.25	21.63	18.61
1841	7.8	10.00	16.86	17.34
1842	7.2	7.75	15.33	14.97
1843	7.7	18.00	14.08	13.08
1844	5.6	6.00	13.08	12.45
1845	7.9	10.25	15.59	13.20
1846	11.2	10.00	16.10	13.84
1847	8.0	7.25	-	-
1848	7.5	10.00	-	-
1849	12.3	11.75	-	-
1850	12.1	8.75	-	-
1851	9.5	10.25	-	-
1852	11.0	10.00	-	-
1853	11.0	9.00	-	-
1854	10.4	9.25	-	-
1855	10.3	10.75	-	-
1856	13.5	16.25	-	-
1857	12.2	12.75	-	-
1858	12.1	12.00	-	-
1859	11.00	12.25	-	-
1860	13.0	14.00	-	-
1861	31.3	23.00	-	-
1862	67.2	36.25	-	-
1863	101.5	45.00	50.30	48.79
1864	83.4	31.75	54.08	57.84
1865	43.2	35.25	39.48	38.73

Table 20 contd.2

Year	American Upland Cents/lb.[x]	Egyptian in Alex. Dollars/Kantar	Egyptian in Liverpool. Dollars/Kantar	Brazilian in Liverpool. Dollars/Kantar
1866	31.6	22.50	40.24	34.45
1867	24.9	19.00	24.91	23.88
1868	29.2	23.00	-	-
1869	24.0	19.50	-	-
1870	17.0	15.75	-	-
1871	20.5	21.56	-	-
1872	18.2	16.16	-	-
1873	17.0	14.94	-	-
1874	15.0	18.84	-	-
1875	13.0	13.68	-	-
1876	11.7	12.25	-	-
1877	11.3	13.59	-	-
1878	10.8	14.06	-	-
1879	12.0	14.34	-	-
1880	11.3	13.75	-	-
1881	12.2	15.00	-	-
1882	10.6	13.50	17.10	14.20
1883	10.6	12.56	16.10	11.95
1884	10.5	11.41	15.09	12.45
1885	9.4	12.00	12.07	11.69
1886	10.3	12.19	12.96	10.68
1887	10.3	13.00	14.08	11.19
1888	10.7	12.94	13.58	11.57
1889	11.5	13.61	14.97	12.69
1890	8.6	13.94	13.96	12.69
1891	7.3	12.06	11.81	10.68
1892	8.4	9.62	9.68	9.06
1893	7.5	9.44	10.56	9.56
1894	5.9	9.44	9.56	8.06
1895	8.2	11.19	11.69	8.06
1896	7.3	10.09	12.19	9.36
1897	5.6	7.87	9.94	8.56
1898	4.9	8.91	8.94	7.42
1899	7.6	12.28	10.94	7.94

(x) Since after 1835 the Kantars was equal to 99 lbs., a price expressed in cents/lb. was practically identical with one in dollars/kantar. From M.D Darwish, op. cit., produced in Charles Issawi, op. cit., pp. 447-8

APPENDIX 21

TABLE 21 HISTORY OF COTTON PRICES AT 10-YEAR INTERVALS FROM 1799-1899

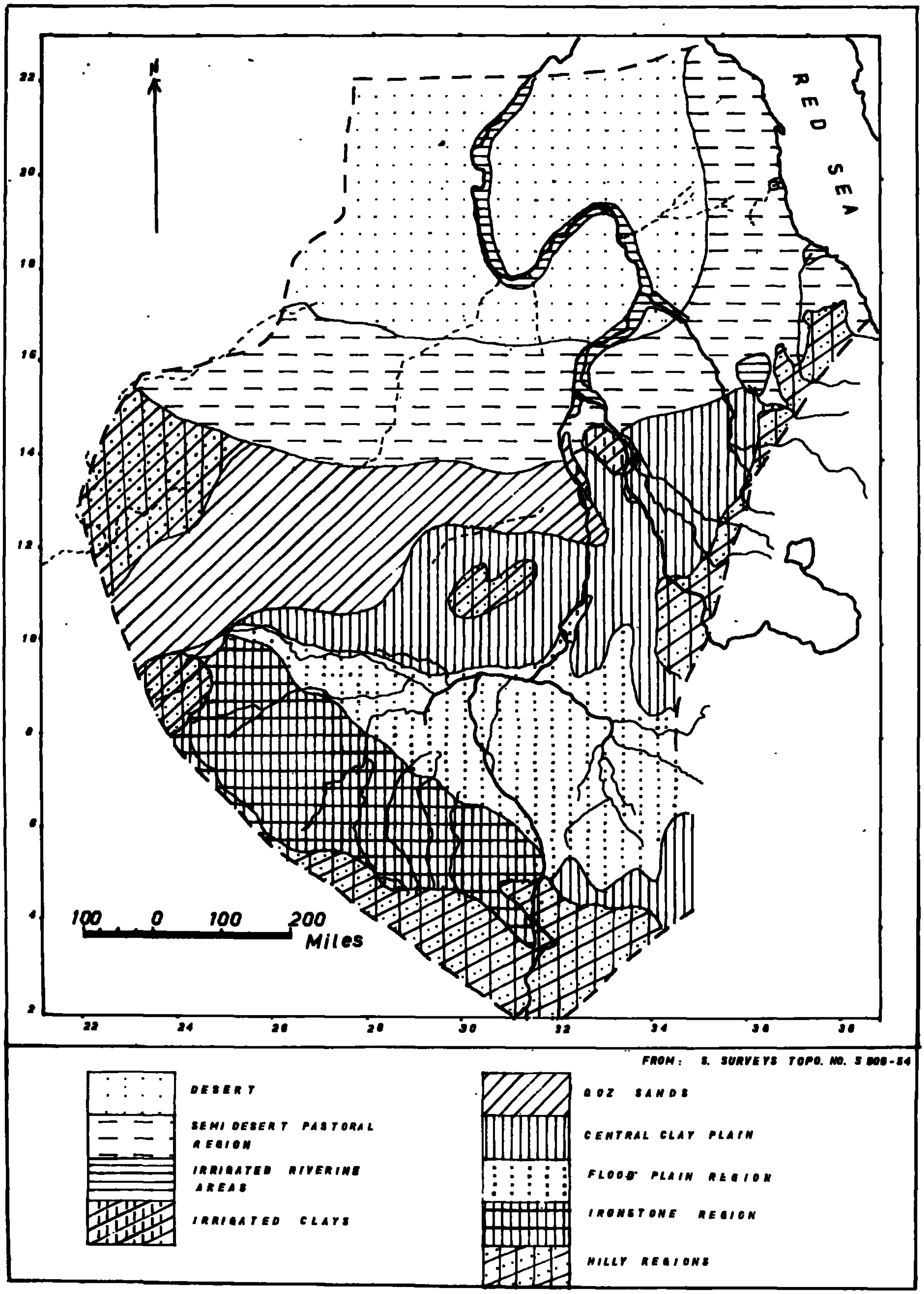
Season	Liverpool Prices (Pence/lb.)					Alexand-ria	American Price of Upland	Year	Index Nos. of General Prices
	Sea Island	Brazil	American	Indian	Egyptian				
	Highest and Lowest					Yearly Averages			1900 = 100
		Pernam	Bowed Georgia	Bengal & Suvat		Dollars/ Kantar	Cents/ lb.		
1799	42-63	29 -56	17 -42	11 -28	-	-	28.0	1799	218
1809	28-69	22½ -38	14 -34	11 -26	-	-	16.0	1809	262
1819	21-48	16 -23½	10 -19¾	5¾ -14½	-	-	17.0	1819	187
1829	9-21	6 3/8- 8½	4 5/8- 7	2 7/8- 5½	5 7/8- 8½	12.00	10.0	1829	132
1839	*20-22	9 -11	5¾ -10¼	4½ - 6¾	*11 -12¼	13.00	9.9	1839	153
1849	-	4¾ - 7 1/8	3 3/8- 7 1/8	2 7/8- 5	-	11.75	12.3	1849	107
	Yearly Averages								
		Pernam Fair	Middling	Fair Surat					
1859	-	8.25	6.75	5.00	-	12.25	11.00	1859	128.0
1869	85.3	12.50	12.12	9.75	-	19.50	24.00	1869	131.0
1879	27.5	6.81	6.31	5.00	-	14.34	12.00	1879	125.0
1889	21.7	6.31	5.94	4.19	ƒ 7.44	13.61	11.50	1889	103.4
1899	16.7	3.94	3.56	‡ 3.03	5.44	12.28	7.60	1899	92.2

Source: Empire Cotton Growing Review, vol. 1 (1924), p. 302

* Last week only ‡ No. 1 Good Oomara ƒ Good Full Brown

N.B. The continuous index number is to give some parallel indication of the general movement of all prices so that a true perspective of these prices as compared with now can be given.

SUDAN : MAIN AGRICULTURAL REGIONS



APPENDIX 22

A BRIEF ACCOUNT OF THE AGRICULTURAL REGIONS OF THE NORTHERN SUDAN

Northern Sudan can be divided broadly into five main agricultural regions from north to south (see attached map).

(1) Desert:

This consists of wastes of sand and stony surfaces which are quite unsuited for any type of cultivation except along the river banks.

(2) Semi-Desert and Pastoral Regions:

Here rainfall is too little to ensure crop production, but it produces enough vegetation to maintain livestock for part of the year at least. The soils consist mainly of sand and clays and the main inhabitants are the camel-owning nomads.

(3) The Riverine Areas:

These consist mainly of the narrow strip of land along the river Nile from Khartoum northwards which can be irrigated from the river. Soils are mainly alluvial and both lift and flush irrigation are practised, the former by pumps, waterwheels and shadufs, and the latter as in the Gash and Baraka Deltas.

(4) The Central Clay Plain:

This is characterised by heavy clay soils which become more saline towards the north. Rainfall is sufficiently reliable, especially towards the south, for crop production, particularly dura, although towards the northern parts special precaution such as terracing to stop run-off has to be resolved to ensure the successful growth of the crop. The favoured spots include the Gadaref District and the Gezira south of the 300 mm. isohyte. Away from these areas nomadism prevails with occasional cultivation in favoured localities.

(5) The Qoz Sands of Kordofan and Darfur:

This zone can produce a crop only during the limited rainy season, but levels of production were not great and most people, after attending to their patches of food crops, depended on gum collection, ostrich feather and cattle for cash. The main food crop of the area, dukhn, however, thrives well. To the south there are clay lands where cattle rearing dominates the way of life. To the north the region merges into the pastoral sandy areas.

APPENDIX 23

TABLE 23

TAXATION SYSTEM DURING THE TURKISH PERIOD (1820-1883)

(a) During the 1820's

Sennar	11,100 burses
Halfa	294 burses
Arabs of the White Nile	314 burses
Total	11,708 burses

N.B. Each burse is equivalent to £E.5

Table 23 contd.

(b) In 1880: HIGHEST AND LOWEST TAX PAYABLE BY NOMADIC TRIBES IN EACH PROVINCE (IN PURSES)

Province	Highest		Lowest	
	Tribe	Amount	Tribe	Amount
		£E		£E
Khartoum	Shukrya	16,327	Batahin Ashma	410
Berber	Kamilab	681	Gasimab	12
Dongola	Gararish	189	Hawawir	65
Taka	Dhababiya	11,023	Malikab	19
Sennar & Fazogli	Rufaa Hoi	9,023	Kawahla	1,316
Suakin	Habab	2,000	Awlad Ali	39
Kordofan	Kababish	8,472	Ziyadiya	55
Dara	Rizigat	3,920	Turgum	25
Darfur	Ziadiya	2,500	Yasier	108

A purse = £E 5

(c) COMPARISON OF TAX ASSESSED AND ACTUALLY COLLECTED BETWEEN 1869-1879

Period	Amount Assessed	Amount Collected
	£E	£E
From September 1869 to September 1870	378,584	315,491
From September 1870 to September 1871	359,661	257,373
From September 1871 to September 1872	356,994	240,339
From September 1872 to September 1873	363,003	301,227
From September 1873 to September 1874	369,336	319,222
Total		
September 1874 to September 1875	370,862	321,767
September 1875 to September 1876	482,985	363,818
September 1877	363,744	271,873
1878	392,498	283,822
1879	402,595	287,705
Total		1,528,985

Table 23 contd.2

Deficit from 1869 - 1874 =

Deficit from 1875 - 1879 =

Deficit in 1882 =

Source: Shatir Busaili: Important Aspects of the History of Sudan of the Nile Valley (Arabic), Cairo (1955)

APPENDIX 24

TABLE 24 SUMMARY OF THE ACCOUNTS OF THE PROVINCES OF THE SUDAN FOR 1882

Provinces	Revenue Collected £E	Revenue Arrears due £E	Expenditure £E
Province of Takka	53,596	15,363	112,416
Province of Suakin	26,668	1,964	20,492
Province of Sennar	40,375	13,729	42,708
Province of Berber	42,530	-	18,614
Province of Fashoda	7.596	12,247	25,698
Province of Khartoum	74,139	17,908	123,391
Province of Equatorial	31,385	-	35,449
Province of Dongola	55,681	82	10,605
Province of Kordofan	47,459	8,339	70,404
Province of Darfur	37,056	-	70,056
Province of B. el Ghazal	14,669	-	9.740

Source: J.D.H. Stewart, op. cit., p. 14

The deficit and surpluses for the same year were as follows:
Takka (deficit) £E67,820; Suakin (surplus) £E6,176; Sennar (deficit) £E1,832; Berber (surplus) £E23,916; Fashoda (deficit) £E18,102; Khartoum (deficit) £E49,252; Equatorial (deficit) £E4,046; Dongola (surplus) £E45,076; Kordofan (surplus) £E4,055; Darfur (deficit) £E14,421, Bahrel Ghazal (deficit) £E3,856

APPENDIX 25

TABLE 25 ESTIMATED POPULATION PRIOR TO DERVISH (MAHDISTS') RULE LOSSES DURING DERVISH RULE (BY CAUSE) AND 1903 ESTIMATES OF POPULATION BY PROVINCE

Province	Population Prior to Dervish Rule	Approximate Loss during the Dervish Rule		1903 Population
		Disease	Warfare	
Bahr-el-Ghazal	1,500,000	400,000	700,000	400,000
Berber	800,000	450,000	250,000	100,000
Dongola	300,000	110,000	80,000	110,000
Ghezireh (Gezira)	550,000	275,000	125,000	150,000
Wadi Halfa	55,000	12,000	13,000	30,000
Kassala	500,000	300,000	120,000	80,000
Khartoum	700,000	400,000	210,000	90,000
Kordofan	1,800,000	600,000	650,000	550,000
Sennar	1,100,000	500,000	450,000	150,000
Suakin (town)	20,000	4,000	5,500	10,500
Suakin (Arabs)	300,000	100,000	150,000	50,000
Kodah (Upper Nile Province)	900,000	300,000	450,000	150,000
Approximate total	8,525,000	3,451,000	3,203,500	1,870,000

Source: Report on the Finance, Administration & Condition of Egypt and Sudan (1903), p. 79

APPENDIX 26

TABLE 26 THE WORLD'S COTTON CROPS, 1902-23 (IN BALES OF 500 LB. LINTERS INCLUDED IN AMERICAN CROP)

	American	India*	Egypt	Russia	China	Others	Total	% of 1914
1902-03	10,784	3,367	1,168	342	1,200	805	17,662	63
1903-04	10,016	3,161	1,302	477	1,200	751	16,907	61
1904-05	13,697	3,791	1,263	536	756	803	20,846	75
1905-06	10,726	3,416	1,192	604	788	938	17,664	63
1906-07	13,305	4,934	1,390	759	805	1,027	22,221	80
1907-08	11,326	3,122	1,447	664	875	950	18,384	66
1908-09	13,432	3,692	1,150	698	1,933	971	21,876	78
1909-10	10.386	4,718	1,000	685	2,531	950	20,270	73

Table 26 contd.

	American	India*	Egypt	Russia	China	Others	Total	% of 1914
1910-11	11,966	3,889	1,515	895	3,467	968	22,700	81
1911-12	16,109	3,262	1,485	875	3,437	1,058	26,226	94
1912-13	14,091	4,421	1,507	870	2,360	1,160	24,409	88
1913-14	14,614	5,066	1,537	969	1,963	1,239	25,388	92
1914-15	16,738	5,209	1,298	1,152	2,332	1,146	27,875	100
1915-16	12,013	3,738	961	1,413	2,068	990	21,083	76
1916-17	12,664	4,489	1,022	1,085	1,569	1,039	21,868	78
1917-18	12,345	4,000	1,262	605	1,583	1,106	20,901	75
1918-19	12,817	3,972	964	334	1,725	1,312	21,124	76
1919-20	11,921	5,796	1,114	302	1,690	1,535	22,358	80
1920-21	13,711	3,600	1,206§	120	1,351	1,462	21,440	77
1921-22	8,378	4,479	972§	78	1,340	1,767	16,914	61
1922-23	10,438	5,196	1,243§	137	1,955	1,799	20,764	74
1923-24	10,681†	5,000†	1,200†	150†	2,000†	1,850†	20,881†	75

Source: Empire Cotton Gr. Rev., vol. 1 (1924), p. 51

* 400 lb. bales † 12 December estimate adding 600,000 linters

§ Estimates

APPENDIX 27

TABLE 27 QUANTITY, YIELD AND PRICES OF THE WORLD'S CHIEF CROPS (1913-1919)

Season	Crop	Yield per Acre	Liverpool Prices (pence per lb.) Lowest	Highest	Average
American	Bales of 500 lbs.	lbs.		Middling	
1913-14	14,609,968	195	6.20	7.96	7.26
1914-15	15,067,247	200	4.25	6.50	5.22
1915-16	12,953,450	200	5.34	8.74	7.51
1916-17	12,975,569	180	8.12	19.45	12.33
1917-18	11,911,896	170	16.90	24.97	21.68
1918-19	11,602,634	156	15.24	24.77	19.73
1919-20	11,000,000*	165*	-	-	-

Table 27 contd.

Season	Crop	Yield per Acre	Liverpool Prices (pence per lb.) Lowest	Highest	Average
Indian	Bales of 400 lbs.	lbs.	No. 1 Fine Oomara		
1913-14	5,065,000=	81	4.70	6.56	5.87
1914-15	5,209,000	85	3.94	5.00	4.46
1915-16	3,738,001	84	4.75	6.90	6.09
1916-17	4,502,000	83	7.10	18.30	11.00
1917-18	4,000,000	64	15.50	20.36	18.78
1918-19	3,671,000	72	13.97	23.00	18.12
Egyptian	Kantars	lbs.	Fully Good Full Brown		
1913-14	7,684,172	444	8.15	10.45	9.44
1914-15	6,490,221	369	6.30	8.30	7.34
1915-16	4,806,331	406	7.50	11.90	10.42
1916-17	5,111.080	310	11.60	31.50	21.56
1917-18	6,307,618	375	28.56x	35.50x	30.97x
1918-19	4,820,660	355	26.59x	30.19x	27.85x
1919-20	6,000,000*	380*	-	- -	-

* Estimates x Sakel 1 Kantar approx. 100 lbs.

Source: Report to the Board of Trade, App. IX Table B

APPENDIX 28

TABLE 28 WORLD'S CONSUMPTION OF ALL KINDS OF COTTON, 1918-26

(RUNNING BALES 000's OMITTED)

Variety	Season	U.K.	Continent	U.S.A.	Asia.	All Others	Totals
	1911-12	3,734	5,137	5,160	507	140	14,678
	1912-13	3,667	4,593	5,553	519	124	14,456
American (including	1919-20	2,980	2,538	6,345	709	209	12,781
Linters in U.S.A.)	1921-22	2,275	3,593	6,252	1,031	216	13,367
	1922-23	1,919	3,293	6,968	859	201	13,240
	1923-24	1,695	3,199	5,890	661	172	11,167
	1924-25	2,344	4,009	6,576	772	228	13,929
	1925-26	2,099	4,194	6,920	1,012	261	14,840

Table 28 contd.

Variety	Season	U.K.	Continent	U.S.A.	Asia	All Others	Totals
	1911-12	45	801	9	3,014	-	3,869
	1912-13	53	813	-	3,073	2	3,941
Indian	1919-20	58	444	12	3,196	-	3,710
	1920-21	39	770	10	3,749	2	4,570
	1921-22	55	824	11	4,032	-	4,922
	1922-23	107	977	21	4,276	1	5,385
	1923-24	201	1,247	27	3,922	7	5,404
	1924-25	183	1,108	31	4,165	34	5,521
	1925-26	168	1,063	30	4,237	38	5,572
	1911-12	374	374	120	23	2	393
	1912-13	393	380	134	17	12	936
Egyptian	1919-20	441	173	216	24	-	854
	1920-21	237	136	106	22	13	514
	1921-22	336	208	151	38	9	742
	1922-23	393	272	175	40	10	860
	1923-24	469	354	149	39	16	1,027
	1924-25	431	350	128	49	13	971
	1925-26	391	334	137	42	17	921
	1911-12	120	1,764	20	747/	1,060	3,713
	1912-13	161	2,128	32	798/	818	3,937
Sundries	1919-20	141	116	160	1,077	614	2,108
	1920-21	70	1,039	67	981	672	2,829
	1921-22	199	716	114	980	708	2,717
	1922-23	351	616	98	1,262	850	2,177
	1923-24	353	529	76	1,351	576	2,885
	1924-25	277	896	66	1,523	785	2,547
	1925-26	370	619	58	1,308	1,103	4,458
	1911-12	4,274	8,075	5,309	4,293	1,202	23,153
	1912-13	4,274	7,914	5,719	4,704	956	23,270
	1919-20	3,620	3,271	6,733	5,006	823	19,453
All Kinds	1920-21	2,024	4,747	5,376	5,436	879	18,462
	1921-22	2,865	5,341	6,528	6,801	933	21,748
	1922-23	2,770	5,158	7,262	6,437	1,062	22,689

Table 28 contd.2

Variety	Season	U.K.	Continent	U.S.A.	Asia	All Others	Totals
	1923-24	2,718	5,329	6,142	5,973	771	20,933
All kinds	1924-25	3,235	6,363	6,801	6,509	1,060	23,968
	1925-26	3,022	7,210	7,145	6,635	1,419	25,431

From the Statistics of the International Federation

* No returns from Russia and Austria in 1919-20

⁄ Including China from a private estimate in 1911-12 and 1912-13

APPENDIX 29

TABLE 29 COTTON PRICES (SEASON'S AVERAGES), 1899-1924

Season	Liverpool Prices (Pence/lb.)					Alex-andria	American Price of Upland	Year	Index Nos. of General Prices
	Sea Island	Brazil	American	Indian	Egyptian				
1899-1900	16.7	5.06	4.87	4.40§	xx6.82	12.28	7.60	1900	100.0
1900-1901	16.4	5.50	5.16	4,37	6.87	13.80	9.30	1901	96.7
1901-1902	19.3	4.87	4.78	4.19	6.31	10.42	8.10	1902	96.4
1902-1903	⁄25.00	5.57	5.44	4.47	8.44	13.65	8.20	1903	96.9
1903-1904	28.40	5.16	6.94	5.56	8.56	16.65	12.16	1904	98.2
1904-1905	27.12	5.25	4.93	4.62	7.37	13.97	8.66	1905	97.6
1905-1906	26.38	6.23	5.94	5.00	9.25	15.99	10.94	1906	100.8
1906-1907	26.70	6.97	6.38	4.87	10.37	19.16	10.01	1907	106.0
1907-1908	35.59	6.79	6.19	5.03	8.81	18.21	11.46	1908	103.0
1908-1909	23.39	5.84	5.50	4.94	8.44	15.46	9.24	1909	104.1
1909-1910	32.85	8.34	7.86	6.06‡	13.21	23.30	14.29	1910	108.8
1910-1911	35.62	8.27	7.84	6.78	10.75	20.66	14.69	1911	109.4
1911-1912	23.73	6.70	6.09	5.44	9.56	17.25	9.69	1912	114.9
1912-1913	25.00	7.11	6.76	5.91	9.79	18.28	12.20	1913	116½5
1913-1914	23.47	7.47	7.27	5.62	9.45	19.02	13.49	1914	117.2
1914-1915	22.00	5.71	5.22	4.19	7.34	12.01	7.94	1915	143.9
1915-1916	27.00	8.22	7.51	5.79	10.42	19.28	11.99	1916	186.5
1916-1917	50.00	13.03	12.33	9.92	21.56	37.81	18.41	1917	243.0
1917-1918	80.00	24.13	21.68	16.10	30.97	38.52	28.86	1918	267.4

Table 29 contd.

Season	Liverpool Prices (Pence/lb.)					Alex-andria	American Price of Upland	Year	Index Nos. of General Prices
	Sea Island	Brazil	American	Indian	Egyptian				
1918-1919	65.00	23.96	19.73	17.15	27.85	37.20	30.36	1919	296.5
1919-1920	-	30.00	25.31	18.05	60.34	87.81	38.21	1920	371.4
1920-1921	-	13.24	11.89	8.21	30.24	34.50	16.08	1921	229.6
1921-1922	-	11.40	11.37	8.72	19.75	37.28	17.78	1922	185.0
1922-1923	-	14.62	14.92	10.25	17.29	30.71	24.06	1923	185.3
1923-1924	-	18.20	17.66	12.37	21.55	39.77 //	31.67	1924	-

/ S. Carolina § No. 1 Good Oomara ‡ No. 1 Fine Oomara xx F.G.F. Brown

'' F.G.F. Sakel // 10 months average

APPENDIX 30

TABLE 30 SPOT PRICES OF AMERICAN AND EGYPTIAN COTTON IN LIVERPOOL, ALEXANDRIA, AND NEW ORLEANS ON THE LAST FRIDAY OF EACH MONTH

Month	Liverpool American Fully Middling	Egyptian F.G.F. Sakel	Premium Percent	N. Orleans American Middling	Alexandria F.G.F. Sakel	Premium Percent
1919-20	Pence/lb	Pence/lb		Cents/lb	Dollars/Ka	
August	19.70	30.00	52	31.25	58.50	87
Sept.	20.48	30.00	46	32.13	53.50	68
October	25.05	35.50	42	39.00	82.50	63
November	25.48	45.00	78	39.00	63.50	111
December	27.59	51.00	85	40.00	97.50	145
January	29.56	77.00	160	39.88	142.00	256
February	31.02	92.50	188	40.25	154.00	284
March	29.38	83.00	184	40.25	161.00	300
April	27.08	84.50	211	41.25	154.00	275
May	27.35	75.50	176	40.00	126.00	215
June	27.63	63.00	128	38.75	105.00	165
July	27.40	67.00	145	38.75	130.00	235

Table 30 contd.

Month	Liverpool American Fully Middling	Liverpool Egyptian F.G.F. Sakel	Premium Percent	N. Orleans American Middling	Alexandria F.G.F. Sakel	Premium Percent
1920-21	Pence/lb	Pence/lb		Cents/lb	Dollars/ka	
August	33.74	67.00	182	30.75	125.00	306
Sept.	23.10	57.00	147	26.50	89.00	236
October	18.05	43.00	138	21.00	74.00	252
November	12.73	30.00	136	15.50	39.00	152
December	9.90	22.00	123	13.50	32.00	137
January	9.97	21.00	115	14.25	33.00	132
February	7.61	14.00	84	11.75	20.50	75
March	8.80	17.50	99	11.50	33.00	186
April	7.99	17.75	122	11.25	30.50	170
May	8.27	16.50	100	11.75	27.50	135
June	7.65	15.50	103	10.38	26.50	156
July	8.33	15.50	86	11.00	29.00	164
1922-23						
August	13,70	18.00	31	22.00	35.00	59
Sept.	12,40	17.00	37	20.25	32.00	58
October	14.29	17.75	24	23.50	32.00	36
November	14.85	18.50	25	25.50	34.50	35
December	15.34	17.90	18	26.50	33.25	26
January	16.42	18.25	11	28.25	33.75	19
February	16.44	17.50	6	29.75	33.00	11
March	15.66	17.50	15	29.00	33.25	14
April	15.56	17.15	10	28.25	32.75	16
May	16.02	16.40	2	28.50	31.75	11
June	16.67	16.20	3	28.75	31.00	7
July	14.57	15.50	6	23.00	27.75	29
1923-24						
August	15.8	16.75	10	24.75	31.50	27
Sept.	17.11	18.35	7	28.50	34.87	22
October	17.88	18.75	5	30.50	34.87	14
November	21.72	26.70	23	35.75	35.75	41

Table 30 contd.2

Month	Liverpool American Fully Middling	Egyptian F.G.F. Sakel	Premium Percent	N. Orleans American Middling	Alexandria F.G.F. Sakel	Premium Percent
	Pence/lb	Pence/lb		Cents/lb	Dollars/Ka	
December	21.17	24.30	15	36.00	45.62	27
January	19.81	23.35	18	33.50	44.62	33
February	17.63	20.50	16	29.63	40.50	36
March	16.46	20.60	25	27.50	40.00	46
April	18.20	23.40	28	30.88	44.62	44
May	18.23	23.10	27	30.88	48.87	45
June	17.43	23.60	35	28.80	48.37	54
July	18.29	25.00	37	30.00	47.27	58
1924-25						
August	x16.76	25.15	50	24.82	47.75	92

Source: Empire Cotton Growing Review, vol. 1 (1924), pp. 305-7

x Standard Middling

G.F.G Good Fully Good

APPENDIX 31

TABLE 31 MONTHLY SPOT PRICES OF VARIOUS KINDS OF COTTON IN LIVERPOOL, 1919-25, ON THE LAST FRIDAY OF EACH MONTH. (FOR AMERICAN IN LIVERPOOL & NEW ORLEANS & EGYPTIAN IN LIVERPOOL & ALEXANDRIA SEA TABLE

Season	Egyptian Uppers (G.F.G.)	Peru Smooth (G.Fair)	Peru Rough (G.Fair)	Peruvian Afifi (G.Fair)	Brazilian Pernam (Fair)	W. African Middling	East African G.Fair	Indian No.1G (Oomara)
1919-20								
August 29	26.50	24.48	29.00	24.50	21.90	18.85	24.20	17.10
Sept. 26	26.50	25.78	28.00	25.00	22.78	19.63	24.90	16.20
Oct. 31	32.50	34.06	30.50	30.50	29.15	25.00	29.05	17.60
Nov. 28	43.00	33.96	33.50	36.50	29.08	23.63	31.00	18.60

Table 31 contd

Season		Egyptian Uppers (G.F.G.)	Peru Smooth (G.Fair)	Peru Rough (G.Fair)	Peruvian Afifi (G.Fair)	Brazilian Pernam (Fair)	W.African Middling	East African (G.Fair)	Indian No.1 G (Oomara)
Dec.	24	49.00	39.34	38.00	45.50	32.34	24.99	34.00	19.85
Jan.	30	71.00	41.80	44.00	58.00	34.56	28.56	44.00	20.35
Feb.	27	72.50	42.72	45.50	77.00	35.27	28.77	49.50	20.85
March	26	66.00	41.38	45.50	71.00	33.88	27.38	48.75	19.35
April	30	60.00	40.08	46.00	69.00	31.58	26.08	47.00	18.50
May	26	51.00	39.08	46.00	59.00	30.58	25.08	47.25	17.25
June	25	41.00	40.28	43.00	56.00	30.38	25.36	43.50	15.75
July	30	46.00	40.90	39.00	52.00	28.90	25.65	50	15.50
1920-21									
Aug.	27	39.50	36.74	36.00	53.00	24.74	21.49	39.50	13.75
Sept.	29	30.50	33.35	29.00	44.00	23.35	20.10	36.00	13.75
Oct.	29	23.00	25.80	22.00	24.00	17.80	16.30	26.00	11.25
Nov.	26	15.50	18.23	18.00	22.00	13.33	11.73	18.00	8.75
Dec.	31	14.00	13.90	13.00	17.00	9.90	9.40	14.50	6.75
Jan.	28	14.00	11.89	13.00	16.00	9.39	9.89	13.00	6.75
Feb.	25	10.00	8.61	12.50	11.00	7.11	7.61	10.50	5.35
March	23	12.50	9.42	12.00	13.00	7.92	8.42	9.00	5.35
April	29	12.00	9.49	10.00	14.00	7.74	8.24	8.75	5.25
May	27	11.25	9.82	10.00	14.00	8.07	8.57	8.75	5.40
June	24	10.50	9.20	9.50	13.00	7.45	7.95	8.25	5.00
July	29	11.00	9.83	9.50	14.00	8.08	7.58	8.75	5.85
1921-22									
Aug.	26	11.25	11.56	9.00	14.00	9.31	9.06	10.25	7.00
Sept.	24	21.00	18.17	14.00	18.00	14.67	14.02	15.00	10.75
Oct.	28	18.00	16.17	13.50	16.00	12.67	12.02	14.50	9.50
Nov.	25	15.50	14.54	13.00	15.00	12.04	10.79	13.00	8.75
Dec.	29	17.00	14.66	13.00	15.00	11.91	10.66	12.75	8.65
Jan.	27	12.75	12.06	12.25	14.00	9.81	8.06	10.25	7.45
Feb.	24	14.75	12.65	12.25	14.00	10.65	8.90	11.00	7.95
March	31	14.25	13.09	12.25	14.00	11.09	9.34	11.00	8.30
April	28	13.75	12.66	12.00	13.50	10.41	8.91	10.50	8.30
May	26	15.00	14.19	12.00	13.50	11.49	10.44	12.25	9.35
June	30	15.75	15.33	13.50	14.00	12.63	11.58	13.25	10.10
July	28	14.00	15.29	13.75	13.30	12.79	11.54	13.50	10.10

Table 31 contd.2

Season		Egyptian Uppers (G.F.G.)	Peru Smooth (G.Fair)	Peru Rough (G.Fair)	Peruvian Afifi (G.Fair)	Brazilian Pernam (Fair)	W.African Middling	East African (G.Fair)	Indian No.1 G (Oomara)
1922-23									
Aug.	26	14.75	15.55	13.75	13.00	13.20	11.80	14.00	10.45
Sept.	29	13.50	14.25	14.00	13.00	12.15	10.75	13.00	9.45
Oct.	27	15.00	15.99	14.50	13,50	13.89	12.74	13.50	10.20
Nov.	24	16.00	16.85	16.00	14,50	14.60	13.35	14.25	10.65
Dec.	28	15.90	17.34	16.00	14.75	15.09	13.84	14.75	10.45
Jan.	26	16.50	18.27	17.25	18.50	16.34	15.02	15.50	11.45
Feb.	23	16½25	17.89	17.50	15.25	16.14	14.89	15.05	10.80
March	28	16.80	16.51	17.50	16.25	15.01	13.76	14.05	10.00
April	27	16.40	16.36	17.50	16.50	15.11	13.86	14.30	10.00
May	31	15.95	16.51	17.50	16.00	15.47	14.01	14.00	10.15
June	29	16.45	17.32	17.50	16.00	16.07	15.69	14.70	10.40
July	27	15.85	15.57	17.25	15.50	14.07	14.07	13.75	9.85
1923-24									
Aug.	31	16.75	15.78	17.00	15.75	15.03	14.78	13.50	10.90
Sept.	28	17.60	17.86	17.50	16.75	17.36	16.86	15.75	11.05
Oct.	26	18.05	19.03	17.50	17.25	18.53	17.72	16.25	11.85
Nov.	30	24.65	23.81	21.00	25.00	22.27	21.62	21.00	15.60
Dec.	28	23.30	23.17	22.00	23.50	21.57	20.92	20.75	15.10
Jan.	25	21.90	21.86	23.00	22.50	20.26	19.61	19.50	14.00
Feb.	29	22.10	19.48	22.50	21.25	17.88	17.23	17.80	12.35
March	28	22.10	18.26	22.00	20.00	16.66	16.01	16.65	11.50
April	25	23.25	20.15	22.25	21.75	18.15	17.65	18.70	12.25
May	30	24.00	20.64	22.50	22.00	18.64	18.13	19.50	12.75
June	27	23.20	19.18	22.50	22.00	17.43	16.93	18.35	11.80
July	25	24.45	20.34	22.50	21.50	18.59	18.09	18.45	12.30
1924-25									
Aug.	29	21.65	17.91	22.50	21.50	16.16	15.66	16.70	10.90

Source: Same as table A

G.F.G. = Good Fully Good

G = Good

APPENDIX 32

TABLE 32

DISTRIBUTION OF THE AMERICAN COTTON CROP
(IN THOUSANDS OF BALES OF 500 LBS.)

Season	Total Commercial Crop	Exports: To Britain	Exports: To Continent, Japan, Mexico	Exports: Total Exports	Percentage of crop taken by U.S. Mills
1899-00	9,422	2,348	3,603	5,951	39
1900-01	10.339	3,050	3,488	6,538	34
1901-02	10.768	3,041	3,601	6,642	38
1902-03	10.674	2,849	3,826	6,675	37
1903-04	10.002	2,577	3,455	6,032	39
1904-05	13,654	4,124	4,609	8,733	33
1905-06	11,234	2,891	3,696	6,587	41
1906-07	13,540	3,750	4,614	8,364	37
1907-08	11,441	2,944	4,517	7,461	35
1908-09	13,817	3,539	4,908	8,447	38
1909-10	10,513	2,430	3,778	6,208	40
1910-11	12,075	3,347	4,269	7,616	36
1911-12	16,101	4,248	6,404	10,652	33
1912-13	14,104	3,604	5,176	8,780	38
1913-14	14,552	3.419	5,447	8,866	38
1914-15	15,136	3.798	4,571	8,369	40
1915-16	12,862	2.866	3,185	6,051	53
1916-17	12,737	2,688	3,076	5,764	55
1917-18	11,837	2,155	2,111	4,266	58

Compiled from the Shepperton Company's "Cotton Facts", 1819, and from the Annual Statement of the American Cotton Crop published by the Liverpool Cotton Association Ltd.

APPENDIX 33

TABLE 33

THE WORLD COTTON SUPPLY AND THE BRITISH EMPIRE'S SHARE IN IT. (BASED ON PRE-WAR FIGURES.)

Grades & Quality	Where Grown	World's Crop Bales of 500 lbs.	Empire's share in Bales	Per Cent
1. Best Sea Island	Islands, South Carolina	8,000		
	West Indies	4,000		
		12,000	4,000	33

Table 33 contd.

Grades & Quality		Where Grown	World's Crop Bales of 500 lbs.	Empire's share in Bales	Per Cent
II.	Sea Islands	Florida and Georgia	70,000		
		West Indies	2,000		
	Best Egyptian (Sakel etc.)	Egypt	550,000		
			622,000	552,000	89
III.	Egyptian	Egypt	700,000		
		Sudan	20,000		
	Staple American	Mississippi Delta etc	200,000		
		Nyasaland, Uganda, E. & S. Africa	40,000		
	Peruvian	Peru	125,000		
			1,085,000	760,000	70
IV.	American	United States	15,000,000		
		Mexico	150,000		
		Brazil	300,000		
		Russia	500,000		
		West Africa	15,000		
		Levant	100,000		
		India	400,000		
		China and Korea	250,000		
			16,000,000	415,000	2,5
V.	Indian, etc.	India	4,500,000		
		Russia	750,000		
		China	1,800,000		
			7,050,000	4,500,000	64
		TOTAL	25,484,000	6,231,000	24,5

N.B. In the case of Egypt the allocation between Grades II and III is based on the figures of the 1917 crop.

Source: Table A. Appendix IX, Report of Board of Trade, p. 70

APPENDIX 34

TABLE 34

EGYPTIAN COTTON CROP, AREA AND YIELD (1899-1913)

Season	Area Feddans	%age of total area cropped	Crop Kantars	Average Yield lbs. per Feddan
1899-1900	1,153,307	16.40	6,510,050	563
1900-01	1,230,319	17.18	5,435,480	442
1901-02	1,249,884	17.14	6,396,911	510
1902-03	1,275,677	17.17	5,838,790	458
Assuan Dam completed				
1903-04	1,332,510	18.16	6,508,947	488
1904-05	1,436,709	18.94	6,313,370	439
1905-06	1,566,602	20.71	5,959,883	380
1906-07	1,506,291	20.14	6,949,383	461
1907-08	1,603,224	20.92	7,234,669	451
1908-09	1,640,415	21.59	6,751,133	412
1909-10	1,597,055	20.83	5,000,775	313
1910-11	1,642,610	21.30	7,573,537	457
1911-12	1,711,241	22.68	7,424,208	433
1912-13	1,721,815	22.42	7,532,920	437

Source: Report to the Board of Trade, Table C, p. 71

APPENDIX 35

TABLE 35

AFRICAN COTTON CROPS (EXCEPT EGYPT) FROM 1902-18 (IN BALES OF 500 LBS.)

Year	TOTAL: East & South Africa	TOTAL: West Africa	Sudan	TOTAL: Whole Africa
1902	-	25	300	325
1903	150	750	2,000	2,900
1904	854	2,550	3,500	6,904
1905	2,024	4,550	4,000	10,574
1906	3,055	7,500	4,063	14,618
1907	4,960	11,600	7,773	24,333
1908	6,844	6,400	9,540	22,754
1909	8,690	13,000	6,890	28,580
1910	15,909	6,700	15,370	37,979
1911	25,888	6,800	21,907	54,595

Table 35 contd

Year	TOTAL: East & South Africa	TOTAL: West Africa	Sudan	TOTAL: Whole Africa
1912	37,180	11,890	15,000	64,070
1913	34,600	16,300	14,000	64,900
1914	50,845	14,850	10,000	75,695
1915	34,890	7,600	24,000	66,490
1916	34,130	20,300	16,200	70,630
1917	31,280	11,900	23,000	66,180
1918	28,840	6,200	12,000	47,040

Source: Report to the Board of Trade (1917), Table D, p. 71

APPENDIX 36

TABLE 36A TO SHOW NET PROFIT AND LOSS OF THE SPINNING TRADE (1884-1914)

Year	No. of Companies	Profit £	Loss £	Average per Company: Profit	Average per Company: Loss	Yearly Average Dividend Paid
1884	60	125,000	-	2,083	-	5
1885	87	-	2,730	-	31	2
1886	90	-	61,718	-	686	3
1887	88	86,810	-	986	-	$4\frac{3}{4}$
1888	85	250,932	-	2,925	-	5
1889	86	220,587	-	2,565	-	5
1890	91	381,050	-	4,220	-	7
1891	101	38,758	-	383	-	$5\frac{1}{4}$
1892	99	-	94,770	-	957	$1\frac{1}{4}$
1893	99	-	60,790	-	613	1
1894	94	4,491	-	48	-	$1\frac{1}{2}$
1895	94	63,167	-	672	-	$1\frac{5}{8}$
1896	94	49,631	-	528	-	$1\frac{3}{4}$
1897	94	157,570	-	1,676	-	3
1898	90	271,804	-	3,020	-	$4\frac{1}{3}$
1899	86	381,176	-	4,432	-	$6\frac{1}{6}$
1900	86	344,548	-	4,307	-	$7\frac{1}{4}$

Table 36A contd

Year	No. of Companies	Profit £	Loss £	Average per Company: Profit	Average per Company: Loss	Yearly Average Dividend Paid
1901	80	279,545	-	3,494	-	$7^{1}/_{6}$
1902	80	-	1,436	-	16	$4\frac{2}{3}$
1903	85	-	45,322	-	503	3
1904	90	31,729	-	352	-	$2\frac{1}{2}$
1905	90	693,070	-	7,701	-	7
1906	90	590,002	-	6,555	-	$9\frac{2}{3}$
1907	90	1,321,157	-	13,211	-	$15^{7}/_{8}$
1908	100	586,511	-	5,865	-	$11\frac{3}{4}$
1909	100	-	272,072	-	2,720	$7^{7}/_{8}$
1910	100	-	368,006	-	3,680	$5^{3}/_{5}$
1911	100	29,812	-	288	-	$4^{3}/_{5}$
1912	100	558,450	-	5,584	-	$7^{1}/_{5}$
1913	100	536,638	-	5,366	-	$7^{4}/_{5}$
1914	100	53,183	-	531	-	$6^{7}/_{8}$

Source: The Economist, January 16 (1915), p. 101

TABLE 36B DECLINE IN TEXTILE EXPORT OF LANCASHIRE, 1912-14

Years	Items		December £	Items	12 Months Ended Dec.31 £
1912			588,178		7,043,477
1913			684,372		8,281,848
1914	(Spinning	155,496	221,216	3,864,445	5,769,427
	(Weaving	49,282		1,254,164	
	(Other	16,438		650,818	

Source: The Economist, op. cit., p. 101

APPENDIX 37

TABLE 37A TO SHOW DATES OF IRRIGATION AND FEDDANS UNDER CROPS AT EXPERIMENTAL STATIONS

TAYIBA

Year	Crops	Area in Feddans	Commenced Irrigation	Ceased Irrigation	No. of Waterings
1913-14	Cotton	668	July 15	April 25	15
	Wheat	578	October 15 (Sharaqi)	March 18	7
	Green Crops	668	August 10	January 30	(578 fedd. 4 (90 fedd. 7
	Dura	578	July 21 (Sharaqi)	October 15	4
	Catch Crop	-	November 10	March 15	3
1914-15	Cotton	935)	July 15	April 5	14
	Exp. Cotton	10)	September 30	April 4	14
	Continuous Cotton	7)	July 21	March 29	12
	Green Crops	973	August 15	February 28	(258 fedd. 2 (715 fedd. 7
	Dura	258	August 8 (Sharaqi)	November 1	3
1915-16	Cotton	1,378	July 15	May 26	17
	Lubia	1,430	September 1 (Sharaqi)	January 31	4
1916-17	Cotton	1,795	July 15	April 15	14
	Lubia	1,376	October 1 (Sharaqi)	January 29	3

Sharaqi = Fallow land

TABLE 37B BARAKAT

Year	Crops	Area in Feddans	Commenced Irrigation	Ceased Irrigation	No. of Waterings
1914-15	Cotton	2,020	September 14 (Bulk of crop planted in Aug. 10 on rain)	April 26	13

Table 37B contd

Year	Crops	Area in Feddans	Commenced Irrigation	Ceased Irrigation	No. of Waterings
1915-16	Cotton	1,910	July 15	May 26	15
1916-17	Cotton	2,506	July 15	April 11	12

Source: Computations Relating to the Note, *op. cit.*, p. 13

TABLE 37C DUTIES OF WATER PUMPED AT EXPERIMENTAL STATIONS: A COMPARATIVE TABLE

	Duty of Water Pumped M^3/feddan per day	Proposed Allowance M^3/feddan per day
January 1 - 15)		($\frac{30 + 24}{2}$ = 27)
)	22.4	( ) $28\frac{1}{2}$
January 16 - 31)		(30 = 30)
February	28.3	35
March	34.4	35
April	34.8	35
May	24.2 (Special case)	
May	0.82	7.5
June	0.84	7.5

Source: Computations, p. 19

TABLE 37D NATURAL SUPPLY-AREA CULTIVATED, MEAN DISCHARGE APRIL 1-15

	1914	1908	Mean 1907 to 1917
M^3 p.s.	55	92	137*
Million per day	4.75	7.94	11.8
Area Cultivable, Feddans	317,000	529,000	790,000

Table 37D contd.

* 140 M^3 p.s. is given in 'Notes on the Water required, etc.', op. cit. as the mean discharge at the critical period. This was taken as corresponding to the mean guage reading. The mean of discharges is 137.

The Maximum of the 1913 flood at Roda was		17.8
Other low floods have been	(1899	17.58
	(1877	17.65

The series of floods, 1899 to 1915 inclusive, has an average maximum lower than that of any other series of 17 years, since 1737. Records are missing from 1801 to 1824.

Source: Computations, p. 36

TABLE 37E AREA CULTIVABLE WITH STORAGE IN 1907-1908

	--	Supply			Requirements for 1,100,000 Feddans			
	M^3p.s	Million M^3/day	Days	Million M^3	M^3p.s	Million M^3/day	Days	Million M^3
1908								
Feb. 1 - 10	214	-	-	-	191	-	-	-
Feb.11 - 29	157	13.6	19	258	191	16.5	19	314
March 1 - 31	110	9.5	31	294	191	16.5	31	512
April 1 - 15	92	7.95	15	119	191	16.5	15	243
				671				1,074

1,100,000 would have required storage in 1907-8 from February 11, 1908

	Million Cubic Metres
Natural River, February 11 - April 15	671
Available Storage to April 15	398
Available supply	1,069
Requirements for 1,100,000 feddans	1,074

TABLE 37F AREA CULTIVABLE WITH STORAGE 1913-1914

Dates	Supply				Requirements for 600,000 Feddans			
	M^3 p.s.	Million M^3/day	Days	Million M^3	M^3 p.s.	Million M^3/day	Days	Million M^3
1913								
December 6-10	184	-	-	-	-	-	-	-
December 11-31	159	13.7	21	288	175	15.2	21	319
1914								
January 1-15	120	10.4	31	322	175	15.2	15	228
January 16-31					115	9.9	16	158
February 1-28	75	6.48	38	182	115	9.9	28	277
March 1-30	65	5.62	31	174	115	9.9	31	
April 1-15	55	4.75	15	71	115	9.9	15	
				1,037				1,437

660,000 feddans would have required storage in 1913-14 from Dec. 11, 1913.

	Million Cubic metres
Natural River, December 11 - April 15	1,037
Available Storage to April 15	398
Available Supply	1,435
Requirements for 660,000 feddans	1,437

Source: Computations, op. cit., p. 46

APPENDIX 42

TABLE 38 THE EARLY FINANCIAL HISTORY OF THE SYNDICATE

Year	Authorised Capital	Issued Capital in ordinary £1 shares	Debenture Capital	Profits	Dividends
	£	£	£	£	%
From 1904-09	80,000	80,000	58,000 (3½%)	Nil	Nil
1910	250,000	130,000	58,000 (3½%)	8,934	Nil
1911	250,000	135,000	58,000 (3½%)	6,169	Nil
1912	250,000	135,000	58,000 (3½%)	16,384	12½
1913	250,000	135,000	58,000 (3½%)	16,608	12½

Table 38 contd.

Year	Authorised Capital	Issued Capital in ordinary £1 shares	Debenture Capital	Profits	Dividends
	£	£	£	£	%
1914	250,000	135,000	57,000 (3½%)	4,761	5
1915	250,000	135,000	57,000 (3½%)	1,392	5
1916	250,000	135,000	57,000 (3½%)	2,678	Nil
1917	250,000	135,000	57,000 (6%)	14,238	10
1918	250,000	135,000	57,000 (6%)	58,492	25
1919	250,000	135,000		57,146	25
1920	750,000	297,790		223,259	35
1921	750,000	300,000		8,968	15
1922	750,000	300,000		126,520	35
1923	750,000	450,000		45,082	17½
1924	750,000	531,119		112,934	20
1925	750,000	600,000		162,885	25

Source: A. Gaitskell, op. cit., p. 94

APPENDIX 39

TABLE 39A TITHES COLLECTED IN THE GEZIRA (A) IN 1909-10 WITH GOOD RAIN, AND (B) IN 1907-1908 (BAD RAIN).

Area	(A) 1909 - 1910	(B) 1907 - 1908
	Amount in Ardebs of 300 lb.	Amount in Ardebs of 300 lb.
Messallemia	20,472	600
Medani	24,404	2,469
Manaqil	27,325	946
Kamlin	10,583	6,811
	82,784	10,826

Source: Peacock, op. cit., p. 58

TABLE 39B AVERAGE COST OF CULTIVATING ONE GADA'A OF LAND UNDER FETERITA (ESTIMATE)

Item:	Price (mm)
Price of seed	30
Sowing	200
Cleaning	400
Harvest	240
Carry to the threshing floor	80
Threshing rate at 20 mm an ardeb	300
TOTAL	£E. 1,250 mm

APPENDIX 40

THE GEZIRA LAND ORDINANCE, 1921

Whereas it is proposed to irrigate parts of the Gezira District lying between the White Nile and the Blue Nile hitherto cultivated intermittently with rain-grown crops and for that purpose from time to time to carry out such works as may be considered necessary;

And whereas the Government has undertaken the construction of very costly irrigation works and has had to raise a large loan to provide the necessary funds for this purpose;

And whereas the boundaries of the existing holdings of land in the said districts if left unaltered would render it impossible to carry on the irrigation and cultivation of the land in a businesslike and economical manner;

And whereas the lands which it is proposed to irrigate are at present cultivable only in years of sufficient rainfall and are of small value and their value will be increased by the irrigation works out of all proportion to their present value;

And whereas the landowners for the most part have no experience of the cultivation of artificially irrigated lands and will not be competent themselves to cultivate nor to arrange for the cultivation of all their land;

And whereas for the reasons aforesaid and in order to make provision for the repayment of the said loan it is expedient that the Government should be empowered to acquire any lands which may be included in any irrigation scheme proposed or carried out by the Government in the said district or which may be required for any works connected with the scheme or for any public purpose subject to the conditions and provisions hereinafter appearing;

And whereas the Government published an explanatory notice to this effect to the landowners in the said district dated the 15th day of March, 1920, a copy of which notice is set forth in the Schedule of this ordinance;

Now it is hereby enacted by the Governor-General of the Soudan in Council as follows:-

Part 1 - Introductory

Short title:-

1. This ordinance may be cited as "The Gezira Land Ordinance, 1921."

Definition:-

2. In this ordinance the words "persons interested" means persons who are registered in the Land Registry as having any right or interest in or over any land to which this ordinance relates.

Part II - Procedure

Notice:-

3. Whenever a scheme or a provisional scheme has been approved for

artificial irrigation of any land in the Gezira District and it appears to the Governor-General that it is expedient that the provisions of this ordinance shall apply to any land comprised in or required for or in connection with such scheme he may direct that a notice signed by him shall be published in the 'Soudan Government Gazette', containing:

(a) A statement that the lands described in the notice are included in the irrigation scheme or are required for the purpose of an irrigation scheme, or for a public purpose and that the Governor-General has decided to apply the provisions for this ordinance to them:

(b) A description of the land and its approximate area and a mention of the place where a plan of the land may be seen.

Appointments of Commissioners:-

4. The Governor-General may by writing under his hand appoint one or more commissioner or commissioners for the purposes hereinafter provided.

The Governor-General may at any time by writing under his hand annul the appointment of a commissioner or appoint additional commissioners or appoint another commissioner or other commissioners to act temporarily or to take the place of a commissioner or commissioners.

Every appointment shall be published as soon as may be in the "Soudan Government Gazette".

If thereby two or more commissioners, each commissioner shall act singly and the work shall be distributed between them in accordance with instructions from the Governor-General or in default of such instructions as they may agree.

Commissioner's Notice:

5. At any time after the publication of the notice by the Governor-General applying the provisions of this ordinance the commissioner shall by notice to the sheikh of the village within which any land included in the scheme is situated summon all persons interested in the land to appear personally or by agent before the commissioner at a time and place mentioned in the notice such time not being earlier than fourteen days after the issue of the notice.

Commissioner's Sitting:

6. On the day appointed by the notice or on any subsequent day to which he may adjourn his sitting, the commissioner shall -

(i) Explain to the persons interested, the proposals of the Government with regard to the land;

(ii) Inform the persons interested of the compensation to be granted for the land proposed to be acquired.

Interests to be Acquired:

7. (i) Land to be acquired under this ordinance shall be hired in the first instance for a period of forty years from the date upon which the notice under section 5 is given, but the Government shall have the right to hire land temporarily for purposes connected with the Scheme for any period of years less than forty which the commissioner may decide.

(ii) The Government shall have the right, at any time during the said period of forty years or any extension thereof, to purchase any land so acquired, or any land comprised in the notice given under section 3 hereof, which will not be irrigated but is, or will be, required for any permanent works or buildings necessary for the scheme.

(iii) The Government may, at the expiration of the said period of forty years or any extension thereof, declare any of the land situated within the irrigated area which will not be irrigated, but is, or will be, required for any permanent works or buildings necessary for the irrigation scheme, to be devoted to the service of the scheme for the common benefit of the owners of all land within the said area, and that the same shall be borne or provided by all the owners of land within the said area, in proportion to the area of their respective holdings.

(iv) No formal lease or conveyance shall be necessary to vest in the Government land acquired under this section.

Compensation:-

8 (i) For land acquired on lease, the compensation shall be an annual rent at the rate of P.T.10 per feddan.

(ii) In the case of land acquired in full ownership, the compensation to be paid shall be at the rate of £E.1 a feddan.

(iii) The persons interested shall also be entitled to be paid compensation, as fixed by the commissioner, for any permanent buildings acquired by the Government hereunder, and such compensation (if any) as the commissioner may assess for timber or for damage to crops standing on the ground at the time when possession is taken.

(iv) Where a number of persons are the registered owners of one holding, it shall be lawful for the commissioner to appoint one or more of their number as agent or agents, to receive the whole rent of that holding on behalf of all the registered owners, and the receipt of the person or persons so appointed shall be a complete discharge for all claims against the Government in respect of the rent payable.

Taking Possession of Land:

9. The agents of the Government may, at any time after the expiration of seven days, from the publication of the notice mentioned in section 3, enter upon or take possession of any waste or agricultural lands mentioned in such notice.

Cultivating Tenancies for Landowners:

10. The owners of every plot of land which is acquired by the Government under this ordinance, and which is irrigated by the irrigation scheme, shall have the right to take up, within a reasonable period after the date when water is first available for the said land under the said irrigation scheme, yearly cultivating tenancies of such areas as they themselves are competent to cultivate, subject to the conditions hereinafter set out, and in other respects upon the usual terms and conditions upon which from time to time all cultivating tenancies within the area of the irrigation scheme shall be granted, and they shall also be entitled to a renewal of tenancies every season so long as they shall have duly performed and observed those conditions.

The period aforesaid shall be fixed by the commissioner in each case and shall be notified by him to the owners, but shall not exceed three years, unless in the opinion of the commissioner there shall be in any case exceptional circumstances which justify the fixing of a longer period.

11. The Conditions above referred to are:-

(i) The tenant shall punctually pay all sums payable by him under the tenancy agreement in respect of the land comprised in the tenancy or the crops grown thereon or the cultivation of the said crops

(ii) The tenant shall cultivate the land in a proper and efficient manner, according to the scheme of crop rotation to be laid down to the satisfaction of the Government or such person or persons as the Government may appoint to manage and supervise the cultivation of the land comprised in the irrigation scheme

(iii) The tenant may not transfer, assign, sublet or part with the possession of the land comprised in the tenancy or any interest therein or in the crops grown thereon, except with the consent of the Government or such person or persons as the Government may appoint as aforesaid

(iv) If the tenant shall not perform and observe the conditions of the tenancy agreement, the Government may re-enter into possession of the land, and thereupon the tenancy shall terminate, and the right to the annual renewal thereof under section 10 of this ordinance may be cancelled or suspended by the Government or such person or persons as the Government may appoint as aforesaid

12. All irrigated lands acquired by the Government on lease under this Ordinance which are not relet to the owners under section 10 thereof, may be occupied by the Government or let on a yearly tenancy to such person or persons as it thinks fit.

Renewal of Hiring:

13. The period of forty years for which land to be acquired by the Government may be leased under section 7 of this ordinance may, at the expiration of that period, be extended by the Government at the same annual rent for a further period, but only if in the opinion of the Governor-General in Council the extension is expedient in the general interest of the owners of the land irrigated by the scheme, and for such period as may be deemed necessary by the Governor-General for that purpose.

14. Notwithstanding any of the provisions of this ordinance, the persons interested shall be at liberty, during the period of hiring of their land by the Government, to transfer or mortgage their rights or interests as at present subject to the rights and powers of the Government under this ordinance.

15. Lands in the Gezira District which have been already occupied by the Government in anticipation of the passing of this ordinance shall be deemed to have been duly acquired under the provisions of this ordinance.

THE SCHEDULE

GEZIRA IRRIGATION SCHEME

Notice

Notice is hereby given to all persons owning land within the area of 300,000 feddans in the Sennar and Blue Nile Provinces to be irrigated by the Makwar Dam and the canals connected therewith, that the proposals of the Government for dealing with this area, a plan of which is deposited in the Mudiria Office at Wad Medani and in the Merkaz Office at Sennar, are as follows:-

(1) The general scheme adopted at Tayiba and Barakat will be followed, and the present owners of the land will not be deprived of their ownership.

(2) The Government will hire all the land within the area that is not Government land and will pay rent for the same, but the land occupied permanently by canals, roads, buildings, regulators and other permanent works may, in due course, be purchased by the Government outright.

(3) This hiring will be in the first instance for a term not exceeding forty years, which is the period laid down for the repayment by the Government of the loan which the Government has raised to carry out the irrigation scheme. The Government will pay a fixed annual rent per feddan for the land throughout the period of hiring, the rate of which will shortly be fixed, and the rent will become payable from the date when possession of the land is actually taken.

(4) Some portions of the land will be required for the purpose of constructing the irrigation works several years before water can be put on the land, but the owners will be permitted, as far as possible, to continue the cultivation of rain crops on the land until the time comes when the land will have to be prepared for the first season of cultivation with the irrigation water.

5. The land in the irrigated area will be let annually to tenant cultivators on the system now in force at Tayiba and Barakat.

In allotting plots in this way, the owners of the land hired will be given the opportunity to take up such areas as they are able to cultivate and, so far as possible, be given the preference in taking up plots on or in the immediate vicinity of their land.

6. The Government's intention is that the hiring of land should cease at the end of the period of forty years, but it reserves the right to extend the period of hiring, if necessary, in the public interest.

7. In assessing the rent to be paid by the Government to the landowners, both now and on any extension of the period of forty years, and also the purchase price of the land occupied by canals, roads and other works, the Government will not take into account any rise of value by the irrigation scheme.

8. The tenant cultivators of the land will, in addition to the cotton crop, be permitted to grow on the plots sufficient dura for their own food requirement, but not for sale.

9. During the period of hiring, the owners of the land hiring will be at liberty, as at present, to transfer or mortgage their rights of ownership to other natives of the same locality.

Note:- The whole of the 300,000 feddans referred to in the above notice are now included in the Blue Nile Province.

Made by the Acting Governor-General of the Soudan in Council this 19th day of September, 1912.

H.W. JACKSON,

Acting Governor-General.

R.V. BRADSLEY,
Acting Secretary to Council.

APPENDIX 41

TABLE 41A ESTIMATED RESIDENTIAL POPULATION IN THE GEZIRA (NORTH OF RAILWAY), 1912

District	Men	Women	Children
Sennar	3,262	5,503	5,430
Wad Medani	8,520	11,495	12,417
Wad Medani (town)	4,442	5,894	5,659
Messallemia	7,634	14,326	11,000
Kamlin	6,523	8,052	9,135
Khartoum	13,960	10,238	7,984
Geteina (east bank)	12,300	15,225	7,125
Kawa	9,000	11,800	5,600
Manaqil	9,841	10,781	11,078
Gos Abu Goma	4,165	5,055	2,385
Total	79,647	98,369	77,813

TABLE 41B SOUTH OF RAILWAY AND ADJACENT DISTRICTS

District	Men	Women	Children
Singa	11,762	15,526	37,977
Sennar	3,615	3,431	2,311
Dinder	2,207	2,518	1,907
Rufaa	12,367	17,000	20,002
Kamlin (east bank)	5,388	5,821	7,607
Geili	7,580	8,248	4,539
Khartoum North	8,300	9,258	10,111
Omdürman	11,823	17,536	21,185
Geteina (west bank)	4,100	5,075	2,375
Dueim	14,700	17,600	8,300
Kost	14,900	18,300	8,400
Goz Abu Goma (S. Railway)	3,335	4,045	19,429
Total	100,385	184,385	126,429

Notes: (1) Statistics from Sennar are derived from lists produced by sheikhs of villages at the same time as the annual herd tax returns.
(2) Statistics for the Blue Nile Privince were obtained by a rough census taken at the time houses were counted for Gaffir's (watchman) tax.

(3) Statistics for the White Nile Province are based on returns showing the number of plots of rainland cultivation in 1912 in the various districts.

Source: Box 112/3, Sudan Archives.

APPENDIX 42

TAXES ON CULTIVATION

(A) Land Tax

On the reconquest of the Soudan it was decided to adopt as a basis for the taxation of land, other than land dependent on rainfall, contained in the Egyptian Decree of 1897 for the Dongola Province, and the Land Tax Ordinance, 1898, was accordingly introduced.

Under this ordinance such land was divided into the following categories:-

(a) Island land irrigable by means of saqias or shadoofs

(b) Land on the mainland irrigable by means of saqias or shadoofs

(c) Foreshore land irrigable by flood

(d) Land irrigable from wells

Land under both (a) and (b) was divided into first and second class, and the rates imposed were 60 P.T. and 50 P.T. per feddan respectively for (a) and 40 P.T. and 30 P.T. for (b). The tax for (c) and (d) was fixed at 20 P.T. a feddan.

The Ordinance laid down that the tax should be levied in such provinces and districts as the Governor-General should from time to time direct, and further, as local conditions varied in different provinces, it empowered Governors to issue regulations for the classification of land and for the assessment of taxes, and also to fix the time when the taxes should be paid, having regard to the seasons during which the various crops are gathered.

In cases where it was found that cultivators of land assessed for land tax had suffered serious loss owing to causes beyond their control, such as low Nile, destruction of crops by pests, remissions of taxation were allowed.

The system was slighly modified from time to time in the light of experience gained, and was necessary to meet local conditions.

The rates and dates of successive increases by which full taxation was gradually imposed were decided with due regard to the conditions of the people, the nature and area of the land, the amount of labour available, the method of irrigation employed and the means of transport of the produce to the markets. In this way it was possible to regulate the gradual imposition of the tax and either accelerate or retard its application as circumstances required. The object of the Government was to prevent land in private ownership remaining unproductive when the natives had the means to cultivate it.

As regards the four categories into which the land was divided under the ordinance, experience gained during the first few years of the country's administration showed that this classification did not afford an equitable basis in all cases for fixing the amount of the tax to be levied. For instance, certain land on the mainland irrigable by means of saqias proved more productive than island land similarly irrigated, although the latter were subjected to a higher tax. Then again, foreshore land irrigable by flood turned out in certain cases more productive than island land or land on the mainland irrigated by saqias, owing possibly either to its proximity to a market or being generally less expensive to cultivate.

It was therefore decided in 1905 to amend the Ordinance of 1899 and substitute the following rates irrespective of the method of irrigation.

	P.T./Per Feddan
First Rate	60
Second Rate	50
Third Rate	40
Fourth Rate	30
Fifth Rate	20
Sixth Rate	10

Towards the end of 1916 it was represented that the application of these rates in certain localities was bearing hardly on the cultivators, and a special committee was appointed in 1917 to report on the land tax system of Khartoum and Berber provinces. The committee recommended that the rate of land tax to be applied to saqia land should be determined by the gross productive capacity of that land, and that the rate to be fixed should represent one-twentieth of this capacity and in the case of foreshore land irrigated by flood one-tenth, which was put into effect.

RECEIPTS REALISED FROM LAND TAX

	£E
1918	63,247
1919	43,331
1920	52,866
1921	39,832
1922	39,675
1923	40,330 (Approx)

THE TAXATION OF RAINLANDS (USHUR) ORDINANCE, 1921

An Ordinance for regulating the Taxation of Lands watered by Rains or natural overflow of Rivers

Whereas ever since the re-establishment of Government in the Soudan, ushur (tithe) has been collected on rainlands in the Soudan under customary regulations, and it is desirable to regulate such collection by ordinance.

Now it is hereby enacted by the Governor-General of the Soudan in Council as follows:

The collection of tax is one of the chief duties of province staff and during the latter months of the year, and the greatest care is taken in assessing the value of the crops, and in practice a margin in favour of the cultivator is allowed.

The tenth of the estimated yield of crops shall be assessed at a money value in accordance with rates to be laid down each year for each province by the financial secretary in consultation with the Governor of such province, due regard being paid to the local conditions of each province in every year and to the market prices in each province for the various kinds of crops.

Owing to the variation in rainfall in different localities from year to year and other climatic conditions which affect the crops during the period of their growth, the revenue from this tax is always a fluctuating one.

The chief crops on which this tax is assessed are dura and dukhn (millets), maize, sesame, ground nuts, rain grown cotton.

Course: Cmd. no. 2171 (1924)

APPENDIX 43

TABLE 43 NUMBER OF FEDDANS APPLIED FOR AND ALLOTTED IN KERMA BASIN FOR THE SEASON, 1912/13

Description of Applicants	No. of Feddans Applied for	No. of Feddans Allotted
Samads and Natives, Dongola Province	44,380	24,760
Merchants, Dongola Province	4,310	2,010
Government Employees, Dongola Province	1,920	710
Egyptian Cultivators from last year	4,888	2,400
Greek Merchants, Dongola Province	720	560
Natives from other provinces	5,880	2,030
Merchants from other provinces	660	120
Egyptian Cultivators Applying for first time	5,890	1,350
Government Employees from other provinces	510	60
	69,150	34,000

Source: "Kerma Basin", Box 112/1, Sudan Archives

For the seasons of 1911/12 the number of feddans applied for and allotted amounted to 67,195 and 27,340 feddans respectively.

APPENDIX 48a

THE SUDAN PLANTATIONS SYNDICATE LTD. AT ZEIDAB

Copy of Agreement for Purchase of Water

An agreement made between the undersigned of the first part hereinunder called "The Tenant" and the Sudan Plantations Syndicate Ltd., hereinunder called "The Company" of the second part:

Whereas the tenant has requested from the Company the necessary water to irrigate the growing of cotton, wheat, and dhurra crops on his own privately owned lands.

Now it is hereby agreed between the parties:-

1. The Tenant shall pay the Company the sum of 250 P.T. on each feddan cultivated for cotton, and the sum of 125 P.T. on each feddan cultivated for wheat, and the sum of 125 P.T. on each feddan cultivated for dhurra as water rent.

   In the event of the Tenant cultivating more than one crop on the same land, the Tenant shall pay to the Company the sum of 250 P.T. on each feddan so cultivated.

2. The Company shall supply the necessary water for the irrigation of the various aforesaid crops according to the rules of cultivation up to and inclusive of the 1st day of May, 1913, but in case of any compulsory circumstances preventing the water from reaching the land at any time, or on account of any machine being broken, or any other compulsory reason, the tenant shall have no claim against the Company for any compensation on account of the water not reaching the land under cultivation; but it is without prejudice to any claims that the tenant may have to reduction of rent.

3. The Tenant shall pay water rents due on each crop at the time of harvesting such crops, and all moneys due to the Company shall be paid to the 1st day of May.

4. The Tenant who signs this contract shall be responsible and liable to pay all water rents in full for all land cultivated or the saqia or saqias cultivated by him or his partners.

5. The Tenant shall not sublet his land or any part thereof without the written permission of the Company, as the water is supplied to the Tenant at a lower rate than that in force on the Company's land.

6. As the water is supplied to the Tenant without security, which is contrary to custom in similar cases, the Tenant agrees that all his crops and livestock shall be a security for the rights of the Company; and the Tenant therefore engages himself not to remove or dispose of any of his crops or livestock without the written consent of the Company, unless the Company has received the water rents due to it either in money or kind.

7. The Tenant shall obey the reasonable orders of the Company's officials in regard to the regulating of the water supply. The Tenant

is willing, should he allow the water to break his gadwells and flow onto adjoining lands, to pay a reasonable compensation to the Company for the water so lost.

8. The Tenant is prepared to make his own gadwells, and to keep them in proper repair, and to clean them in order not to impede the flow of water to other Tenants further on.

9. The English copy of this contract is the official contract. The Arabic translation is merely for the information of the Tenant.

The Tenant ______________________________

The Company ______________________________

Zeidab ______________191______

APPENDIX 44b

THE SUDAN PLANTATIONS SYNDICATE LTD., AT ZEIDAB

Copy of Agreement for Tenant Hiring Land

An Agreement made between __________________ of the first part, hereinafter called "The Tenant" and the Sudan Plantations Syndicate Ltd., hereinafter called "The Company" of the second part.

Whereas the said Tenant has leased from the Company 30 feddans of land at Zeidab for the cultivation of cotton, wheat, and leguminous crops, and the said tenant having seen the land specified and having a thorough knowledge of its boundaries.

Now it is hereby agreed between the parties:-

1. The Tenant shall cultivate about one-third of the land in a cotton crop, about one-third of the land in a wheat crop, and the remaining land in a leguminous crop.

2. The Tenant shall pay the Company the sum of 412 to 512 piastres for each feddan as rent on the land cultivated for cotton, and the sum of 258 piastres for each feddan of land cultivated for crop, and the sum of 154 piastres for each feddan of land cultivated for leguminous crop, as rent.

3. The Tenant shall pay rents due on each crop at the time of harvesting such crops, and all other moneys due to the Company shall be paid on or before the 30th April, 19_____.

4. The Company shall supply the necessary water for irrigation of the various aforesaid crops according to the rules of cultivation, but in case of any compulsory circumstances preventing the water from reaching the land at any time, or on account of any machine being

broken, or any other compulsory reason, the Tenant shall have no claim against the Company for any compensation on account of the water not reaching the land under cultivation, but this is without any prejudice to any claim that the tenant may have to reduction of rent.

5. The Tenant shall deliver back to the Company the land cultivated in cotton and leguminous crops free of all cultivation, together with all gadwells claim and in proper working order on the 1st day of April, 19__, and the land cultivated in wheat crop in like manner on the 30th of April, 19__.

6. The Tenant shall not sublet the land or any part thereof without the written permission of the Company.

7. As the land is let to the tenant without security, which is contrary to the custom in similar cases, the Tenant agrees that all livestock in his possession and crops shall be a security for the rights of the Company, and the Tenant therefore engages himself not to remove or dispose of any of his livestock and crops without the written consent of the Company unless it has received the rent for the whole year, and all advances and other sums of any kind due to it. The Company's rights are a first charge on the Tenant's livestock and crops, and in the event of the Tenant becoming insolvent, or making any arrangement with his creditors, or if any legal execution takes place against any of his property the Company may seize his livestock and crop or whatever the law allows.

8. The Tenant shall in all things obey the reasonable orders of the Company's officials in all matters relating to the cultivation, irrigation, and harvesting of the aforesaid crops. In case of the Tenant becoming careless in the cultivation of his crop the Company shall have the right, without the consent of the Tenant, to seize his livestock and crops, and take such steps as the Company may consider proper for the safeguarding of the crops, and any expenses incurred thereby shall be charged against the Tenant, and shall be recoverable from the proceeds of his livestock and crops without waiting for the consent of the Tenant.

9. In the case of any tenant who, in the opinion of the Company, shall be in need of advances in money or kind to enable him to cultivate and harvest his crops, the Company will be prepared to make such advances at such times, on such conditions and to such extent as the Company shall in its absolute discretion think fit. But in the event the Tenant becoming careless or using such advances for other purposes, the Company shall discontinue such advances, and shall have the right to take such steps for the safeguarding of the crops as are mentioned in Clause No. 8 of this agreement.

10. The English copy of this contract is the official contract. The Arabic translation is merely for the information of the Tenant.

Interest at 8% per annum on advances.

Signed by The Tenant__________________

The Company__________________

Zeidab__________________19____

APPENDIX 45

COPY OF AGREEMENT WITH TENANTS AT THE GEZIRA AGRICULTURAL EXPERIMENTAL STATION (TAYIBA).

Managers:

THE SUDAN PLANTATION SYNDICATE LTD.

An agreement made between_________________ of the first part hereinafter called "The Tenant" and the Sudan Plantation Syndicate Ltd. (acting as managers for the Gezira Agricultural Experimental Station) hereinafter called "The Company" of the second part.

Whereas the said tenant has leased from the Company_________ feddans of land at Tayiba for the cultivation of cotton, wheat and leguminous and other crops, and the said tenant having seen the land specified, and having a thorough knowledge of its boundaries.

Now it is hereby agreed between the parties:-

1. The Tenant shall cultivate about one-third of the land in a cotton crop, about one-third of the land in a wheat crop, and the remaining land in leguminous and other crop.

2. The rent for the aforementioned________ feddans shall be at the rate of________ piastres per feddan.

3. The Tenant shall pay rents and all other monies due to the Company on or before the 15th March, 19___.

4. The Company shall between the 15th July and last day of February following supply water necessary for the irrigation of the various aforesaid crops according to the rules of cultivation, but in case of any compulsory circumstances preventing the water from reaching the land at any time, or on account of any machine being broken, or any compulsory reason, the tenant shall have no claim against the Company for any compensation on account of the water not reaching the land under cultivation; but this is without prejudice to any claim that the Tenant may have to reduction of rent.

5. The Tenant shall deliver back to the Company the land free of all cultivation, together with all gadwells: (channels) clean and in proper working order on the first day of April, 19__.

6. The Tenant shall not sublet the land or any part thereof without the written permission of the Company.

7. As the land is let to the Tenant without security, which is contrary to the custom in similar cases, the Tenant agrees that the crops and all animals belonging to the Tenant shall be a security for the rights of the Company, and the Tenant therefore engages himself not to remove any of the crops or animals without the written consent of the Company unless the Company has received the rent for the whole year and all advances and other sums of any kind due to it. The Company's rights are a first charge on the crops and animals and in the event of a Tenant becoming insolvent or making any arrangements

with his creditors, or if any legal execution takes place against any of his property the Company may seize the crop and animals.

8. The Tenant shall in all things obey the reasonable orders of the Company's officials in all matters relating to the cultivation, irrigation and harvesting of the aforesaid crops. In case of the Tenant becoming careless in the cultivation of his crop the Company shall have the right without the consent of the Tenant to take such steps as the Company may consider proper for the safeguarding of the crops, and any expenses incurred thereby shall be charged against the Tenant, and shall be recoverable from the proceeds of the crops without waiting for the consent of the Tenant.

9. In case of any Tenant who, in the opinion of the Company, shall be in need of advances in money or kind to enable him to cultivate and harvest his crops, the Company will be prepared to make such advances at such times, on such conditions, and to such extent as the Company shall in its absolute discretion think fit. But in the event of the Tenant becoming careless or using such advances for other purposes, the Company shall discontinue such advances, and shall have the right to take such steps for the safeguarding of the crops as are mentioned in Clause 8 of this agreement.

10. The English copy of this contract is the official contract. The Arabic translation is merely for the information of the Tenant.

Zeidab_________________191___.

Signed by:-

The Tenant______________________

The Company_____________________

APPENDIX 46

LIST OF TENANTS EJECTED FROM WAD-EL-NAU AREA, SEASON 1923-24

Names and Reasons for Expulsion

Hamad-el-Nil Station:

(1) Dafalla Mohammed-el-Khalid Monsour: Seen once, no work done.
(2) Mohammed Mustafa Mohammed Kheir Fazari: Impersonating rightholder.
(3) Aly Mustafa Mohammed Kheir Fazari: Impersonating rightholder.
(4) Magdub Mohammed Ahmed: No work done and continually absent.
(5) Guma-el-Imam: Disappeared.
(6) Ali Fazari Mohammed Kheir Fazari: Impersonating rightholder.
(7) Mohamed-el-Amin Mustafa: Impersonating rightholder.

Darwish Station:

(8) Abdalla Mohammed Ali: Though this man received his hoshia in the middle of May, all the work that he had done by the 4th of July, when a new tenant was put in, was assessed at 5 P.T. He was not a rightholder. Present tenant, Hassan Hossein, who is not a rightholder.
(9) Abdel Rahman Nourain Sherf: Ejected. Had no work done two months after he had been given the hoshia. Was a rightholder in place of his father, who at the time would not take a hoshia, but now has one.
(10) Ali Bella Hameidon: Ejected. Built his tukle (hut) and dug part of water channel and this disappeared for three months. He is a partner of the present tenant, Mohammed Ahmed el-Fikki. Neither is a rightholder.
(11) Ababas Mohammed el-Hossein: Ejected as he did not turn up for three months after he had been given the hoshia. Was replaced by Abdel Gadir Sheikh Sateh, who is not a rightholder.
(12) Ahmed Mohammed Abdel Rahman: Ejected as he did not turn up. Was not a rightholder.
(13) Khalafalla Abdalla: Ejected as he did not turn up; not a rightholder. Replaced by Abdel Rahim Ahmed Yousef, also not a rightholder.
(14) Suleiman Abdel Hamid Babikr: Ejected as he did not turn up. Was not a rightholder. Replaced by Dafalla Mohammed Babikr.

Source: Memorandum No. 2. Appendix No. 1: Cmd. No. 2171 (1924), pp. 51-52

APPENDIX 47

THE SUDAN COTTON ORDINANCE, 1912

An Ordinance for improving and maintaining the quality of the cotton in the Sudan and other purposes.

It is hereby enacted by the Governor-General of the Sudan in Council as follows:

Short Title

1. This Ordinance may be cited as the Cotton Ordinance, 1912.

Interpretation

2. In this Ordinance the Director of Agriculture means the Director of Agriculture and Forests, and includes any person duly authorised to act on his behalf.

Import of Cotton Seed

3. No cotton seed shall be imported in the Sudan except in accordance with such rules as may be framed under Section 16, or until such rules shall be issued under a permit granted by the Director of Agriculture.

In Prescribed Areas Cotton Seed to be Supplied or Approved By Director of Agriculture

4. The Governor-General in Council may from time to time prescribe areas or districts, and in such areas or districts as may be prescribed no cotton seed may be used for sowing unless supplied for the purpose by or under the authority of the Director of Agriculture, or approved by the Director or an Inspector of that Department.

In Prescribed Areas Cotton to be Picked Clean

5. In such areas or districts as may be prescribed by the Governor-General in Council cotton must be picked clean, free of all leaves, bolls, and dirt, and none but clean cotton shall be sold or offered for sale.

In Prescribed Areas Old Cotton Plants to be Destroyed

6. (i) In such areas or districts as may be prescribed by the Governor-General in Council the occupier and owner of any land shall be responsible to destroy all cotton plants on such land after the first season's crop has been picked from them, and on no account shall cotton plants be allowed to remain for a second season or more than one year in the ground.
(ii) Provided nevertheless that the Director of Agriculture may by permission in writing exempt the owner or occupier of any plot of land from the obligation imposed by the last sub-section.

Licenses for Ginning Factories

7. (i) No person shall erect or use a ginning factory or permit the same to be used unless he holds a license from the Director of Agriculture.

7. (ii) The owners of all ginning factories existing upon the publication of this Ordinance shall be entitled to obtain a license upon application to the Director of Agriculture within three months from the publication of this Ordinance.

Conditions and Renewal of Licenses

8. (i) Licenses shall be issued in accordance with conditions imposed or framed from time to time by the Governor-General in Council under Section 16, and for such periods as the Governor-General in Council may from time to time decide. They shall be renewable at the expiration thereof unless there have been breaches in respect of the ginning factory of the provisions of this Ordinance, or of any regulations issued under this Ordinance.

Revocation of Licenses

(ii) A license may be revoked by the Director of Agriculture for breach in respect of the ginning factory of the provisions of this Ordinance or of any regulations issued under this Ordinance.

Transfer of Licenses

(iii)A License shall not be transferable except with the consent in writing of the Director of Agriculture.

Inspection of Ginning Factories

9. Every ginning factory shall at all times while working be open to the inspection of the Governor, or of an Inspector of the province, or an official duly authorised by the Director of Agriculture.

Separation of Cotton Seeds

10. (i) Different varieties of cotton shall be kept separate previous to ginning and shall be ginned separately.
(ii) The gins shall be carefully cleaned of all seeds of one variety before the ginning of another variety is begun.

Use of Cotton Seed from Cotton Ginned in the Sudan

11. (1) Cotton seed from cotton ginned in the Sudan shall not be used for sowing in the Sudan unless in accordance with rules to be framed under Section 16, or, until such rules shall be issued, under a permit to be granted by the Director of Agriculture.

Regulations for Cotton Seed Leaving Ginning Factories

All other cotton seed produced in Sudan ginning factories shall not leave the ginning factory except for export or for such other purposes as may be permissible under rules to be framed under Section 16, or, until such rules are issued, under rules made by the Director of Agriculture with the Approval of the Governor-General in Council.

Employment of Children

12. No child shall be employed in any ginning factory unless he is over the age of nine years and is medically fit.

Fencing of Machinery

13. (a) Every flywheel directly connected with a steam engine or other mechanical power in any part of a ginning factory, and every part of a steam engine.
(b) Every hoist near which any person is liable to pass or be employed, and
(c) Every other part of the machinery, or mill gearing of a factory which may in the opinion of the Inspector of the province be dangerous if left unfenced, and which he may have ordered to be fenced:

shall while the same is in motion be kept by the occupier of such ginning factory securely fenced.

Any order under clause (c) may be set aside on appeal or otherwise by the Governor of the province.

Precautions Against Fire

14. The occupier and manager of every ginning factory shall be responsible to keep in good order and in accessible positions in the factory a sufficient supply of fire buckets or other means for extinguishing fire.

Notice of Accidents

15. When any accident occurs in a ginning factory, causing death or bodily injury, whereby the person injured is prevented from returning to his work in the factory during 48 hours next after the occurrence of the accident, the occupier of such factory, or in his absence his principal agent in the management of such factory, shall give notice of the accident to the Mamur of the district within 24 hours of the occurrence of the accident, or in the event of it not being ascertained within that period that the accident is one of which notice is required to be given, shall give such notice within 24 hours of this being ascertained.

Power to make Rules

16. The Governor-General in Council may make rules for the purpose of maintaining or improving the quality of cotton grown in the Sudan, and for the regulation of the working of ginning factories, and for protecting the health and safety of persons engaged therein, and in particular he may:-
(a) Prohibit the cultivation and export of cotton of inferior quality, or of any particular kind, or of all cotton other than specified kinds or qualities.
(b) Prohibit the export of unginned cotton.
(c) Regulate the import, distribution, or use of cotton seed, or prohibit the import, distribution, or use of cotton seed of inferior quality, or of any particular kind, or of cotton seed other than certain specified kinds or qualities.
(d) Make regulations for the sowing and use for other purposes of cotton seed from cotton ginned in the Sudan, and provide for the inspection of cotton seed and cotton ginned or unginned.
(e) Make regulations for factories, for the issue of licenses under Section 8, for their inspection, and for the ginning, baling, and interpretation of cotton and cotton seed.
(f) Make regulations with respect to the hours and conditions of labour of children and young persons in ginning factories.

16. (g) Make regulations for grading or classifying, and for making it compulsory for cotton to be graded or classified by an official classifier, and for the making of bales of cotton or parcels of cotton seed, and for the prevention of the export of cotton, which is not graded, classified and marked.
(h) Make regulations requiring cultivators, owners, and managers of ginning factories and others to furnish such statistics in connection with their business as may be determined.
(i) Fix penalties not exceeding a fine of £E.10 for contravention of any regulation.

Penalties

17. Any person who in breach of this Ordinance or of any order or rule made thereunder:-
(a) Import cotton seed contrary to Section 3.
(b) Uses cotton seed contrary to Section 4.
(c) Suffers cotton to be picked, otherwise than in accordance with, or sells or offers for sale or purchases cotton contrary to Section 5.
(d) Suffers cotton plants to remain in land occupied by him for more than one year contrary to Section 6.
(e) Erects or uses a ginning factory without license contrary to Section 7.
(f) Refuses an authorised official access to any part of a ginning factory contrary to Section 9.
(g) Mixes different varieties of cotton or gins together different varieties of cotton to Section 10.
(h) Removes or suffers any cotton seed to leave a ginning factory contrary to Section 11.
(i) Allows any child to perform forbidden by, or to work in contravention of Section 12.
(j) Neglects to fence any machinery in contravention of Section 13.
(k) Neglects to provide or keep in good order such fire buckets or other means for extinguishing fire in contravention of Section 14.
(l) Neglects to send any notice or to furnish any return in contravention of Section 15.

Shall be punished with a fine which may extend to £E.10.

Provided that no prosecution shall be instituted except with the previous sanction of the Governor or Director of Agriculture.

Cotton and Seed May Be Confiscated When An Offence Is Committed

18. Any cotton or cotton seed in respect of which any offence under any section of or under any of the regulation made under this Ordinance has been charged or is suspected of having been committed, shall be liable to seizure by a magistrate, police officer, or custom officer, and cotton or cotton seed in respect of which any person has been convicted of an offence under any section of or under any regulation made under this Ordinance may by order of a magistrate of the first second class be confiscated.

Burden of Proof as to Age of a Person

19. When an act or omission would, if a person were under nine years of

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age, be an offence punishable under this Ordinance and such person is in the opinion of the Court apparently under that age, it shall be on the accused to prove that such person is not under that age.

By What Court Offices Triable

20. Offences may be tried by a magistrate of the first or second class and summarily or otherwise.

Made by the Governor-General of the Sudan in Council this 11th day of November 1912.

(signed) G.F. CLAYTON, Secretary to Council

(signed) REGINALD WINGATE Governor-General

THE COTTON REGULATIONS, 1913

Issued under the Cotton Ordinance, 1912

In accordance with the provision of Sections 3,4,5,6 and 16 of Cotton Ordinance, 1912, the Governor-General in Council hereby orders and prescribes as follows:-

Districts Prescribed Under Section 4

1. The district of Tokar, Red Sea Province, is a prescribed district to which the provisions of Section 4 of the Ordinance shall apply.

Hence no seed other than that supplied for the purpose by or under the authority of the Director of Agriculture or approved by the Director or an Inspector of that Department shall be shown within the limits of the said district.

Approval of the Director of Agriculture or an Inspector of that Department will not be given for the introduction of any variety or varieties of cotton seed for sowing in the said prescribed district other than a variety or varieties previously notified in the Sudan Government Gazette.

Districts Prescribed Under Section 5 and 6

2. The province of the Red Sea, Kassala, Blue Nile, Sennar, Khartoum and Berber are prescribed districts to which the provisions of Section 5 and 6 shall apply.

Hence within the limits of these said provinces cotton shall be picked clean free of all leaves, bolls, sand and dirt, and none but clean cotton shall be sold or offered for sale. The occupier and owner of any land shall be responsible to destroy all cotton plants on such land after the first season's crop has been picked from them, and on no account shall cotton plants be allowed to remain for a second season, or more than one year in the ground.

Cotton Not to be Placed on the Bare Ground

3. In the districts mentioned in the last clause all cotton must be picked into sheets, baskets, or other receptacles, and when picked must not be placed on the bare ground.

Species of Cotton Prohibited Under Section 16(a)

4. The cultivation and export of the species of indigenous cotton known as "Abu Hareira", is hereby prohibited in Sennar Province.

Prohibition of Export of Unginned Cotton Under Section 16(b).

5. The export of unginned cotton from the Sudan is prohibited unless under a written permit from the Director of Agriculture.

Provided nevertheless that this prohibition shall not extend to the export by land of unginned cotton into Abyssinia and Erytrea.

Permit to Import Cotton Seed

6. Whereas by virtue of Section 3 of the Ordinance no cotton seed may be imported into the Sudan except under a permit from the Director of Agriculture, applications for permit to import cotton seed must be made to the Director of Agriculture in writing, and must give full particulars of the quantity, variety and place of origin of the seed it is proposed to import.

The Director of Agriculture shall not grant a permit unless satisfied as to the quality and origin of the cotton seed.

Unless otherwise stated in the permit, cotton seed may be imported into the Sudan through Port Sudan only.

Cotton Seed to be Fumigated on Import

7. Cotton seed imported into the Sudan from places other than Egypt shall, and from Egypt shall, if so required by the Director of Agriculture, before crossing the Customs boundary, be submitted by the consignee or owners to fumigation to the satisfaction of an Inspector of Sub-Inspector under the Plants Diseases Ordinance, 1911, and the Customs Authorities shall not allow such cotton seed to cross the Customs boundary unless the importer produces a certificate signed by such Inspector or Sub-Inspector that the fumigation has been carried out.

Tokar Cotton to be Officially Classified and Weighed

8. (i) All cotton grown in the Tokar District must be brought into the Tokar Cotton market to be there classified by the official classifier and weighed by the official weigher.

All bales or bags containing such cotton shall be marked by the official classifier with the Government mark, and as cotton shall be put up for sale in the market unless so marked.
(ii) It is prohibited to move cotton grown in the Tokar district out of the district unless in bales or bags bearing the Government mark.

Destruction of Noxious Weeds

9. The occupiers of cultivated land in the Tokar plain must destroy all noxious weeds, such as "hambuk" and "ushur" and other plants likely to harbour pests on their land.

Fees in Tokar Cotton Market

10. The Governor of the Red Sea Province may by public notice fix fees for the official classification, weighing and marking of cotton in Tokar cotton market.

No cotton in respect of which any such fees are payable may be removed from the Tokar cotton market until the fees have been made.

Cotton Growing Elsewhere than in Tokar District

11. Unginned cotton which has been grown in any district other than Tokar shall not be brought into the Tokar cotton market nor passed off as, nor mixed with, cotton grown in the Tokar district at any time while in the Sudan.

Cotton Intended for Export not to be Adulterated

12. Cotton intended for export shall not be adulterated with any other substance.

Licenses for Erecting or Using Ginning Factories

13. Licenses for ginning factories shall be annual and shall be renewable on the 1st day of January in every year. They shall be in the form set out in the Schedule (see below).

Applications for licenses shall be addressed to the Director of Agriculture, Khartoum, by letter, and should state:-

(i) The name and residence of the owner,
(ii) The situation of the ginning factory,
(iii) Detailed information of the number and kinds of gins and presses erected or to be erected.

Employment of Children

14. (i) No child under the age of nine years shall be permitted to enter the work rooms in any factory.
(ii) No child between the age of nine and 12 years shall be employed in any factory unless he has been examined by a Government medical officer, who has certified his age and that he is fit for such work.
(iii) Such certificate must be produced on demand by the Governor or Inspector of the Province or Mamur.

Hours of Work for Children

15. (i) No child shall be employed in any factory, nor permitted to remain in the work room in any factory during the night, that is, between 7 p.m. and 5 a.m.
(ii) No child shall actually be employed in any factory for more than seven hours in any one day.

Interval of Rest

16. Every child who is actually employed in any factory for six hours in any one day shall be allowed an interval or intervals of rest amounting in the aggregate to at least half an hour.

17. Children not to be employed near dangerous machinery.

18. Table of Hours of Work for Children.

19. Statistics to be provided by Managers or Owners of Ginning Factories.

20. Penalty.

THE SCHEDULE

Form of License

(Issued Under the Cotton Ordinance, 1912)

to enable

(Name)____________________________________

(Address)______________________________

to erect and *use a cotton ginning factory of ≠_________gins and ≠______ presses at__________________________ of the following description:

(Insert full particulars as to kind of gins and presses.)

____

____

This license is renewable on the 1st day of January, 19____, and is not transferable save with the written consent of the Director of Agriculture and Forests. It is revocable by the same authority for breach in respect of the ginning factory of any of the provisions of the Cotton Ordinance, 1912, or of any regulations issued from time to time under the said Ordinance.

(Signed)
Director of Agriculture and Forests

Date____________________ day of ____________________19_______

(Signed)__________________
Secretary To The Council
__________day of_______19___

(Signed)________________
Governor-General

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* Cancel italicised words if factory already erected

≠ Insert No. of gins and presses

APPENDIX 38

TABLE 48a METEOROLOGICAL DATA, MEDANI, 1918/19-20

Period		Maximum Av. Temp.	Minimum Av. Temp.	Humidity
1919		F°	F°	%
September	1-15	99.1	72.7	64
September	16-30	99.3	71.4	61
October	15	102.9	70.7	45
October	15-31	105.6	71.6	43
November	1-15	104.0	65.3	34
November	16-30	98.4	61.3	26
December	1-15	97.3	57.4	31
December	16-31	96.3	57.7	33
1920				
January	1-16	95.7	59.5	43
January	16-31	90.5	54.1	21
February	1-15	91.2	56.5	25
February	16-29	93.6	55.8	33
March	1-15	98.4	59.4	26
March	15-31	108.9	66.4	30
April	1-15	108.1	62.2	23
April	16-30	105.6	60.1	41
May	1-15	103.5	72.1	19
May	16-31	101.5	72.1	51
June	1-15	111.8	73.2	57
June	16-30	104.5	70.7	63
July	1-15	100.9	70.3	73
July	16-31	101.3	69.3	71
August	1-15	97.5	70.5	73
August	16-31	92.1	75.7	77

TABLE 48b TEMPERATURE AND THRIPS

Month	Max. Av. Temp.		Min, Av. Temp.		Incubation Period of Egg				Av. Length of Larval Stage			
					Max. No. of Days		Min. No. of Days					
	1919	1920	1919	1920	1919	1920	1919	1920	1919	1920	1919	1920
Feb.	100.2	92.4	59.5	56.1	15.0	15.0	9.0	13.0	12.0	14.0	6.0	-
March	104.4	103.6	63.7	62.9	11.0	9.7	6.0	8.2	8.5	8.9	4.3	5.2
April	107.1	106.8	65.1	61.1	9.0	-	4.0	-	6.5	-	4.0	3.8
May	107.6	105.0	72.1	72.1	-	-	-	-	-	-	3.7	-

Source: H.W. Bedford, (1912), op. cit., pp. 4-6