SUDAN GOVERNMENT.

DEPARTMENT OF AGRICULTURE AND FORESTS.

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THE CULTIVATED CROPS OF THE SUDAN INCLUDING COTTON.

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INCLUDING COTTON.

INTRODUCTION.

Frequent enquiries are received regarding cultivation in the Sudan — especially in connection with cotton.

To provide some information in a handy form I have written this article.

I hope also that the information will be of use to officials generally — more especially to those who have newly joined the service and are interested in agriculture.

I must point out that the article has been written at odd moments in my spare time, after office hours etc..

Owing to pressure of official work it has been impossible to devote the attention to its compilation which one would desire.

Later if opportunity permits I hope to deal with the ground covered more completely; and in more detail.

To facilitate understanding of the article I would draw the reader's attention to the glossary of Arabic terms, the table of equivalents in currency, weights and measures ; and the map at the end.

W. A. D.

Khartoum,
1st January 1924.

GENERAL DESCRIPTION

OF

AGRICULTURAL CONDITIONS AND ANALYSIS OF AREAS CULTIVATED.

The Sudan embraces some one million square miles of territory. It is bounded on the North by Egypt, on the West by French Equatorial Africa, on the South by the Belgian Congo and the Uganda Protectorate, on the East by Abyssinia, Eritrea and the Red Sea. It lies North of the Equator and stretches from the 4th. to the 22nd. parallel of latitude. In this enormous tract the wide variations in climatic conditions are reflected in the plant and animal life—the main factor of influence being the amount of rainfall.

Starting from Halfa which lies near the 22nd. parallel and close to the boundary with Egypt we pass through what is practically desert country until we reach the 18th. parallel. In this belt the rainfall—in many years practically non-existent—is too light for the production of crops and cultivation is confined to a narrow strip along the banks of the Nile where also is found the bulk of the population.

From the 18th. to the 15th. parallel the rainfall improves but is still too precarious for normal rain cultivation. The population is still mainly riverain but whilst based on the river the people turn their attention to rain crops with which in occasional years they are fairly successful. In this area scrub and grass have considerably improved and nomadic tribes with herds of camels, goats and sheep are in evidence.

From the 15th. to the 13th. parallel the rainfall has still further improved : and in the main we have now passed into an area where in ordinary years rain crops can be grown.

In this belt we find the main rain cultivation of the Sudan : the people are no longer confined to the rivers but scattered over the country. The amount of grazing and number of livestock has now largely increased. From the 13th. parallel to the 10th. we pass into heavier scrub country and grass land where the rainfall is sufficient for the production of crops but where a cultivating population is less in evidence—except in the south west corner of the area.

In this belt we find large herds of cattle and sheep.

From the 10th. parallel to the 4th. we pass into an area of still heavier rainfall. Here the tribes are mainly pastoral, are possessed of large herds of cattle but do not incline to cultivation save in the most meagre form.

In this area we find the forests of the Sudan capable of yielding timber but so far removed that economic exploitation under present conditions is impossible.

Bearing the foregoing in mind we may for convenience divide the country broadly into three belts based on the amount of rainfall (1) a northern belt from the 22nd. parallel to a line running from a point between Kassala and Tokar passing through between Khartoum and Kamlin and running south westerly through a point north of El Obeid. In this northern belt the rainfall is hardly existent or at best precarious and we may regard this zone as practically arid, (2) the middle belt with its southern boundary marked by a line running from Gallabat, through Roseires and Kodok and thereafter proceeding more or less due west. In this middle belt the rainfall is sufficient for the cultivation of rain crops such as dura, dukhn, semsem etc. and a certain amount of cotton and in this zone we find the bulk of the cultivation today. (3) The southern zone lying south of the Gallabat, Roseires-Kodok line is marked by a wealth of natural vegetation, a population not inclined to cultivation, and lack of transport but undoubtedly this zone possesses great potentialities more particularly for the growth of rain cotton.

The rains occur in the summer falling mainly in the months of July, August and September in the middle belt—this period being shortened in the northern and prolonged in the southern belt.

In the Northern belt the total annual rainfall ranges from next to nothing at the extreme north to an average of some 10 inches as we reach the southern limit: in the middle belt the average ranges from some 10 inches in the north to some 30 inches in the south: in the southern belt the average may be taken similarly as ranging from 30 to 50 inches. In the northern belt the months April to June are very hot and dry: in the rainy season July to September the temperature falls: November to March is cooler and may be considered the winter.

As we proceed south the range of temperature between summer and winter is less marked as also is the diurnal range.

Except in the rainy season the atmosphere is very dry.

CULTIVATION IN THE SUDAN.

The cultivation may be divided into rain, flood and artificial according to the water supply.

The Sudan is served by the White Nile, the Blue Nile, the Nile, the Atbara and the Sobat. These are the main rivers. Apart from these and their tributaries there are various khors which flow only during the rainy months notably the Gash and the Baraka.

These rivers rise during the rainy months and inundate large areas along their banks. As the rivers fall these inundated areas become suitable for sowing and give rise to flood cultivation. Some like the Gash and Baraka form rich alluvial deltas which are very suitable for cultivation.

Under artificial is included land cultivated by means of water raised from the rivers by pumps, water wheels and leather buckets.

The following table shows the total area in Feddans of land cultivated in the Sudan from 1905 to 1921 that is during a period of 17 years.

Year.	Rain	Flood	Artificial	TOTAL
1905	846,103	84,116	198,312	1,128,531
1906	951,628	95,241	117,073	1,163,942
1907	1,186,514	116,697	120,760	1,423,971
1908	907,769	82,639	115,767	1,106,175
1909	1,288,677	148,015	102,073	1,538,765
1910	1,569,296	112,387	106,746	1,788,429
1911	1,192,265	117,676	116,556	1,426,497
1912	1,582,740	143,665	120,616	1,847,021
1913	2,025,710	98,957	130,559	2,255,226
1914	1,926,627	78,758	58,327	2,063,712
1915	2,247,917	120,381	95,674	2,463,972
1916	1,298,258	99,089	92,227	1,489,574
1917	1,685,928	292,972	105,885	2,084,785
1918	1,859,700	289,723	115,321	2,264,744
1919	1,437,193	132,545	113,911	1,683,649
1920	1,642,222	151,410	114,887	1,908,519
1921	2,624,645	145,358	125,657	2,895,660

The average area cultivated annually for the 17 years from 1905 to 1921 is :—

Rain	Artificial	Flood	Total.
1,545,482	114,726	135,861	1,796,069

which expressed in percentage of the total area becomes

86% Rain.
6.4% Artificial.
7.6% Flood.

The two outstanding features of interest in this table are firstly the small total area cultivated ranging from rather over a million feddans in the poorest to under 3 million feddans in the best year with a gross area of some 640 million feddans in the country: and secondly the large percentage under rain cultivation—out of an average annual area of some $1\frac{3}{4}$ million feddans cultivated there being some $1\frac{1}{2}$ million feddans under rain cultivation.

The above figures must be taken only as r o u g h l y approximate—especially the rain areas ; the figures for artificial and flood are more approximate.

No area of cultivation is included for Darfur, as no returns have yet been made.

The areas of cultivation exclude areas exempt from taxation e.g. in Kordofan—also exclude considerable areas cultivated but with crops too poor for assessment.

MAIN CROPS IN THE SUDAN.

The main crops grown in the Sudan are Dura (*Sorghum vulgare*), Dukhn (*Pennisetum typhoideum*), Semsem (*Sesamum indicum*) and Cotton. The three first mentioned are grown mainly under rainfall and the last (cotton) mainly under artificial irrigation and on naturally flooded land.

The following analysis shows the average areas in feddans for these crops under rain, artificial and flood irrigation for the years 1905 to 1921 and for comparison the areas similarly for the years 1920 and 1921.

DURA.

Average	Rain.	Artificial.	Flood.	TOTAL.	Percentage of gross total area cultivated in the country.
1905 to 1921	1,073,688	32,817	56,628	1,163,132	64%
1920	1,144,493	25,827	39,400	1,209,720	63%
1921	1,908,627	27,412	37,388	1,973,427	68%

DUKHN.

1905 to 1921	328,232	4,238	12,014	344,484	19%
1920	351,374	4,647	17,278	373,299	19%
1921	513,475	6,654	14,642	534,771	18.4%

SEMSEM.

1905 to 1921	92,222	2,180	38	94,440	5.2%
1920	108,583	2,208	—	110.791	5.7%
1921	160,007	1,085	—	161,092	5.5%

COTTON.

1905 to 1921	5,544	9,856	30,654	46,054	2.5%
1920	2,055	14,308	42,663	59,026	3 %
1921	3,981	17,542	59,907	81,430	2.8%

From the foregoing analysis it will be seen that of the total area cultivated in an average year in the Sudan.

64%	Dura.
19%	Dukhn.
5.5%	Semsem.
3 %	Cotton.

The balance of the gross area cultivated is accounted for by the minor crops—the chief of which are Earthnuts, (*Arachis hypogaea*), Lubia, (*Dolichos Lablab*), Wheat, Maize. Barley.

The following table shows the average area under these crops for the 17 years 1905 to 1921, and the areas under rain, flood and artificial irrigation respectively for the year 1920 and is inserted here for convenient reference.

MINOR CROPS IN FEDDANS.

	YEAR 1920.				Average for 17 years 1905 to 1921
	Rain	Flood	Artificial	TOTAL	
Earthnuts	25,348	63	1,076	26,487	12,605
Lubia ...	7,111	28,762	15,625	51,498	34,841
Wheat ...	—	3,702	15,506	19,208	22,551
Maize ...	2,394	7,824	22,073	32,291	19,208
Barley ...	—	2,725	2,813	5,538	9,634

MILLET—*Sorghum vulgare*—(Arabic Dura).

This is the staple food of the people and is the crop most widely cultivated. It is by far the most widely sown rain crop: is also grown on naturally flooded land and on land artificially irrigated.

On rainland the amount and regular distribution of the rainfall is the deciding factor towards a successful crop.

The great area of production is the middle belt, the chief area being the Gezira. Where the rainfall is light the land is generally "terassed" *: this consists in running light earthen training banks across the slope of the land thereby holding up the surface rainwater and applies generally in the northern end of the dura belt.

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* By means of a "teras" the rain water is held up, and the water storage thereby increased.

In the "diagram" A B is the retaining bank: the land slopes in the direction of the arrow heads. The lower end of such a 'teras' is known as the "hugna" and being more heavily irrigated is generally more productive: the upper end is known as the "Sudra".

The bulk of the dura crop is grown on land with an average rainfall varying from 10 to 25 inches. Land with an average rainfall of 10 to 15 inches is "terassed" : with a heavier rainfall "terassing" is less in evidence and disappears almost entirely as 20 inches is approached.

Method of Cultivation :—

Little preparation is given to the land beyond seeing that the rain "terasses" are repaired prior to the rainy season.

Time of Sowing :

In the main dura belt sowing takes place as soon as the land has been soaked and the rains are assured i.e. towards the end of July.

Method of Sowing :—

On rainland dura is sown by seluka stick in even rows about I metre apart with 80 cms. between the seed holes,

Amount of Seed : —

7 to 10 rotls seed are required per feddan. A man and a boy will sow one feddan per diem — the man prepares the seed holes with the seluka stick and the boy follows dropping the seeds into the hole which he covers by raking the loose soil with his foot.

Thinning :—

When about a foot high the plants are thinned and 4 to 5 left in each hole.

Hoeing :—

On an average the land is twice hoed or "fassed". Four men should fass a feddan in a day under ordinary conditions.

Period of Growth :—

An average period of growth for the early maturing duras is 90 to 95 days. If the crop is somewhat hastened through lack of water a fair yield is obtained in 70 to 75 days.

Under heavy rainfall the period required is 110 to 120 days whilst on flooded land, e.g. the Gash delta late sown duras such as Aklamoi and Toleb require 130—145 days.

As a rule the varieties of better quality require more water and a longer period of growth : and generally they yield more heavily.

Harvesting :—

When ripe the heads are snipped off, collected and piled in a heap at the threshing floor.

Threshing :—

The grain is beaten out by means of sticks—somewhat after the manner of threshing by flail. The process is laborious and takes up much time.

In this respect a great saving in manual labour and time might be effected by the introduction of portable threshing machinery adapted for dura—the threshing machines being hauled and driven by a steam traction engine or some form of good tractor. These threshing plants might be run either by Government or private Companies and the charge for threshing might be based on a share of the crop calculated in cash or taken in kind.

Cleaning :—

This is done in the primitive way of throwing the grain in the air when the wind is favourable. At best the grain after being cleaned in this fashion contains a good deal of small stones and particles of earth.

Cleaning plants have been installed by the Government and by private enterprise and all dura for export passes through these cleaning plants.

Yield :—

The average yield per feddan varies greatly over the dura belt and is of course mainly dependent on the amount of rainfall received.

It may vary from under 1 ardeb where the rainfall has been unfavourable to 4 to 6 ardebs where conditions of rainfall etc. have been satisfactory. The average over the dura belt may be taken as 2 to 2½ ardebs of 300 rotls each–which may be reckoned as a fair average return on the ordinary rain cultivation.

Varieties :—

Many varieties of dura are found in the Sudan, each having its own particular merits

Feterita and Gassabi.

These are early maturing duras suitable for growth on land receiving a moderate to light rainfall.

Feterita is the most widely grown of all: is very drought resistant: matures early giving a yield in 70—75 days. The grain is white, of fair quality and is said to stand well in a matmura (a circular pit dug in the ground for storage).

Gassabi requires more water for growth than Faterita and where these two varieties are grown on "terassed" land, Gassabi will be found in the "hugna" or lower end of the "teras"; matures early, in 85—90 days or even earlier if hastened; gives a white grain of good quality which commands a higher price than Faterita.

Wadakr, Wad Massanet, Bahana.

These varieties are typical of heavier rainland.

Owing to the greater amount of water etc., they require a longer period of growth and take from 100 to 120 days to mature. Wad-akr gives a white grain: Wad Massanet and Bahana a red grain. These red duras are considered somewhat inferior but are less readily attacked by birds.

Aklamoi and Toleb

These varieties are grown on flooded land in the Gash delta. Both varieties required well flooded land and though requiring a long period of growth, they yield heavily and give grain of good quality.

Mugid and Feki Mustahi

These varieties are grown on sakia land under artificial irrigation: also on gerf land as the Nile flood falls. They require a good deal of water, have a fairly long period of growth (120 days) but under suitable conditions give heavy yields and grain of excellent quality—especially that of Feki Mustahi.

Safra :—

A yellowish brown dura grown on flood land notably on the White Nile: also in the lower end of a rain teras on land of moderate rainfall.

The following table shows the chief varieties of dura grown in the Sudan (*see next page*).

CHIEF VARIETIES OF DURA IN THE SUDAN.

Name of Variety.	Place of growth.	GENERAL REMARKS.	Quality of Grain.
Mugid	Gerf	Tall heavy yielding dura white grain of good quality	1st Class (a)
Feki Mustahi... ...	Gerf and Sakia land...	Heavy yielding dura : naked grain yellowish white and of good quality ...	,, ,, ,,
Wad El Fahl ...	Sakia	Heavy yielder and grain good	,, ,, ,,
Gassabi	Hugna of teras in rain land ; and on Sakia land.	Medium height : yield medium : grain white ;	,, ,, (b)
Hegari	Hugna of well watered teras and Sakia land	Tall dura : grain yellowish white with characteristic shiny coat	,, ,, ,,
Aklamoi	Gash Delta and heavy rain land.	Characteristic large drooping head : yields heavily when plenty of moisture available : up to 10 Ardebs per feddan—time of growth 120 days when sown middle of July on rain land ; generally grown on Gash Delta where sown end of August and time of growth 130 days ;	—
Toleb	Gash Delta	A good dura—yields heavily : time of growth 140 days : sown end of August or beginning of September : withstands cold better than dura akalmoi...	,, ,, ,,
Baid El Warral ...	Hugna of teras or heavy rain land.	Found in small quantity : grain very white and individually large	,, ,, ,,
Abd El Kheir or Zirzera	do.	Medium height : characteristic is the small size of the grain, grain heavy ...	,, ,, ,,
Mikado or Shelshelly	Hugna of teras and anywhere with moderate rainfall.	Very tall : heads dark brown with characteristic bending attitude : naked grain white with shiny coat	1st Class (b)

CHIEF VARIETIES OF DURA IN THE SUDAN. — *(Continued).*

Name of Variety.	Place of growth.	GENERAL REMARKS.	Quality of Grain.
Safra	Hugna of teras : on land of moderate rainfall and on flood land.	Medium height : grain yellowish brown ... ... Largely grown on White Nile	1st Class (b).
Feterita Tawil ...	Hugna of teras : Heavy rain land	Variety found from Sabil southwards	2nd Class.
Feterita	Everywhere.	Most widely grown : gives good fodder : stands well in a matmura : white grain	,, ,,
Wadakr	Heavy rain land ...	Dura medium height : white grain	,, ,,
Hamaezi	Hugna of teras and heavy rain land.	Tall dura : grain light brown	,, ,,
Hegari Ahmar ...	cf. Hegari.	cf. Hegari, grain red with shiny coat	,, ,,
Had Kerrik	Hugna of teras on land with moderate rainfall.	Grain light red	,, ,,
Wad Massanet ...	Heavy rain land ...	Grown in large quantity near Singa : grain dull red ;	,, ,,
Bahana	do.	Found in quantity near Singa : grain dark brown	,, ,,
Dura Semsem Ahmar	Hugna of teras ...	Found in very small quantity : grain flat with hollow on one side : grain red	Special use.
Dura Semsem Abyad	do.	Grain white : this and the previous variety are roasted without crushing and eaten as a luxury	,, ,,

The weight of a kela of dura is approximately 27½ rotls.

The weight of an ardeb of dura equivalent to 12 kelas or 198 litres or 5.44 bushels is 330 rotls.* (approximately)

Ardebs of different volume are however in common use in different parts of the country.

Storage :—

Dura is generally stored in a circular pit dug in the ground —called a matmura.

The most common size of matmura contains 15—20 ardebs : the larger may contain 150 ardebs. The latter is the more profitable there being comparatively less waste. An old matmura is said to preserve the grain better than a new one from the fact that the interstices in the soil have become closed up in course of time.

Dura feterita is considered to stand storage best : varieties such as Hegari do not stand so well.

A peculiar sour musty smell is characteristic of dura kept in a matmura : the longer or more badly the grain has been kept the more marked is the smell. If badly kept the dura assumes a reddish tinge. The best soil for a matmura is that of fairly close texture and with good natural drainage.

When the hole has been dug, the dura is filled in until within 9 inches of the top : the dura cleanings are then laid on and the last 6 inches filled with earth which is continued about a foot above the level of the ground in order that the rain water may run off.

General :—

Since dura is the staple food of the people and is dependent on a rainfall varying from year to year, the tendency of the native though otherwise improvident, is to fill his matmuras in the good years and tide over the lean.

Nevertheless the production in a good rain year is far in excess of the country's requirements even allowing for the filling of the matmuras : and in good rain years there are considerable quantities available for export. The export may vary from

* See Table giving weights per kela of various seeds.

practically nothing to some 30 or 40 thousand tons per annum—the highest recorded being 85.000 tons in 1917 when war requirements led to an urgent demand for dura.

At the same time dura is primarily grown as a food supply and only incidentally finds a market abroad in good rain years.

The area cultivated is large but the yield per feddan is low and in the outside market the price obtained in competition with maize etc. is not remunerative enough to tempt cultivation of this crop for export pure and simple.

As a feeding stuff dura may be regarded as competing with maize, oats, barley and to a less extent wheat. In this connection comparative trials have been made with poultry, pigs, sheep dairy cows and fattening cattle which have proved dura a satisfactory food.

BULRUSH MILLET—*Pennisetum typhoideum*—**(Arabic Dukhn.)**

The cultivation of dukhn may be regarded as similar to that of dura.

Dukhn, however, requires less water, has a shorter period of growth and will grow on poorer and more sandy soil. Hence it is cultivated in preference to dura on sandy soil where the rainfall is light.

Dukhn is not so readily attacked by Budda (*Striga hermonthica*) a plant semi-parasitic on dura and readily distinguished by its red flowers. Again dura in certain districts suffers severely from stemborer and can with advantage be replaced by dukhn for a period.

The main area of dukhn production is Kordofan Province : a certain amount is also grown on the Red Sea Coast.

Dukhn like dura is primarily grown as a food crop.

SESAME—*Sesamum indicum*—**(Arabic Semsem.)**

Sesame is grown mainly on rainland though small quantities are grown under artificial irrigation.

Broadly it is grown on the areas receiving rather heavier rainfall in the main dura belt.

It requires a heavier rainfall than the early maturing duras.

The chief localities of growth are Kordofan where a brown variety is grown : Fung Province and the Southern part of Kassala Province in the Gedaref and Mefaza areas where a white variety is grown. The latter is also the variety grown under artificial irrigation.

The brown variety requires rather less rainfall and prefers a freer, more sandy soil.

Sowing :—

The usual method is to sow when the land is dry enough for light stirring—after the previous rain. The seed is "broad-casted and lightly turned in with the "milod"—each work-man taking in hand a strip about 2 metres wide. One quarter of a kela of seed is required per feddan. As the seed is small, this quantity should be mixed with fine dry sand to ensure uniform distribution.

The time of sowing varies for different districts but in general sowing should begin as soon as the rains are assured. This will generally be towards the end of July.

Thinning :—

When 6 or 7 inches high the plants require thinning. If the plants are left too thick there will be little save vegetative growth so that thinning is essential. As a rough guide, in a newly thinned patch, a man should just be able with care to thread his way through without treading down the stands.

Weeding :—

Weeding must be done by hand as the plants are too close together for work with "milod" or fas. Two weedings are sufficient and these are required in the early stages of growth.

Period of Growth :—

110-120 days are required for growth.

The ripening stage is marked by the stalk and leaves turning from dark green to pale yellow. Care must be taken that the semsem is not allowed to become dead ripe as the pods tend to burst and scatter the seeds very readily.

Harvesting :—

At the ripening stage the semsem should be examined daily and when the pods are nearly ripe, the crop is cut, bound

into sheaves and stacked. The final filling and ripening of the seed therefore takes place in the sheaf ; the sap from the stem is sufficient for this purpose and loss from shedding is avoided.

Threshing :—

The semsem having been stacked 6 or 7 days is very easily threshed. Old sacking should be laid down and the crop threshed on this to prevent admixture with dirt.

Most of the seed is knocked out by simply beating the sheaves on each other : and the process is completed by beating with a stick.

The seed is then cleaned in part by native sieves and in part by the primitive method of tossing the seed into the wind. Thus prepared, semsem for the local market contains a good deal of dirt but all semsem for export is passed through the Government cleaning plants.

Yield :—

The yield may be taken at 1½ to 2 ardebs on rain land : on land artificially irrigated an average yield may be taken at 4 ardebs.

General :—

From 1905 to 1918 the average total area under semsem annually was 86,000 feddans.

Recently there has been a general tendency to increase this crop and the average annual area may now be taken as some 120,000 feddans.

A large part of the crop is used locally.

The seed is crushed in native presses and gives a good edible oil. The refuse from the native press forms a good cattle cake.

There is a steady demand for export, the main market being Egypt, but shipments are also made to Marseilles etc.

The oil is used in confectionery, for cooking etc., for mixing with edible oils and to some extent in the tinning of fish. In Egypt the uncrushed seed very often is slightly roasted, made into small cakes and eaten as a sweetmeat.

COTTON.

Cotton is grown on land artificially irrigated and on land naturally flooded. A small amount is also grown on rain land.

The area of land naturally flooded varies widely from year to year so that under present conditions the annual area laid down to cotton varies considerably : and largely with the volume of the Baraka and Gash floods.

The average yearly area under cotton for the period 1905 to 1918 was approximately 42,000 feddans but in years of good natural flooding this has risen to close on 90,000 feddans.

During the same period the average annual area has been for cotton.

Under	Artificial Irrigation	9,000 feddans
,,	Rain	6,000 ,,
,,	Natural Flood	27,000 ,,

In the near future the main increase will be in land artificially irrigated in the great Gezira plain—the large triangular block of country lying between the Blue and White Niles with its apex at Khartoum. Here the area of cotton under artificial irrigation will increase rapidly when the Makwar Dam is completed. It is anticipated that this work will be finished in 1925 when 100,000 feddans of cotton will be irrigated yearly—this area being capable of expansion to 300,000 feddans in due course when arrangements have been made for additional water storage.

This will tend to steady the annual output of cotton from the Sudan.

Though the total area ot cotton is small compared with the area under dukhn and dura the importance of the cotton crop is not to be judged thereby. Of all crops so far tried in the Sudan cotton gives promise of being the preeminent crop of the country as it is in Egypt.

Cotton is grown entirely for export. The small amount of inferior cotton grown in the country and spun on native hand looms into "damur" is of no importance.

Two kinds of cotton are grown.

The Egyptian variety—long staple—is grown in the Gezira under artificial irrigation and on the Tokar and Gash deltas.

The variety has been changed from time to time in accordance with the variety of long staple in favour at the time in lower Egypt. Thus Abassi, Afifi, Nubari, Assili, and Sakellarides etc. have been grown with equal success. At the moment Sakellarides is the variety grown.

With careful handling the resulting crop of Sakel on the areas aforementioned is equal and frequently superior to Fully Good Fair Egyptian Sakel and sells in Liverpool as such.

Along the Nile north of Khartoum a long staple American is the favourite variety. It is true that some private estates in this neighbourhood still cling to Egyptian long staple but general experience has proved pretty conclusively that in this area an American long staple is more satisfactory.

The reason for the change from Egyptian to American as we proceed north along the Nile 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 we proceed northwards towards the Nubian desert. Cold snaps are at times experienced in December, January and February. In this region the season broadly is therefore as follows.

April, May, June and the first half of July are hot and dry. The second half of July, August and the first half of September are damp and comparatively cool—i.e. the rainy season. The second half of September, October and early November show a marked fall in humidity and a rise in temperature.

The result is that with early sown cotton—April and May—the plant during the rainy season, shows great vegetative growth and becomes possessed of a large area of leaf surface. With the rapid change to a dry and hot atmosphere in October transpiration through the large area 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 cannot be unnecessarily delayed.

Experience after several years has shown that a more quickly maturing variety e. g. American long staple—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.

At Tokar on the other hand which lies in proximity to the Red Sea the humidity throughout the growing season is much higher and the winter temperature is more equable. The same applies in a less degree to Kassala.

The fall in humidity, though greatly lessened and considerably retarded is still felt in the Gezira: but here the fall in humidity more nearly approaches the winter fall in temperature which diminishes considerably the adverse effect.

We may divide the cotton areas of the Sudan into four distinct localities—

1. The Gezira.
2. The deltas of the Baraka and the Gash—Tokar and Kassala.
3. The area on the Nile from Khartoum northwards.
4. The area in the Southern belt of heavier rainfall.

It is proposed to deal with these in turn.

THE GEZIRA.

The Gezira embraces roughly the triangular area lying between the Blue and White Niles with the apex at Khartoum and the base along the railway line from Sennar to Kosti. On this area when the Makwar dam is completed, one hundred thousand feddans will in the first instance be put under cotton yearly.

The dam is expected to be finished in 1925 so that in July 1925 some 80,000 feddans will be sown to cotton and the full area of 100,000 feddans in July 1926.

The Makwar dam is designed to act mainly as a barrage or weir but also partly as a reservoir. In the first place it raises the level of the river so that the gravitation canal taking off immediately above the barrage will irrigate the cotton tract by free flow—from 15th July to 18th January the water is therefore taken from the normal flow of the river. From the 18th January the water required for the irrigation of the cotton etc. will be drawn from the dam reservoir, and therefore during this period of low supply, the whole normal flow of the river will be allowed to pass.

As the cotton will be cultivated on a three course rotation—that is the same land will carry cotton only once every three years—, a block of 300,000 feddans will be required to provide for the 100,000 feddans of cotton in the rotation.

This block of 300,000 feddans comprises a very small portion of the Gezira plain, which contains as much as three million feddans between the 14th and 15th parallels of latitude with the possibility of a further million feddans from the 15th parallel to the apex at Khartoum. But owing to the limited amount of water available at low Nile it has been decided that 100,000 feddans cotton in the Gezira is all that can be allowed without detriment to Egypt until such time as further storage can be arranged either on the White Nile, at Lake Albert or in the Sudd : or on the Blue Nile in its upper reaches. Storage on the Blue Nile affects more particularly further development of the Gezira plain.

The first block for development in the Gezira plain—comprising a suitable area of 300,000 feddans—starts from a point 57 kilometres (36 miles approx.) north of Makwar near Hag Abdalla. It runs northwards parallel with the river and mainly west of the Government railway to Hassaheissa,

The block is some 85 kilometres long South to North and 14 to 25 kilometres wide, East to West, with an average width of some 18 to 19 kilometres being rather narrower at the extreme South and at the North end.

The site is ideal for an irrigation scheme.

The highest portion of the plain lies roughly along the line of the Government railway and therefore generally within a few kilometres of the Blue Nile. From this there is a pretty rapid slope to the bed of the Blue Nile but a very gradual slope down to the White Nile.

The plain as a whole has therefore a gradual slope to the north in the direction of the Blue Nile flow and a gentle slope to the west to the White Nile. The alignment of irrigation canals is therefore easy and uniform which facilitates the division of the land into regular and compact blocks handy for supervision and administration.

Save for occasional shallow depressions which occur locally the plain is remarkably level and regular so that practically no

levelling is required. The amount of clearing required is likewise very small with the exception of certain areas in the extreme south which are covered with light scrub.

The soil may be described as a stiff loam with a considerable percentage of clay : uniform and of great depth. It is supposed to be wind-borne in origin, subsequently altered in texture by the infiltration of rain water alternating with the dry summer heat. During the rains the soil swells in an extraordinary manner and contracts when the hot dry spell sets in, giving rise to enormous cracks and fissures. The same applies to a less extent when this land is artificially irrigated.

Towards the northern end of the block the soil is rather light in colour but gets darker as we proceed into the country of heavier rainfall—the change to the darker colour being generally ascribed to the greater amount of humus present.

In the local depressions already mentioned the soil, as a general rule, is very stiff.

On the block now under discussion pumping stations have been erected at intervals along the river to act as nuclei for the training of cultivators and forward the development of the main scheme. As the system now in force on these stations will apply to the Gezira when the land comes under gravitation water, it will be advisable to discuss these stations now.

The stations are at Tayiba 7 miles north and Barakat 6 miles south of Wad Medani ; Hosh or Hag Abdallah near the southern limit of the block and a new station at Wad El Nau midway between Barakat and Hosh.

The areas cultivated yearly to cotton on these stations are :

Tayiba	1700	feddans	
Barakat	2200	,,	
Hosh	6000	,,	
* Wad el Nau	10000	,,	(proposed in 1923).

In the first place the whole of the land is expropriated from native owners by Government and a yearly rent of 10 piastres per feddan is paid.

The period for which the land is thus taken on lease is 40 years.

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* Since the above was written the Wad El Nau Station has been completed and the full area of 10,000 feddans laid down to cotton.

The Sudan Plantations Syndicate act as the Government agents in running the stations.

Cultivation is carried out on a partnership system between the native owners, the Government and the Sudan Plantations Syndicate.

The duties of the three partners are as follows.

The Government arrange for the land and the water supply and take 35% of the gross yield.

The native provides the labour and takes 40%.

The Syndicate act as agents in supervising cultivation and marketing the crops and take 25%. They also arrange cash advances to the tenants ; carry out minor canalisation and erect buildings.

The land is divided into 30 feddan blocks—this being the unit for one native tenant. Of these 30 feddans, ten are laid down to cotton.

Egyptian long staple cotton is grown—the variety at the moment being Sakellarides.

At Tayiba the rotation followed is a 3-course as follows :—

1st	Year	Cotton
2nd	,,	Lubia
3rd	,,	Fallow
(4th	,,	Cotton)

At Barakat etc the rotation is also 3-course.

1st	Year	Cotton
2nd	,,	Fallow
3rd	,,	,,
(4th	,,	Cotton)

Method of Cotton Cultivation in the Gezira.

Cultivation :— The land is steam ploughed well ahead of the ensuing crop—generally as soon as the rains have ceased—say October.

It is ridged by steam tackle.

The above operations are carried out by the Syndicate and charged to the native tenants at cost—or rather against the tenants account.

The making of the small water channels and dividing off of the 10 feddan block into patches for irrigation is carried out by the tenant himself.

Sowing :—

Sowing takes place from 15th July to early August.

The amount of seed issued is one ardeb of 12 kelas for every 10 feddans : some resowing is necessary as a rule but 1½ kelas per feddan may be taken as an outside figure.

The seed is sown on the sides of the ridges in the dry.

The distance between the ridges is 80—90 cms. and the distance between the stands 40—50 cms.

Irrigation :—

Watering is given every 12 to 18 days depending on the time of year—the waterings being rather more frequent in October and widened a little in the colder months of December and January.

The amount of water given per feddan is roughly 450 cubic metres every 15 days.

Thinning :—

When a few inches high the plants are thinned and two plants left in each stand.

One man should thin a feddan in a day.

Fassing :—

Two fassings are given and after the second fassing "taradding" with the native plough is carried out : this consists in running up the existing ridges so that the stands are now brought from the side to the middle of each ridge.

Four men should fass a feddan in a day.

Watering :—

From 14—16 waterings are given during the growing season. These run from the middle of July to the end of March.

Picking :—

Picking begins in late December or early January and is finished by the end of April or early May.

A picker will pick anything from 50 to 70 rotls in a day. This appears a small amount but they usually work a very short day. Generally pickers are paid so much per rotl—the usual price being 1 millieme per rotl. When labour is plentiful the price may fall to 23 or 25 piastres per 315 rotls. The amount compares unfavourably with the quantity picked per man in Egypt but this is due in great part to the manner in which a field of cotton opens in the Sudan. The same regular two flushes with a smaller third which applies in Egypt is not applicable in the Sudan where the cotton does not open with the same regular flush.

Yield :—

The average yield over a series of years has been approximately 4 kantars of lint per feddan (400 lbs).

Destruction of old cotton stalks :—

When picking is finished, all cotton stalks are cut down and burnt on the field to minimise the risk and danger of pests—a date limit being fixed for this purpose.

Ginning and marketing of the cotton :—

The cotton is ginned at Wad Medani at the Syndicate's factory, shipped to England for sale and the ultimate proceeds divided between the partners in the ratio stated.

The system as aforedescribed will apply to the first block of 300,000 feddans developed in the Gezira scheme. Briefly the Government provide the land and the water for irrigation : the native tenant provides the labour : and the Sudan Plantations Syndicate supply supervision and administration and act generally as the estate agents. This will hold for a limited period of years from the time the gravitation water reaches the land—the period agreed on at present is ten years, but this may be extended with a rearrangement of the Syndicate's percentage. At the end of this limited period the Government will in all likelihood assume the duties of the Syndicate as well as the provision of land and water until such time as the native cultivator is sufficiently advanced to require a minimum of supervision when a combined water rate and land tax may take the place of the present partnership system.

Including the new Wad El Nau pumping station the immediate output of the Gezira may be put at 80,000 kantars

high grade Egyptian cotton of the Sakel variety. In the early months of 1926 with 80,000 feddans under cotton the output should be rather over 300,000 kantars which in 1927 should rise to close on 400,000 kantars, when the full area of 100,000 feddans is laid down.

TOKAR

This area comprises the Baraka delta. The Baraka is a summer torrent which rises in Abyssinia, flows through Eritrea and debouches on to its own delta in the vicinity of Tokar.

It comes down in spate during late July, August and early September, the bulk of the flushes occurring in August. The flushes are of short duration extending from a few hours to at most a day. The number of flushes varies but 6 to 8 may be taken as an average in the year. On issuing from the foothills the river seeks the lowest levels and in consequence over a series of years swings from east to west of the delta and vice versa. The water is very heavily charged with silt by the deposit of which the fan shaped delta has been built up.

The shifting of the areas irrigated due to the vagaries of the flood gives rise to a natural fallowing. For this reason we find the bulk of the cultivation say on the west side of the delta for a series of years. Suddenly the flood breaks to the East or down the middle of the delta and with the change in the direction of the flood, the area cultivated changes. The period within which the flood swings over various parts of the delta naturally varies : it may be 6 or 7 years, frequently more and occassionally less. But the process is continually going on and has considerable advantages as well as disadvantages.

The so-called natural fallowing enforced by the shifting of the flood allows the soil to recuperate. Again land which has been well flooded for several years in succession tends to become full of weeds and grass. This means fairly expensive cleaning and thereby raises the cost of cultivation. During the enforced fallow the weeds die out and by the time the flood swings back little or no cleaning is required.

The enforced fallow is also a great help in controlling many insect pests. This will be readily understood when it is remembered that a large block which has carried cotton for several

years is suddenly left high and dry : and the nearest point of the new area may be 10 to 12 miles away.

The great disadvantages of the shifting flood are (1) the insecurity that any particular area will be flooded in the ensuing year with the consequence that native tenants are averse to spending money and labour on their holdings in preparation for water which may never arrive. (2) the fact that the flood being under no form of control, considerable areas of the delta are too lightly flooded to give any crop and in consequence this amount of water is wasted : also a certain amount of water is unavoidably lost through passing to unsuitable land.

The soil is very fertile and the climate suitable for the growth of cotton. The humidity is high owing to proximity to the sea and the winter temperatures are equable. On the whole Tokar has the climate most suited for cotton growing of all areas so far tried in the Sudan.

The one factor which prevents a large output of superior cotton from this area is the lack of a sufficient water supply— this being limited to the Baraka flood which as afore stated consists of a series of flushes ending early in September. From this date until the cotton is picked no further irrigation is received although there is a slight and rather erratic winter rainfall of some 6 inches occurring between late November and the middle of February. In consequence from the time the cotton is planted right through the growing season until the crop is picked the land receives no further water apart from the rather erratic and slight winter rainfall.

Control of the Baraka flood in its upper reaches at once suggests itself in order that the waters available may be distributed to the best advantage and waste eliminated : but the configuration of the country combined with the fact that the stream is so heavily laden with silt makes a scheme of this nature an undertaking of very considerable difficulty and some danger whilst the cost of constructing these permanent works renders the ultimate benefit doubtful. The problem continues to receive attention and a study of the changing levels of the delta and the behaviour of the main channel now being carried out will in course of time enable a decision to be taken with some measure of assurance.

The whole of the Tokar delta is Government land and each year the land is allotted on an annual tenancy to native cultivators, on the basis that Government takes 1/5 of the value of the crop in lieu of rent and taxes. At the time of allotment a tenant is also charged a small fee of one piastre per feddan on the number of feddans allotted.

The average area sown yearly is some 40,000 to 50,000 feddans but the whole of this area does not bear a crop, the average area bearing a satisfactory crop being some 20,000 to 30,000 feddans. With an exceptional Baraka flood the area may rise as high as seventy to eighty thousand feddans.

Sowing :—

Sowing takes place early in September.

This is done by seluka in even rows.

On an average the width between the rows is 90 to 100 cms. and the distance between the cotton stands 70 to 80 cms.

A man and a boy will sow one feddan in a day.

About ½ kela of seed is required per feddan which is sufficient to allow for a certain amount of resowing.

Thinning :—

Is carried out when the plants are a few inches high — two and three plants being left in a stand.

Fassing :—

As a rule only one fassing is given and this only when the land is dirty.

Over large areas owing to a heavy deposit of silt from the flood, growth of weeds is entirely prevented and no fassing is given.

Picking :—

Takes place from early February to the end of May. Picking is done by contract : in the early part of the season one millieme per rotl is the common figure paid for picking but this figure rises as a rule towards the end of the season.

An average quantity per picker is thirty or forty rotls per day but the day worked is short.

After Cultivation :—

When picking is finished all cotton stalks must be cut down and burnt — under penalty of a fine. A time limit is fixed and the work is carried out by the sitting tenant. This is rigidly enforced to prevent loss through pest attacks.

Seed Supply :—

The cotton seed supply is arranged entirely by Government. No seed is allowed into Tokar save that brought by the Department of Agriculture for issue to the cultivators.

The seed supply is obtained each year from Grade I Cotton of the season's cotton crop, ginned at Port Sudan or Suakin and brought back to Tokar for issue to cultivators against payment.

The seed is issued individualy to cultivators when the sowing season commences and cost collected when the cotton is being picked and marketed.

From time to time fresh strains have been brought in either from Egypt or the Gezira. The Government also maintains a seed farm at Tokar to keep up the general average and an experimental farm where newly introduced varieties are tried.

All seed is thoroughly sunned before issue to cultivators to diminish the risk from pests — more especially pink bollworm. The seed is spread in thin layers not more than an inch or so deep, and exposed to a minimum sun temperature of just over 50° C — for two or three hours — in practice the temperature running from just over 50° C to 60° C as tested by a thermometer placed under a layer of the seed.

Care must be taken when sunning not to leave the seed exposed to dews at night.

The common procedure is to spread the seed in the morning, turn it over occassionally and bag it up in the afternoon. If the temperature has been satisfactory, no further treatment is essential but for safety a second sunning is frequently given. The seed should be spread on "bursh" matting, or ground must be selected in which there are no cracks or lumps of soil etc. where larvae of pink-bollworm etc., would find cover.

Usually a floor is prepared either with "bursh" matting, "zibla" (i. e. a mixture of mud and dung which sets hard). or a cement floor or roof is utilised.

In the Sudan no difficulty is experienced in obtaining the sun temperature necessary for the destruction of the pink boll-worm larvae etc. provided the correct seasonal period is selected for sunning.*

The average yield per feddan on the Tokar delta is 450—500 rotls seed cotton.

This low average yield is due to the fact that large areas cultivated are very lightly watered and on these the yield is very low. The reason for the cultivation of such areas is that the cost of production is low whilst the varying factor of a light rainfall during the growing period encourages the cultivator to persevere with the cultivation in the hope that the crop will pull through.

At the same time on well watered areas the yield runs from 1000 to 1200 rotls seed cotton and on exceptionally well watered areas the yield runs over 1500 rotls seed cotton per feddan.

On moderately watered land the yield will run from 700 to 800 rotls.

Compared with the Gezira we can therefore regard Tokar as an area where the cost of cultivation is low, the average yield is low but the area cultivated is large and there is always the gamble to the cultivating lessee of receiving a piece of well watered land where at a low cost of production a good yield of cotton will be obtained.

The partnership system continues but here the native cultivator gets 80% of the crop as his share compared with 40% in the Gezira — which helps to compensate him for the lower yield and the heavier risks of failure.

Allotment of the land is carried out prior to the Baraka flood.

In consequence large areas of land allotted are not watered owing to the vagaries of the flood whilst subsequent to the flood some further allotment of freshly watered areas requires to be

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* For fuller information see Entomological Bulletin No. 5 by H. H. King, Govt. Entomologist.

made. Allotment of the whole area subsequent to the flood at once suggests itself as the more suitable course whereby only land actually flooded, would be allotted. But the extreme difficulty of moving on the Delta immediately following the flood, combined with the blinding sand storms which blow daily at this period and the rush to get the cotton seed planted, render this more desirable alternative altogether impractical.

Should the Baraka flood be controlled at some future date, thereby giving some assurance of irrigation and eliminating in part the risk of insufficient water undoubtedly the share to Government could be increased.

I have already mentioned that at Tokar the supply of cotton seed is controlled entirely by Government.

Also under the Cotton Ordinance all cotton grown on the delta must be brought to the Tokar market enclosure to be classified, weighed and sold.

The cotton is classified by the Government classifiers' weighed by Government weighers and sold in a daily auction run under the Inspector of Agriculture.

The cotton is graded into 4 classes and marked

T.C.$_1$ T.C.$_2$ T.C.$_3$ and T.C.$_4$

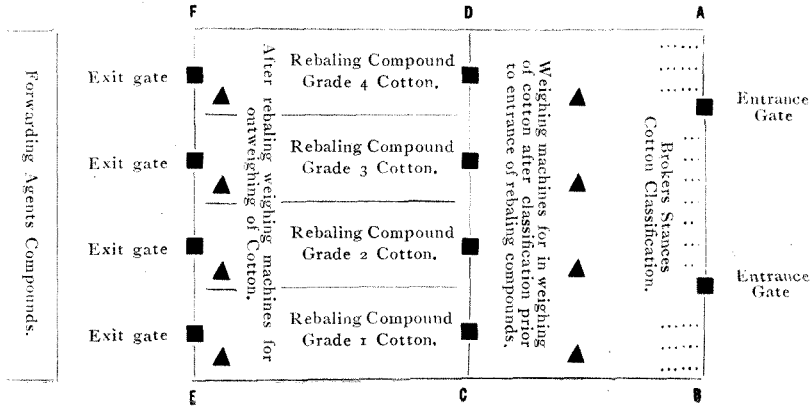
TC$_1$ Corresponds to Fully Good Fair Sakel and upwards

TC$_2$,, ,, Good Fair to F. G. F.

TC$_3$,, ,, Fair to Good Fair.

TC$_4$,, covers cottton of inferior grade.

With the help of the following diagram I now describe the procedure of classification, weighing and sale by auction.



To explain the foregoing.

In the first place roughly an acre is fenced in with a good wire fence. ABEF.

This is divided by a wire fence CD.

The cotton is brought from the fields by the cultivators either the night before or early morning and deposited outside the compound along the line AB. The cotton is there taken over by agents : each cultivator selecting the agent he prefers.

These agents are licensed by Government and pay a deposit of £E. 50 each to insure good faith which is returned at the end of the season. Only agents who are licensed by Government can operate.

The dotted lines inside the compound along the line AB are individual brokers' stances.

Here the cotton is brought and deposited for classification. After classification by the Government classifiers the cotton is brought to the Government weighing machines marked ▲. At the weighing machines there is a Government weigher, a Government clerk who takes down all particulars of the cotton and the agent's clerk who takes down similar particulars.

After weighing the cotton passes into the rebaling compounds. Meantime the lists are made up to show the weight of each grade of cotton in the hands of each agent, the total for each grade and the total for the day. Whilst these operations are proceeding intending purchasers have full opportunity and plenty of time for examining the cotton.

The auction takes place at 12 noon.

Each grade (but including the several brokers lots of that grade) is offered separately, roughly in lots to suit purchasers. That is, if 1000 kantars of Grade I were on the market it would be offered in lots of 250 or upwards. That is to say a buyer can bid for 250, 500, or 1000. Suppose a buyer bids 300 piastres per kantar for 1000 kantars—the total cotton for the day. A second buyer now bids 301 P.T. for 250 kantars and a third 300½ P.T. for 250 kantars. The position then becomes as marked by the clerk on the board.

A	(name of bidder)	500 K.	300 P.T.
B		250 K.	300½ P.T.
C		250 K.	301 P.T.

And suppose a buyer now bids 301 P.T. for 750 K. the position becomes.

C	250 K.	301	P.T.
D	750 K.	301	P.T.

and so on until bidding stops.

In connection with the above by this system buyers cannot bid for lots in the names of particular agents : nor can there be any appreciable difference in the price at which cotton of the same quality is sold during the day. These two points are of the first importance.

When the auction is over the cotton is emptied from the cultivators' own sacks in the baling compounds who can then get their own sacks back, collect the price of the cotton from their agents less the authorised fees payable to the agents including the Government share and depart the same day.

The agents take over the cotton from the cultivators at the entrance gates of the enclosure, provide porterage through the classifying compound, over the weighing machines and into the rebaling compounds; also they provide their own clerk as distinct from the Government clerk for recording weights of individual lots. They collect the price from the buyer : pay the Government share and pay the cultivator. They are responsible for any shortage or variance in the out weights after rebaling of their consignments. The agent is allowed a fixed rate per kantar for porterage and a fixed commission per kantar which he deducts— as well as the Government share of 1/5— from the price paid to the cultivator.

Previously weighing and classification fees were charged by Government but these are now included in the 1/5 share i.e. 1/5 of the price realised in the auction is taken by Government in lieu of rent etc.

Rebaling in buyers sacks is arranged by Government at a fixed rate by a licensed Sheikh of porters : and the cotton as re-baled is weighed on the out weighing machines whence it passes into the forwarding agents compounds.

Each bale bears its own number, its weight in rotls, its grade (TC. etc.) and the buyers distinctive mark. From the Government rebaling compounds the bales pass into the compounds of the Forwarding Agents who are commercial firms. They arrange transport by the Government Light Railway to Trinkitat and thence by native boat to the ginning factories at Suakin or Port Sudan.

Alexandria and Liverpool prices are posted daily in the auction.

The local auction prices for the various grades are posted as soon as the daily auction is over.

During the bidding, bids are marked on a black-board with chalk and marking proceeds simultaneously with the bidding.

Tokar auction as now evolved has been running several years and the results justify one in saying it provides a fair and open market. The importance of this lies in the fact that in such places — lacking decent accommodation and the ordinary amenities of life—it is almost impossible without strict control to prevent an agent acting both for seller and buyer : and when placed in that position acting mainly for himself.

The average yearly output of cotton from Tokar may be put at 40,000 kantars high grade long staple Egyptian cotton of the Sakel variety— rising to 70,000 kantars in a very good year and falling to 25,000 in a poor. The size of the crop is almost entirely dependent on the volume of the Baraka which as previously stated varies from year to year.

KASSALA.

The Gash delta is very similar in many ways to the Baraka delta or Tokar.

The Gash is a mountain stream which rises in Abyssinia and a few miles north of Kassala begins spilling over its own delta.

It comes down in spate during July and August and flows off and on for an average of 75 days.

Over a series of years it swings from side to side of the delta. The river is heavily charged with silt and the delta formed by successive flood deposits is very fertile.

The annual discharge is taken to be 4 or 5 times that of the Baraka and may be taken as some 800 million cubic metres. In 1922 the discharge recorded is just short of 636 million cubic metres.

None of the Gash water is lost, there being no outlet to the sea.

The area annually flooded may be taken as 4 to 5 times that of Tokar. In an average year it is assumed that some 150,000 to 200,000 feddans are flooded.

The climate of Kassala differs somewhat from that of Tokar. At Kassala there is a considerable summer rainfall—an average of some 12.6 inches—but no winter rainfall, whilst the crop is growing.

Again the humidity during the growing season is much lower as Kassala is cut off from the sea by the Eritrean hills and is also much further distant : and the winter temperatures are less equable.

Nevertheless though less favoured climatically than Tokar, it has been proved that good long staple Egyptian cotton can be grown at Kassala : and the industry is now established on a commercial scale.

The factor which has prevented rapid development is the lack of suitable transport.

Kassala lies some 240 miles from the nearest station on the Port Sudan railway and the only means of transport has been by camel.

This method is tedious and cumbrous and incapable of handling an output of more than 10,000 kantars.

The cotton is ginned at Kassala and only the lint is transported. Under these conditions the seed cannot be exported and is used as fuel or destroyed.

At the moment of writing it seems assured that the question of transport * will be solved satisfactorily by the building of a

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* Since the above was written the railway from Thamiam to Kassala is now in process of construction and is expected to reach the Gash delta by March 1924—in time to move the cotton crop of season 1923—1924.

The administration of the Gash delta will also pass to the Sudan Plantations Syndicate who have been granted a concession for 40 years from 1st July 1924. With the arrival of the railway, the cotton crop will be transported as seed cotton to Port Sudan and ginned there.

railway from Thamiam to Kassala and when this has been done it may be taken for granted that there will be rapid development and an area of 100,000 feddans laid down to cotton annually within a comparatively short time.

The variety of cotton grown is Sakellarides and the method of sowing similar in all respects to that of Tokar.

The cost of cultivation at Kassala is higher than at Tokar owing to the greater prevalence of grass and weeds which necessitate more cleaning.

To counteract this, the irrigation is more certain and more abundant : but there is the lack of winter rain during growth, a lower humidity and less equable winter temperatures. From the time of sowing i.e. at the end of the flood early in September or late August—until the cotton is picked in March, April and May. no further water is received by the cotton.

As at Tokar, Government takes a share of the crop in lieu of rent and tax. At Kassala this started at 1/7 whilst the industry was being established and was later raised to 1/6 *

Owing to lack of transport and accommodation for buyers it has not yet been possible to establish an auction at Kassala.

To provide a market Government had in some years to purchase the cotton and more recently the cotton has been offered for sale by tender at Kassala and sold on this system.

Once a railway is built it will be possible to establish an auction on the lines of the Tokar auction †

The output of cotton from Kassala in recent years has varied from 4000 to 13,000 kantars but is capable of rapid development on completion of the railway. At an early date the output should reach 200,000 kantars.

Owing to the changing volume and vagaries of the Gash flood the area and output will vary from year to year but it is estimated that an area of 100,000 feddans will be cultivated yearly with cotton.

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* Since the above was written the Government share has been raised to 1/5.

For the 1924—25 season under the administration of the Syndicate the native cultivator will pay ½ the crop but he will receive cash advances during the growth of the crop, also the advantages of the railway.

† The Syndicate will also arrange the marketing of the crop and in future the Kassala crop will most probably be shipped direct to Liverpool and sold.

The yield per feddan has been rather higher on the average than at Tokar but this mainly because the better watered areas only have been cultivated. The average yield may be taken at some 500 to 600 rotls seed cotton per feddan but on well watered areas yields of 1200 to 1500 rotls and even higher are common. As the area cultivated increases to include lightly watered land the average yield will tend to decrease and approach that of Tokar.

COTTON ALONG THE NILE FROM KHARTOUM, NORTHWARDS.

This consists of comparatively small areas along the Nile irrigated by means of pumps—and a small quantity irrigated by means of sagias.

In the neighbourhood of Khartoum a few private estates grow long staple Egyptian but on the whole in this area the growth of long staple Egyptian is somewhat risky. As we proceed northwards the risk with long staple Egyptian is intensified and a long staple American takes its place.

The chief estate is that of the Sudan Plantations Syndicate at Zeidab where some 3400 feddans long staple American are grown annually—of the Webber strain.

On the seven Government Pumping Stations in Berber and Dongola Provinces an American long staple is grown—the gross area being some 3800 feddans.

On the Zeidab estate cotton is grown on a three course rotation of one year cotton and two years fallow. Whilst on the Government pumping stations cotton is grown on a 4 course rotation of Cotton—Fallow—Cereals—Fallow—Cotton.

On the Zeidab estate the land is steam ploughed and ridged on behalf of the native tenants against their account.

The Syndicate take one half the crop in lieu of rent and water. Otherwise the cultivation and system is similar to that described for Tayiba and Barakat.

The Government Pumping Stations were a war measure erected by means of a grant from the Egyptian Government for the purpose of producing food stuffs. After the war i.e. in May 1920 they were taken over by the Sudan Government at a valuation and continue to be run as a safeguard against or rather to

minimise the risk of famine in bad rain years or a low Nile flood in these northen provinces.

In point of fact if run for cereals only they cannot be made to pay their way and for this reason the growth of American cotton was pushed in order to get a crop with a higher monetary value.

So far the yield of American cotton on these stations has been good averaging rather over 3 kantars and in some cases 4 kantars per feddan. Government take ½ the crop in lieu of water rate for cotton on these pumping stations.

On the Zeibab estate the yield of American cotton is rather more erratic : in certain years when the season is suitable a yield of close on 4 kantars has been obtained but a nearer average would be some 3 kantars per feddan and frequently the output averages barely 3. On the other hand as shown at Zeidab and elsewhere the yield of Egyptian varieties in this locality—lying as it does in proximity to the Nubian desert and subject to cold snaps in the winter—may fall as low as one kantar per feddan—though again in occassional years fair yields of 3 to 3½ kantars are obtained with an Egyptian cotton.

On the Zeidab estate sowing takes place in May : on the Government Pumping Stations sowing takes place mainly from the middle to the end of July.

The amount of cotton grown under sagia irrigation calls for no remark beyond the fact that it is mainly American and at present the areas so cultivated are increasing owing to the high price of cotton. From the neighbouring Government pumping stations seed is supplied to these sagia cultivators, a cash advance is made on the resulting crop and the cotton marketed on their behalf by the Department of Agriculture.

The method of cultivation is very similar to that described for the Gezira. As pointed out, the time of sowing is in some cases thrown considerably forward. Where American is grown the number of waterings required is less—from 12 to 14 being given. Save at Zeidab ploughing and ridging is not carried out by steam tackle but by ploughs drawn by bullocks and on sakias the work is done mainly by hand.

A few private estates just north of Khartoum grow a small quantity of long staple Egyptian but they call for no special

remark. The quantity of cotton produced is small and varies from year to year depending on the price ruling for cotton. These enterprises have not been very successful due in part to the climatic conditions which are none too favourable so far north especially in the winter months for Egyptian cotton and in part to overcropping and therefore overwatering of the soil with the resulting deleterious effect. With the introduction of fallowing, the latter adverse factor can now be obviated but on most estates the climatic factor is met by substituting a long staple American.

In any case any increase in the growth of Egyptian cotton under pump irrigation is out of the question since the 20,000 feddans perennial water (i.e. water from 1st March to 15th July) granted by Egypt, is for all practical purposes already exhausted.

Perennial water or pumping means the right to take water the whole year round and is limited by the amount of summer water granted by Egypt. Summer water or pumping means the right to take water from 1st March to 14th July in any year and for the Sudan is limited to 20,000 feddans at present by Egypt.

Flood water or pumping means the right to take water from 15th July in one year to 28th February in the next and is unlimited.

All pumps for irrigation are licensed—either perennial or flood.

These regulations apply only to plant mechanically driven, there being no limit to the amount of water raised by sakias (water wheels driven by bullocks) or by hand labour.

It may be possible to grow American cotton within the so-called flood period i.e. from 15th July to 28th February when there is no restriction on the amount of pumping but on the present estates the period for American extends at least one month and a half beyond this period—either the American is sown in May when summer water is required or if sown in July then watering is required in March and frequently a watering is required in April when again summer water is needed. In consequence all estates where either Egyptian or American is grown at present—have summer water rights and the total summer water allowed for the Sudan viz. 20,000 feddans has now been

exhausted. Egyptian cotton cannot be grown without summer water under pump irrigation and the growth of American inside the flood period is a doubtful proposition.

In consequence little increase in the output of cotton can be expected from the northern Sudan through pump irrigation until an dditional area of summer water is allowed by Egypt.

RAIN GROWN COTTON.

At present the amount of rain grown cotton is small but is capable of immense development.

Hitherto rain cotton has been grown mainly in the Gedaref and Mefaza areas, along the banks of the Blue Nile and in rain terasses in the Fung and the Blue Nile Provinces.

A beginning has also been made with the growth of American cotton in Kordofan notably in the Khor Abu Habl where considerable stretches of very stiff black land in the bed of the Khor are flooded annually and also on the light sandy soil known as Goz land under rainfall. It is too early yet to say what will be the ultimate result in this locality.

But it is in the southern belt of heavier rainfall that we must look for real development of rain grown cotton on a large scale— in the Upper Nile, Bahr el Ghazal, Mongalla and the southern area of the Nuba Mountains and Fung Provinces.

In the Upper Nile Province experiments have already been carried out which show that good long-staple American cotton can be grown under rainfall. Following on this, seed has been issued to native cultivators, instruction and supervision provided, a guaranteed price offered by Government before the crop is laid down with the result that the crop now being picked is anticipated to yield 3000 kantars. By these means it is hoped to stimulate the industry and gradually build it up to a scale that will justify provision of suitable transport.

At the same time the sparsity of the population, their present degree of civilization and in the case of some tribes their disinclination to the labour of cultivation render rapid development of rain cotton in this southern area a matter of some anxiety : and to establish the industry assistance must be given in the provision of seed, instruction and supervision, and a ready market

for the crop when picked. Add to the adverse factors aforementioned the distance of these areas from seaport, the lack of suitable transport with the consequent heavy freight charges and development in these localities will appear a matter of some difficulty.

Nevertheless the present rate of progress—aided mainly by the current prices for American cotton—is highly encouraging and with the industry established, the possibility for development is very great.

Under rainfall two varieties are grown namely long staple American and the native variety called Belwa.

American is grown mainly for export and is the type encouraged by Government—American seed being issued in these new areas etc.

The native Belwa—an inferior cotton of short staple—is grown by natives for the manufacture of the native cloth called damoor though even in this respect American is gradually taking the place of Belwa. Belwa is a hardier variety than American—considerably more drought resistant—and will give something of a yield with a water supply on which American would fail.

Method of Cultivation.

Sowing takes place as soon as the rains are assured and the ground has been well soaked. In the heavier rain country care must be taken not to sow too early in case the opening bolls are damaged by the later rains : and a period of some 4 to 4½ months should be allowed.

About ½ kela seed is required per feddan.

Sowing is done by seluka stick in even rows — the rows being one metre apart and the distance between the seed holes 80 cms.

Two fassings are required.

Thinning to 2 and 3 plants in each stand when the plants are a few inches high is essential.

Destruction of all cotton plants at the end of the season must be insisted on to prevent pests : and a time limit should be fixed.

The method of cultivation is generally similar to that laid down for naturally flooded land described under Tokar.

ESTABLISHMENT OF THE COTTON INDUSTRY IN A NEW AREA.

The method employed is first a general agricultural survey of the particular district and selection of the most promising localities. To decide this, attention is paid to the type of soil, the rainfall or the natural flooding, temperatures and humidity, the amount of population and the transport.

Seed is issued to the native cultivators against payment when the crop is picked, instruction in planting etc. given, and the growing crop supervised.

To provide a ready market, the cotton is purchased as picked, and arrangements made for classification, transport, ginning and sale. On sale any appreciation over costs is paid out to the native cultivator—for this reason the original figure paid when the crop is picked must be and is intentionally left fairly wide.

To combat pests, rules are laid down under the Cotton Ordinance for the destruction of all cotton stalks at a fixed date, thereby ensuring a dead season.

As the area increases ginning plant is established and sale by auction or tender started.

The following table gives the output of cotton from the main cotton areas for the years 1920, 1921, 1922 and 1923.

Place and Year.	No. of Feddans.	Type of Cotton.	Yield in kantars (315 rotls).	Time of Planting.	Time of Picking.	How marketed.	REMARKS.
TOKAR							
1920	36,000	Assili (Brown Egyptian)	48,883	Sept.	Jan. to June	Sold by daily auction at Tokar	Ground under natural flooding Baraka delta.
1921	50,000	$\frac{2}{3}$ Assili $\frac{1}{3}$ Sakel	75,000	,,	,, ,, ,,	,, ,, ,, ,, ,, ,,	The area is only roughly approximate and a considerable portion insufficiently watered.
1922	46,000	Sakel ...	34,544	,,	,, ,, ,,	,, ,, ,, ,, ,, ,,	
1923	21,000	Sakel ...	35,650	,,	,, ,, ,,	,, ,, ,, ,, ,, ,,	
KASSALA							
1920	—	Sakel ...	4,971	Sept.	Jan. to May	Marketed by Govt. in Liverpool	Under natural flooding in Gash delta.
1921	—	Sakel ...	12,888	,,	,, ,, ,,	,, ,, ,, ,, ,,	The area cultivated is indefinite but the yield may be taken at 500—600 rotls. seed cotton per feddan.
1922	—	Sakel ...	3,280	,,	,, ,, ,,	Sold by tender at Kassala	
1923	—	Sakel ...	12,750	,,	,, ,, ,,	,, ,, ,, ,, ,,	
GEZIRA							
TAYIBA							
1920	1,710	Sakel ...	9,578	July 15th	Jan. to April	Marketed in Liverpool by S.P.S.	
1921	1,700	Sakel ...	5,444	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
1922	1,698	Sakel ...	5,987	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
1923	1,680	Sakel ...	7,456	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	

BARAKAT							
1920	2,056	Sakel ...	9,778	July 15th	Jan. to April	Marketed in Liverpool by S.P.S.	
1921	2,011	Sakel ...	7,074	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
1922	2,100	Sakel ...	8,215	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
1923	2,006	Sakel ...	8,186	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
HOSH							
1922	6,020	Sakel ...	24,560	July 15th	Jan. to April	Marketed in Liverpool by S.P.S.	
1923	6,700	Sakel ...	23,392	,, ,,	,, ,, ,,	,, ,, ,, ,, ,,	
ZEIDAB							
1920	4,420	American	8,156	May	Sept. to Dec.	Marketed in Liverpool by S.P.S.	
1921	4,751	American	7,637	,,	,, ,, ,,	,, ,, ,, ,, ,,	
1922	4,396	American	9,389	,,	,, ,, ,,	,, ,, ,, ,, ,,	
1923	4,317	American	11,638	,,	,, ,, ,,	,, ,, ,, ,, ,,	
Government Pumping Schemes, DONGOLA AND BERBER							
1920	,597	American	2,686	July 15th	Dec. to April	Sold by tender at Port Sudan	
1921	1,105	American	3,024	,, ,,	,, ,, ,,	Sold in Liverpool	Offered by tender Port Sudan but not sold.
1922	1,115	American	3,577	,, ,,	,, ,, ,,	Sold by tender at Port Sudan	
1923	3,091	American	11,549	,, ,,	,, ,, ,,	,, ,, ,, ,, ,, ,,	

Apart from the areas and quantities quoted in the foregoing table the new station at Wad el Nau in the Gezira must be mentioned where some 10,000 feddans have been laid down to cotton in July 1923 which is estimated to give an additional 35,000 to 40,000 kantars early in 1924.

The chief development in the near future will take place in the following areas :—

Gezira :—

When the Makwar dam is completed say in July 1925 an area of 100,000 feddans will be put under cotton — estimated to give 350,000 to 400,000 kantars.

Kassala :—

On completion of the Kassala railway early in 1924 the Gash delta should develop rapidly and should yield in due course 150,000 to 180,000 kantars annually depending on the volume of the Gash flood from year to year.

The Southern belt of heavier rainfall.

Considerable development is anticipated in the growth of rain grown cotton in the Upper Nile, Mongalla, Bahr el Ghazal, and the southern areas of the Nuba Mountains and Fung Provinces—more especially if the present high prices continue.

GINNING FACTORIES.

There are five ginning factories in the Sudan situated at :—

Wad Medani—belonging to the Sudan Plantations Syndicate—gins the Gezira crop.

Zeidab —belonging to the Sudan Plantations Syndicate—gins the Zeidab crop.

Port Sudan —belonging to Government—Gins the Government Pumping Schemes and part of Tokar crop.

Suakin — ,, ,, Messrs. Debbas—gins part of Tokar crop.

Kassala — ,, ,, Government—gins the Kassala crop.

With the advent of the railway the Kassala factory is now closed down and for the next year or two at least, the crop will be ginned at the Port Sudan factory.

These factories are licensed and subject to Government inspection.

Various regulations are enforced relative to the ginning of different varieties and movement of seed. No seed is allowed to leave the factory except for export and any seed required for sowing is subject to approval by Director of Agriculture. By these means the control of seed for sowing purposes is established. Breach of the conditions renders the license liable to revocation.

The main point to be noted in connection with these ginning factories is the rigid control which Government exercises in the way of seed control and the prevention of admixture of varieties at the gins.

In the Sudan factories both Egyptian and American cottons are ginned on Platt roller gins. It is found that the saw gins tear the lint of the long staple American. The ginning of American with its fuzzy seed on the roller gins is a slow process and the output per gin per hour is very much less than with Egyptian.

The cotton bales, as turned out from the different factories, are not uniform but vary in size and weight. Still all the factories turn out a really compact and tidy bale.

At Zeidab and Medani the African bale of 405—420 rotls weight is the type.

The Port Sudan and Suakin bales are larger and average 610 to 620 rotls per bale.

A kantar of cotton unginned is 315 rotls. This is estimated to give when ginned 100 rotls of lint, 200 rotls of seed and 15 rotls representing loss and waste.

In point of fact in the Sudan 315 rotls seed cotton will usually give less than 100 rotls lint. For instance at Tokar 320 to 325 rotls seed cotton is a safer figure to take for 100 rotls lint.

MAIZE — *Zea Mays* — *Arabic Dura shami, Aish el Rif.*

Maize is not widely grown in the Sudan and is mainly grown on land artificially irrigated.

In recent years there has been some increase in its cultivation in the regions of heavier rainfall where birds are troublesome mainly on land adjacent to the river on the southern reaches of the Blue Nile.

In recent years the total area under this crop has been from 25,000 to 30,000 feddans—of which some 14,000 to 20,000 feddans have been artificially irrigated.

The main regions of growth are the Berber and Dongola Provinces.

The preparation of the land and method of sowing is similar to that of dura : on land artificially irrigated the planting being considerably closer than on rain or naturally flooded land.

From ¾—1 kela of seed are required per feddan. Usually it is well to soak the maize 8—10 hours before sowing.

On rain land sowing takes place as soon as the rains are assured : on land artificially irrigated either an autumn or a winter crop may be taken.

When about a foot high the plants should be thinned to 3 or 4 in each hole : or to 2 and 3 depending on whether the original sowing has been fairly wide as on rain land or flooded land or closer as on land artificially irrigated.

If thinning is omitted the crop will tend to produce stalk and leaf but little grain.

Two fassings are required.

Period of Growth :—

110—120 days are required to bring the crop to maturity. With a winter crop on land artificially irrigated this period will usually be somewhat exceeded.

Harvesting :—

When the crop is ripe the cobs are cut and gathered in heaps. The spathe covering the cob is then removed. If white ants are prevalent as happens in some districts it is usual to erect

a platform with a few pieces of wood and the maize stems : spread the cobs on this and let them remain in the sun for a few days.

The grain is then stripped off by hand. Machines for threshing have been tried experimentally and do well but so far have not been employed on a practical scale.

Yield :—

The yield may run from 2 to 4 ardebs on rain land and from 4 to 8 ardebs on land artificially irrigated.

Storage :—

Maize is readily attacked by weevil in this country and any maize kept in storage must be looked after.

Spreading in the sun or treating with carbon bisulphide are two means of combatting the pest : or where possible storing in the open.

General :—

Maize may be regarded as a crop grown for food but not for export sale.

On the whole it is not favoured by the native mainly because it is more difficult to grind and replaces dura only on account of birds or for some similar reason.

Owing to the cost of artificial irrigation, the world's price for maize does not admit of its being grown on a paying basis. The local demand for maize is small.

It may therefore be regarded in the same category as dura namely that it is grown for food only and merely incidentally may any of the crop find its way to outside markets.

DOLICHOS LABLAB—*Arabic Lubia Afin.*

This crop is fairly widely grown on naturally flooded land as the Nile flood falls and on land artificially irrigated but only to a small extent on rain land. It is the crop grown on the leguminous shift in the Gezira.

In recent years some 30,000 to 50,000 feddans have been cultivated annually.

Several kindred varieties are grown but the one mentioned is by far the most common.

The crop is grown mainly for forage and food : and—except on European estates—less as a regenerating crop.

On land naturally flooded it is sown by seluka as the flood recedes : and on artificially irrigated land it is sown in a similar fashion except that the fas is used in place of the seluka for making the seed holes.

It is the hardiest leguminous crop in the Sudan and will grow when sown almost at any season of the year.

The bulk of the crop is sown however in July or August on the artificially irrigated land and on flooded land from September to December.

Whilst the crop is growing, native cultivators pick off the leaves which they use as a vegetable and later the immature green pods.

When the crop is ripe the pods are picked off and threshed and the beans used by the natives in various forms as food.

Later the crop is grazed off by livestock or as sometimes happens the lubia is cut and stored for forage.

On European estates the lubia is usually grazed off by livestock : or watered and grazed a second time. This undoubtedly is the better method.

The method of sowing is very similar to that of dura.

From 1—2 kelas seed are required per feddan.

The time of growth till the pods are ripe is 90—100 days but new pods keep on forming and picking is spread over a considerable period.

The yield of beans per feddan is small from 1½ ardebs—2 ardebs per feddan.

For storage as fodder the crop is not suitable.

It is difficult to cure as the leaves tend to fall off as soon as the plant dries and get blown away with the wind with the result that little is left save the dry woody stem.

Apart from the effect on the soil, much better value from lubia as a forage crop, is obtained by successive grazing before the plant is allowed to produce too much wood—and especially by folding the stock on the land.

Lubia is not to be regarded as a crop for export. Under artificial irrigation it is not a paying crop: and its value depends on its indirect benefits.

It must be regarded merely as a regenerating leguminous crop with beneficial effect on the soil: and as a crop producing a certain amount of food for man and beast.

The yield per feddan of green forage may be taken as 3 tons with a good crop, giving roughly a ton of dry forage.

WHEAT — *Triticum sp.* — *Arabic Gamh.*

Wheat is grown on land artificially irrigated and on land naturally flooded—mainly on the former.

It is a winter crop in the Sudan.

In recent years the total area has been some 20,000 feddans for which artificial irrigation accounts for all save 2 or 3000.

As the rains of the Sudan fall in the summer months, growth of wheat on rain land is impossible on account of the high temperature.

The Sudan is not self supporting as regards wheat supply and annually large quantities of flour are imported.

CULTIVATION
on Land Artificially Irrigated.

Cultivation :—

The land is ploughed and cross ploughed: and zahaffed in order to get a tilth.

The seed is sown in the dry.

Date of Sowing :—

Sowing takes place from the first week of November to the middle of December.

About 5 kelas seed are required per feddan.

The seed is broadcasted then zahaffed in and the first watering given.

Periods of Growth :—

The period of growth is 120 to 150 days.

Harvesting :—

The crop is cut by the mangil (a small reaping hook), bound into sheaves and brought to the threshing floor.

Some attention is given to the preparation of this threshing floor. The loose surface of earth is removed from a considerable patch: which is sometimes "ziblad" to get a hard and smooth surface.

Threshing is performed by using live-stock to tread out the grain—bullocks, donkeys etc. being used for the purpose.

Occasionally the Egyptian "noorag" is used: the bullocks moving round in a circle hauling the noorag behind.

The noorag has the additional advantage of chopping the wheaten straw: which in the chopped form is known as tibn and is used to give bulk in a ration of dura etc. when feeding live stock.

Cleaning is done by the primitive method of tossing the grain and tibn in the wind. This is repeated once or twice till the grain is fairly free of straw etc.

The whole method is cumbrous and tedious in the extreme.

On certain European estates threshing machines with winnowing appliances were introduced but as wheat is not a paying proposition under artificial irrigation, its cultivation as a revenue crop has practically been abandoned on these stations.

The native method of threshing etc. as described is that almost wholly in vogue.

The average yield under artificial irrigation is about 4 ardebs per feddan.

On Naturally Flooded Land.

Sowing takes place with the fall of the flood when the colder weather sets in towards the end of November and in December. No preparation is given to the land.

Sowing is done by seluka, the seluka holes being placed close together say 4—6 inches each way.

The amount of seed required per feddan by this method is about 1 to 1½ kelas. The period of growth is rather less than on land artificially irrigated owing to failing water supply.

Harvesting and threshing is similar to that already described.

The yield is lower than that of land artificially irrigated and may be taken as 2½ ardebs per feddan. When conditions of water supply and soil are favourable much higher yields are occasionally obtained from land naturally flooded but 2½ ardebs may be taken as the average from the bulk of land naturally flooded.

General :—

Wheat of good quality is grown in the Sudan and a fair yield per feddan is obtained. This applies equally to the local wheats such as the Dongolawi, varieties introduced from Egypt and the more recently imported varieties from India and Australia etc. The last mentioned introduced by the Government Botanist and after trial at the Research Farm distributed on a small scale in the main wheat districts, indicate a shorter period of growth and greater immunity from disease.

At the same time it must be pointed out that wheat under artificial irrigation is not a paying crop : it is only the comparatively high prices which prevail and the need for increasing the food supply in the Northern Provinces which make the growth of this crop in a modified form possible. And it is abundantly clear that under present conditions the Sudan cannot become a wheat exporting country. The best that can be hoped is that it may be possible to produce the country's requirements.

In Berber, Dongola and Halfa Provinces, wheat is used in part as a diet by the natives—elsewhere this does not apply save in a very slight degree.

BARLEY — *Hordeum* — *Arabic Shaeer.*

A small amount of barley is grown in the Sudan.

In recent years the total area has been from 4,000 to 8,000 feddans.

Methods of sowing etc. given for wheat apply for all practical purposes : and the remarks re its value as a paying crop or for export are intensified.

EARTH-NUTS—*Arachis hypogaea*—*Arabic Ful Sudani.*

This crop is grown entirely on rain land and the main regions of production are Kordofan, Upper Nile, Fung and Kassala Provinces.

In recent years some 25,000 feddans have been grown annually : in addition a few hundred feddans are grown under artificial irrigation and natural flooding.

The bulk of the crop is consumed in the country but a few thousand tons are exported to Egypt varying from 1000 to 4,000 tons yearly.

The crop requires a free working sandy loam for successful growth.

The land is well tilled prior to the rains.

On rain land sowing is done by seluka or fas in even rows 80 cms. between the rows and 60 cms. between the seed holes.

Two or at most three nuts are placed in each hole.

Amount of Seed :—

About 2½ kelas shelled nuts are required to seed a feddan.

Fassing :—

The land must be kept clear of weeds.

The surface soil is kept loose and friable in order that the "runners" may penetrate, Also it is advisable to bring the loose earth round the plants to allow the runners to penetrate and the nuts to form.

Two fassings are required which in addition to removing the weeds and allowing the runners to penetrate, aid in preserving the soil moisture.

Period of Growth :—

5 months are required to bring the nuts to maturity.

Harvesting :—

The drills may be ploughed up, or dug up with a fork or the plants simply pulled up by hand and the nuts shaken off and collected.

The nuts should be well cleaned and sized.

The best nuts are large, uniform, smooth skinned and white.

Yields :—

On suitable soil with a good rainfall a yield of 4 ardebs is an average.

On land artificially irrigated and where the soil is of a free sandy nature 8—10 ardebs are obtained.

On land naturally flooded where the soil was suitable a yield of $5\frac{1}{2}$ ardebs has been obtained.

General :—

Earthnuts is a favourite crop with the native of the Sudan supplying as it does a very palatable delicacy when roasted with a little semen. The haulms of the plant supply also good forage for livestock.

The nuts when crushed supply a good edible oil but in the Sudan the nuts are simply roasted and eaten by the natives.

The labour required especially at harvesting is very considerable.

The chief reason why there is not a marked increase in the cultivation is that in the main rain belt of cultivation the rainfall is too light.

For this reason the bulk of the crop is grown on the berm land of the river—which is of a free texture and where the considerable rainfall is aided by infiltration of water from the river or by a light flooding.

In the Upper Nile and White Nile Provinces where the rainfall is considerable and also in the Nuba Mountains, a fair quantity of the crop is grown.

The two factors of a free working soil and considerable rainfall—either helped by infiltration from the river or by a light flooding—prevent its cultivation in the main dura belt where generally speaking the rainfall is too light and the soil too stiff.

Under artificial irrigation where the soil is suitable the crop is a very satisfactory one in a rotation and with average prices is a paying crop from a monetary stand-point. But it requires a free working sandy loam and this factor prevents its being cultivated on a general scale on pumping estates-where as a general rule the soil is too stiff save in isolated patches.

The earthnuts exported go mainly to Egypt where, as in the Sudan, the nuts are roasted and eaten as a delicacy. To a less extent they are used in the manufacture of confectionery.

CASTOR — *Ricinus communis* — *Arabic Kherwa.*

Castor is not generally cultivated as a crop but grows in the wild state readily aud luxuriantly on well watered areas notably on khor deltas, "mayas" and heavy rain lands.

Various varieties in addition to the indigenous castor, e.g. Java, Indian and Abyssinian—have been tried in the Sudan—all of which grow very readily.

On well flooded land or land of heavy rainfall where the growth of grass is excessive castor owing to its rapid growth is a suitable crop.

Method of Cultivation.

Sowing :—

The seed may be sown by seluka in even rows two metres apart with the distance between the seluka holes 1 metre.

Fassing :—

About ½ kela beans is required for sowing a feddan.

Little after cultivation is required as a rule: one fassing will generally be sufficient.

Period of Growth :—

The period of growth is 4 to 4½ months.

Yield :—

12 kantars per feddan of beans may be considered a fair yield but cultivated experimentally on land naturally flooded over 18 kantars have been obtained.

The harvesting and especially the threshing of the castor is the most expensive item in the cost of cultivation.

The best plan is to pick the heads before they are quite ripe—this will involve cutting down the tree if growth has been excessive as often happens.

The heads are then spread in the sun in thin layers to prevent heating and allowed to dry.

The kernel in due course under the heat of the sun bursts and sheds the beans : this process is completed by threshing with a stick in the manner of a flail.

General : -

Attention might be given to castor as a bye crop in districts where there is an abundance of well watered land, the cultivation of which is rendered difficult or expensive owing to excessive growth of grass.

The question of transport must of course be kept in mind as the value per ton will not admit of expensive transport in addition to ordinary cost of cultivation.

Prices have fluctuated in the home markets very widely in recent years but a figure of £.10 to £.12 per ton may be regarded as nearly normal.—although the present price is over £25 per ton.

LUCERNE—*Medicago sativa—Arabic Berseem.*

This crop is not grown to any extent in the Sudan by natives. It is however grown for the supply of forage to the Army and by private individuals for horse forage etc.

Method of Cultivation.

The land must be well prepared by ploughing, cross ploughing and harrowing and a good tilth obtained.

The best time for sowing is from the middle of November when the winter weather has set in. It can however be successfully sown at the beginning of the rains.

About 20 rotls seed are required per feddan.

Once established it will remain for a matter of five years or so. Care should be taken to weed out, grass or weeds and so assure a clean growth whilst the crop is on the ground.

The first cut is obtained some 70 days after sowing : and thereafter a cut about once a month.

The crop can be grown only under artificial irrigation and will require water about 3 times a month.

The crop should be cut just as the flowers are forming or bursting open. It must not be left to run to seed otherwise when cut the subsequent stand will be considerably thinned.

This is a very satisfactory crop for growth in Government gardens— the crop being nice to look at and providing valuable forage. It is rather expensive to lay down as a good deal of preparation for the land is required.

Seed acclimatised in the Sudan is more successful than seed freshly imported from Egypt.

The local price of seed is some 7 piastres to 8 piastres per rotl but varies occassionally up to 10 piastres.

I have now dealt with the main crops cultivated at present in the Sudan.

Of the crops examined the most promising for the Sudan is cotton. In fact in this respect in the not distant future the annual prosperity of the Sudan will like Egypt be largely decided by the cotton crop of the year.

Next to cotton the crop which probably will most readily pay for attention is Semsem—which so far is entirely a rain crop. It will probably remain a rain crop as on stiffish soil it does not respond readily to artificial irrigation.

Under artificial irrigation semsem appears to give the best results on the free berm soil of the river—the area of which is after all comparatively limited.

GENERAL.

In the Sudan we may assume broadly that land is cheap and abundant and that the limiting factor —apart from a sparse population—is the water supply, either in the form of rain, natural flooding or artificial irrigation.

On this basis the general axioms as regards tillage, rotations of crops, retention of soil fertility etc. are considerably modified.

Tillage :—

On rain land we find that apart from the construction or repair of rain 'terasses' little if any preparation is given to the land. In point of fact the native cultivator prefers to cultivate a larger area and is content with a smaller return per feddan : this in contrast to trusting his efforts to a smaller area well handled. To some extent the erratic rainfall is responsible for this attitude. In a year of good rains he reaps a fair crop from his comparatively larger area and in a year of bad rains he loses little more than the seed. On the other hand the cultivator who endeavours to copy dry farming methods may and does in a year of average rains reap a higher return per feddan but in a year of poor rains it is small consolation for him to see his crop take a little longer in dying than that of his less energetic neighbour. In point of fact the position appears to be that the amount of rainfall is too erratic to guarantee a decided advantage from a system of dry farming—this combined with high and prolonged summer temperatures which largely remove the cumulative effect of dry farming.

In addition the main crop grown namely dura is of little value for export whilst even with dry farming a crop like cotton gives little promise of being a success in the zone of lighter rainfall.

We may therefore take it that no tillage of the land beyond "fassing" the crops is carried out on rain land. On naturally flooded land the same applies.

On land artificially irrigated the land is however ploughed or fassed. Ploughing on the larger pumping estates is done by steam plough e.g. at Barakat, Tayiba, Zeidab etc..

On smaller estates the beladi plough and less often the English plough drawn by bullocks is used whilst on sakias breaking up of the soil is still largely done by fas.

Rotation of Crops :—

Ordinarily in agriculture a rotation of crops is adopted but in the Sudan owing to the cheapness and abundance of land this in many cases is entirely neglected and in others exists only in a very modified form.

On Rainland :—

In heavy rain districts dura is often grown on the same piece of land for several years : the ground becomes exhausted and is abandoned.

A fresh area is chosen where the process is repeated. After a lapse of years the original area recovers and is again cultivated. This in a primitive fashion approaches the simplest form of rotation but could only be practised where land is cheap and abundant and the population sparse. A modification of this is found in the gum bearing regions of Kordofan. Here the land is cropped with dukhn for 4 or 5 years and in the last years the self sown gum trees are left to establish themselves.

In 6 years these gum trees reach the bearing stage and are tapped for 8 years or so, then the gum garden is worn out, the trees are cut or burned down and dukhn or semsem is again sown and the process repeated.

On rain land where the rains are more erratic and less plentiful the danger of exhausting the soil is much less and in the northern end of the dura belt, a balance seems to have been reached between the amount of plant food drawn from the soil and the restoration brought about by an enforced fallow.

On Land Naturally Flooded :—

On land naturally flooded especially in the deltas of the khors Baraka and Gash much the same thing happens. Owing to the swinging of the flood from side to side of the delta—which is common to all silt laden khors—a natural rotation is enforced. For instance the middle of the delta may be flooded for a number of years which owing to the deposition of silt rises in level. A flood bigger than usual suddenly comes along breaks through the raised channel and seeks the lower levels say to the west of the delta. Here the successive floods tend to discharge their waters until the levels on the western side are raised. In turn a flood breaks through the raised channel on the western side and the waters seek the eastern areas of the delta.

This continued process enforces a kind of natural rotation and thereby prevents exhaustion of a naturally rich soil. The deposits of silt on weathering aid in maintaining the fertility.

I may here note that in practice sowing is not carried out on freshly laid down silt but on the old soil underneath. When the freshly laid down silt has received a year's weathering it is then suitable for sowing. The point is mentioned on account of the common belief that silt is invariably fertile but the fact aforementioned is well understood by native cultivators.

In the deltas of silt laden khors like the Baraka and Gash we find roughly the more sandy land at the apex of the delta and the heavier soil at the lower end. The slope of the land on the Baraka and Gash is, however, comparatively steep and save in occasional pockets or upstream of a training bank the deposit of fine silt or clay is not great. In the pockets referred to I have seen as much as a metre of fine silt and clay laid down in local patches in one flood : and over considerable areas a foot or so of deposit is not uncommon.

On these areas where there is a foot of deposit the common practice is to remove the fresh silt and sow on the old soil underneath.

The methods of sowing usually practised render this possible. If sown by seluka stick the seed hole is pressed down to the old soil, the new silt cleared away, and a light covering given to the seed from old soil. When sown by fas in the seluka fashion, the seed holes are dug down to the old soil, the new silt lifted out en bloc and the seed covered with the old soil. This renders the cost of sowing more expensive especially when there is a foot of new silt but the extra cost of sowing is more than repaid by the fact that hardly ever in the first year is any cleaning required on land covered by silt to this depth. In consequence on the Baraka delta a native cultivator who obtains land covered with a foot of fresh silt is regarded as particularly fortunate not only because the land is well watered but also because the cost of cultivation is reduced seeing that no cleaning is required.

On Land Artificially Irrigated. :—

On land artificially irrigated the process of rotation is more complex but, in the Sudan, is not as yet based mainly on exhaustion of plant food in the soil but rather on the harmful effect of continued artificial irrigation on the physical texture of the soil itself. In the ordinary course the simple plan is to

adopt a rotation which will aim at maintaining or increasing the natural fertility of the soil whilst regulating the labour demand and giving the best or at any rate a fair return. In the Sudan, however, this is rendered more complex by the effect on the soil of continued artificial irrigation—especially on the stiffer soils : this combined with the fact that land is plentiful.

In the Gezira plain where the development of artificial irrigation will be greatest in the coming years two rotations are at present in force : and both, in the main, aim at restoring the physical texture of the soil by the introduction of a dry fallow after continued irrigation.

The first is a 3-course rotation.

1st Year Cotton
2nd Year Lubia
3rd Year Fallow
} practised at Tayiba etc.

The second is also a 3-course rotation.

1st Year Cotton
2nd Year Fallow
3rd Year Fallow
} practised at Barakat etc.

Various other rotations were tried at Tayiba. A 2-course rotation with cotton—lubia was given a thorough trial but the cotton yields fell and the land got foul. Also a 3-course rotation cotton—wheat—dura and lubia was tried but the bad effect of continuous irrigation was soon evident.

This deleterious effect may be illustrated by the following observation made some years ago. A block of stiffish land had lain fallow for some years. The land was broken up in the autumn prior to sowing with cotton in the following May. On a representative plot of ten feddans in this block a winter crop of berseem was taken. This was ploughed up and sown to cotton along with the rest of the block. The ensuing crop showed this 10 feddan plot as well below the average of the block. In point of fact the beneficial effect of cropping with berseem on the plant food in the form of nitrogen in the soil had been more than counterbalanced by the deleterious effect of the continued irrigation. Had the ten feddans been cropped with a leguminious crop a year ahead, the crop grazed off by livestock and fallowed a year the result would have been different as the fallow would have restored the physical texture.

The harmful effect of continued artificial irrigation on a stiff soil is marked by the lengthened time an ordinary watering takes to disappear after application.

Continued artificial irrigation tends to change the physical texture of a stiffish soil in a marked form and the cheapest and most effective method so far as can be seen of counteracting this is by introducing a dry fallow which should be placed prior to the best paying crop—in this case cotton.

On the freer working sagia land—which lies on the berm of the river as a rule—the effect of continued watering is less obvious though the tendency is in the same direction. On the other hand on this freer type of soil continued irrigation tends to encourage an excessive growth of grass and weeds so that the land becomes foul and a dry fallow is again introduced as the easiest and cheapest means of cleaning the ground—based on the fact that land is cheap and abundant.

The marked unwillingness of the native cultivator to plough and break up land is generally attributed to inherent indolence but several factors are responsible for this attitude.

In the first place the abundance of uncultivated land makes it possible for a cultivator who has run out any particular area to find on easy terms a new patch which he can cultivate until his own land has been given a rest. In the second place in the northern Provinces along the river, the usual scarcity of cattle food or natural grazing renders the retention of bullocks for tillage expensive and difficult, and when, as is generally the case on sagias, the land is broken up by manual labour, the expense is still greater.

In short the type of cultivation which the native cultivator prefers is that which he practises on rainland or on land naturally flooded : and anything beyond this he regards with disfavour.

In the Gezira and on some of the larger estates the question of tillage has been overcome by the introduction of steam ploughs and cultivators.

Here the land is ploughed and ridged for cotton on behalf of the native cultivator and the cost is charged to his share of the crop. This leaves to him only the lighter forms of labour e.g.

the distribution of the water, fassing and picking — a form of labour which corresponds more nearly to his own system of rain cultivation.

If we take an area where development is to be carried out on some scale by artificial irrigation either by means of a pumping installation or by gravitation canal, in the first place a partner or partners with capital are required because in the ordinary sense native cultivators are not possessed of capital.

The land must be either the property of the partner supplying the capital or he must have the administration of it. This is necessary in order that he may select suitable and get rid of undesirable or slack tenants. He must put up the money for and carry out the erection of all capital works e.g. machinery, canalisation etc. : and he must allot the land in suitable tenancies.

Further he must carry out all the heavy work such as ploughing, ridging etc., leaving only the lighter work e.g. fassing, watering, picking to the native tenant.

He must also provide any financing required and arrange marketing and sale of the crop, (the marketing of the crop is essential as their share of the crop is the only security native cultivators usually have to offer).

It is understood that the cost of ploughing ridging etc. and any cash advances are chargeable against the tenant's share : also that all expenses in marketing is a general charge against the proceeds of sale before distribution.

In the Gezira with cotton as the crop, the division is 60% to the partners supplying land, water and general administration and 40% to the native tenant.

It is the custom of the country to divide the crop in this way amongst the various partners and the following division applicable to a sakia in proximity to the Gezira Scheme will be of interest—on this the share system in force in the Gezira for the native cultivator is largely based.

The following diagram represents a sakia in that locality as divided into ten equal parts representing ten equal shares of the crop.

WORKING OF SAKIA (in the Gezira locality)

LAND.		SEED AND IMPLEMENTS.
Sakia wheels (kept in repair).		Tenants.
Cattle.		Tenants.
Cattle.		Tenants.
Cattle food.	Seed & Implements.	Tenants.

Land = 1/10 share of the crop.

Sakia wheels and repairs } = 1/10

Cattle = 2/10

Cattle Food = 2/30 (i.e. 2/3 of 1/10)
Seed and Implements = 1/30 + 1/10 } = 2/10

Tenants (i.e. labour) = 4/10 or 40% to the tenants.

According to custom the land takes 1/10 of the resulting crop.

The sakia wheels kept in satisfactory repair take 1/10.

The cattle for working the sakia take 2/10.

Cattle food accounts for 2/30; and seed and implements for 4/30.

Tenants (or labour) take 4/10 or 40%.

In the Gezira Scheme the tenants pay for the seed but as the crop is cotton the cost is negligible. With a crop like wheat, if the tenant provided the seed the cost would be appreciable—compared with the resulting value of the crop - and would necessitate a rise in his share.

In the Northern Province of Dongola the shares are somewhat different.

The following diagram represents a sakia in that locality as divided into twelve parts.

WORKING OF A SAKIA (in Dongola).

LAND.		CATTLE AND CATTLE FOOD.	
Sakia wheels.			
Cattle and Cattle food.		Tenants i. e. Labour.	

Here the owner of the land takes 1/12 of the crop as his share: the owner of the sakia wheels takes 1/12 : the owner of the cattle who also provides the cattle food takes 5/12; and the tenant labourers take 5/12, equivalent to 41.6% of the crop and they supply any seed and implements required.

WEIGHTS OF VARIOUS SEEDS.

The following table represents the weight in rotls per kela of various seeds—obtained from actual weighings.

The kela is a measure of capacity in the form of a truncated cone—wider at the base than the top. The usual custom is to heap or "com" the measure in which case the capacity of the kela is equivalent to 16.5 litres or .453 bushel. The heaping of the measure depends to a considerable degree on the skill of the operator which has a considerable effect on the weight per kela—apart from the usual factors causing variation such as the variety, the season, sufficiency of water for the crop, cleanliness of sample etc.

With dura weighing 27—28 rotls approximately per kela heaped, the "struck" kela (i e. the grain level with the top of the measure) will weigh 25—26 rotls approximately. Again dura a year old will weigh 1—1½ rotls less per kela than the season's crop.

The weights now given are for the heaped measure according to custom and are to be taken as approximatety correct only.

	Weight per kela in rotls.	
Ads Sudani (*Cajanus indicus*)	32	rotls.
Barley	22	,,
Castor (*Ricinus communis*)	20	,,

	Weight per kela in rotls.
Cotton Seed *(Egyptian : Sakel)*	22½ (a) rotls
Cotton Seed *(American)*	12 (b) ,,
Dates *(Barakawi)*	20 ,,
Dukhn	29 ,,
Dura	27—28 ,,
Faterita	27 ,,
Gassabi	28 ,,
Hamaezi	28½ ,,
Wad akr	28 ,,
Safra...	28 ,,
Earthnuts *(Ful Sudani)*	14½ ,,
Ful Masri—*Egyptian Beans*	29 ,,
Hommos *(Cicer arietinum)*	31 ,,
Lucerne—*(Berseem Hegazi)*	30 ,,
Lubia Afin—*(Dolichos Lablab)*	28½ ,,
Maize	30 ,,
Semsem *(white)*	22 ,,
Semsem *(brown)*	22 ,,
Termis	29 ,,
Wheat	29 ,,

(a) The so-called ardeb *sack* well and fully packed will take a good 300 rotls of Egyptian Sakel Cotton Seed.

Similarly the so-called ardeb *sack* will take 210 rotls of American Cotton Seed.

GLOSSARY

Ardeb = A measure of capacity = 12 kelas = 198 litres = 5.44 bushels.

Belwa = Name given to indigenous variety of cotton

Berm = The strip of higher land along the bank at the edge of the river.

Bursh = Matting plaited from dom palm leaves.

Damour = Cotton cloth spun on the native hand loom.

"Fas", "fassed" = A hoe shaped like an adze.

Feddan = 1.038 acres.

Hugna = The lower end of a rain teras.

Kantar = 100 rotls : in the case of cotton = 100 rotls lint or 315 rotls seed cotton.

Kela = A measure of capacity = 16.5 litres = .4533 bushel.

Khor = A watercourse which comes down in flood during the rains but is usually dry the rest of the year.

Matmura = A circular pit dug in the ground for storage of dura.

"Mayas" = Natural basins—usually in the depression behind the berm of the river—which fill from the river during high flood.

Milod = An implement for weeding somewhat like a Dutch hoe.

Noorag = An implement for threshing wheat provided with six cutting circular discs—hauled by oxen.

Rotl (rottle) = .99 lb.

Sagia = Water wheels with chain of buckets driven by oxen for raising water.

Seluka = (a) A special stick used to make seed holes.

(b) The land uncovered on the fall of the river flood or the crops sown thereon.

Sheikh = Head of a village.

Sudra = The upper end of a rain teras.

"*Taradding* = Running up of the original cotton ridges by means of the native plough—thereby throwing the cotton stands more to the centre of the ridge.

"*Teras*", "*terassed*" = The basin formed by running earthen banks across the slope of the land to hold up rain water.

Tibn = Chopped wheaten straw.

Zahaffa = A log of wood drawn by oxen to break clods and form a tilth.

Zibla, Zibla'd = A mixture of cattle dung and mud used a sa plaster or for flooring.

TABLE OF EQUIVALENTS IN CURRENCY, WEIGHTS AND MEASURES.

One Pound Egyptian (LE. 1) = 100 piastres (100 P.T.)= 1000 milliemes = (1000 m/ms) = £1 - 0 - 6d (in English Currency).

Square Measure :—

1 Feddan = 4200 square metres = 1.038 acres.

Weights :—

1 Rotl. = .99 lb.

1 Kantar = 100 rotls = 99 lbs.

N. B. :— *1 Kantar of cotton* = 100 rotls lint = 315 rotls seed cotton i. e. cotton unginned.

Capacity :—

1 Kela = 16.5 litres = .453 bushel.

1 Ardeb = 12 kelas = 198 litres = 5.44 bushels.

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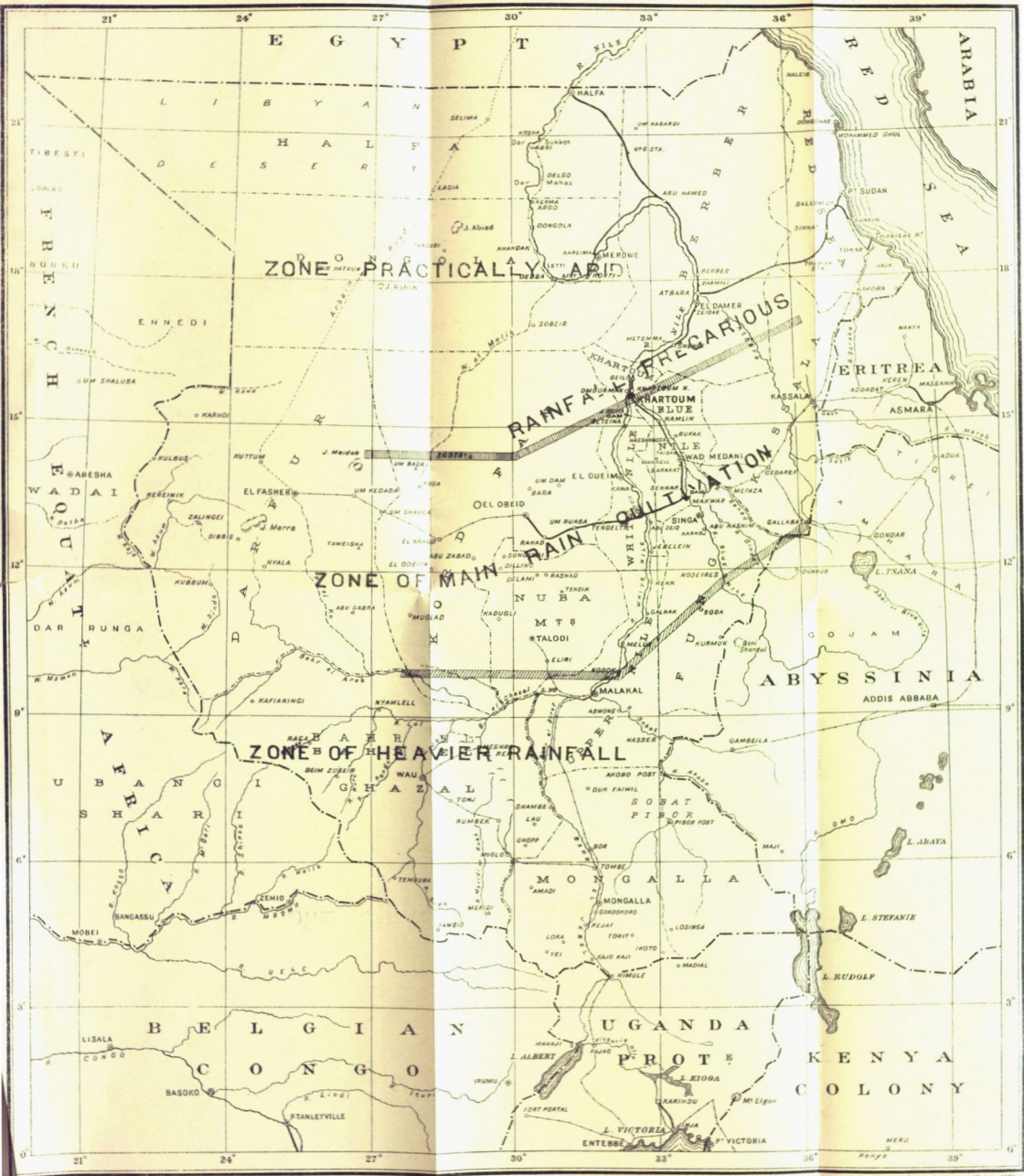
THE ANGLO-EGYPTIAN SUDAN.



Scale. 1: 8,000,000.

MILES 100 50 0 100 200 300 400 MILES

Reference.

Railways
Telegraphs or Telephones
International Boundaries
Province Boundaries

Survey Dept. Khartoum. March, 1929.