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THE SUDAN'S GRAIN SUPPLY

by

J. H. K. JEFFERSON

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THE SUDAN'S GRAIN SUPPLY

By J. H. K. Jefferson.

(Following this paper are some comments by the Director of Agriculture in the Ministry of Agriculture, which are indicated in the text by numbers.—*Ed.*)

THE grain supply of the Sudan is a subject of interest for two reasons: firstly because of its unique pattern, secondly because of the care and management necessary if it is to continue to satisfy national demand.

In most agricultural countries town-dwellers and peasantry obtain their staple foods from areas near to their town and villages. In the northern Sudan the staple food, *dura* (*sorghum* millets), and staple oil seed, *simsim* (*sesamum*), are produced in a relatively narrow belt across the centre of the country and sent long distances to consuming areas, both rural and urban.

For instance, Port Sudan is 515 miles by rail from the nearest producing area—around Gedaref; Khartoum and Omdurman are 108 miles from the centre of the irrigated Gezira, but 250 miles from the main Fung areas. The Northern Province, which consumes much of the commercial *dura* crop each year, is 450 miles from the Fung and 520 miles from the Gedaref area. Nearly every ton of *dura* is sent many hundreds of miles to reach its consumer: this is a remarkable state of affairs in a purely agricultural country.¹

This divorcement of producer from consumer results in the consumer neither knowing nor caring how the major industry of the country is faring. I say "major industry" in the face of the cotton industry because, after all, one cannot eat cotton and even the Sudan cotton industry could not pay for imported grain to feed the nation if its own grain-growing were to fail. It is important that the consumers, who form the wealthy and influential part of the nation, should know what is happening in the producing areas, because their sympathy and co-operation are going to be needed in a coming struggle to put the producing areas on to a sound basis.

It is the educated and intelligent classes among consumers who must play their part in bringing to fruition certain vital pilot measures of rural reorganisation recently started by the Government.

The northern Sudan's commercial grain crop is produced in a narrow belt averaging about 150 miles in width, stretching from the Butana bridge in the east to the eastern edge of the Nuba Mountains in the west.

The belt is characterised by the *kitr* bush, by heavy black clay and by uncertain rainfall.²

The crop varies considerably with the seasons, but a good year would see 100,000 tons marketed. This quantity would be made up by 30,000 tons from the Gedaref area, 40,000 tons from the Fung area in the Blue Nile Province, 15,000 tons from the irrigated Gezira area, 10,000 from the Manaqil area and about 5,000 from west of the White Nile.

Broadly, the *dura* crop is produced by five methods: by true *teras* cultivation, by rainland village cultivation without *teras*, by irrigation in the Gezira, by *harīg* cultivation and by *mahal* cultivation. (a) Roughly the proportions filled by these methods are:—

True <i>teras</i> cultivation	5—15%
Village cultivation	40—60%
Irrigation	10—20%
<i>Harīg</i> cultivation	5—20%
<i>Mahal</i> cultivation	0—10%

The first and the last three of these headings give no cause for worry and the last two will be explained later. The second heading gives considerable cause for worry.

Village cultivation of the commercial *dura*-growing belt, besides being indispensable to the consuming areas, is also vital to hundreds and thousands of villagers and their families, whose livelihood it is. Village pattern, tradition, system of land tenure and agricultural method are the same to-day as they were generations ago. They are suited to conditions in which, with small populations, land is ample for all purposes and new areas are always available for cultivation while the old are being rested. The old plan—or lack of plan—cannot be a basis for a grain-growing industry which will carry the burden of demands made by a nation expanding under the impact of modern organisation. Signs of a breakdown are now very evident, but before discussing them I should like to enlarge upon the inherent technical faults which make the present village system hopeless as a national production unit.

Everyone knows that in order to obtain a steady yield of crops from a piece of land, some steps must be taken to maintain its fertility. These steps may be rotation of crops, cultivation, manuring, folding with animals or leaving the land to recuperate under natural fallow. In the rain belt the last method is used, and all cultivators know how important it is to fallow their land every four or five years for about a similar period. In the old days, when land was apparently in unlimited

(a) A descriptive note on these methods will appear in Part 2 of this Volume.—*Ed.*

supply, this was done, and enough produce resulted to maintain rural areas and provide a surplus for the small towns. Things must have gone on in this way for many generations.

Since 1900 modern transport has on the one hand encouraged the growth of towns by providing swift and cheap extraction of rural produce, and on the other encouraged rural development by the reciprocal effect.

It is difficult to say how many new villages have appeared in the last fifty years, or to what extent old ones have increased in size, but anyone familiar with the rain belt knows that the growth in both directions has been very rapid. The system of land tenure in the rain belt is generally one in which the land vests in the state or is under tribal authority and an individual has cultivation rights only over the land he is actually using or can use. The cultivator cannot reserve other areas for his future agricultural operations ; he might insist on his right to an area to which he had established title by former cultivation, and maintain it under fallow, but in practice this is only done to a limited extent — probably because traditionally there was always ample fallow land available and a fallow area actually reserved was an unheard-of thing. When demand, transport, security, public health and medical services stimulated rural development, common land under bush or grass was used for settlement and cultivation ; but to begin with no special effect was felt, since most of the land was not within the orbit of existing villages. Indeed, prosperity reigned, with gross yields and transport returns increasing annually. Eventually the perimeters of the expanding circles of village cultivation began to touch, and within a few years villagers found that new areas were unavailable and they were forced to cultivate plots after they knew that they should be rested. In this period yields dropped steeply and villages became impoverished, for the black soil is very sensitive to over-cultivation ; this affects its power to retain water between showers, and crops fail through drought.³

The system of land tenure, aggravated by the occurrence of water supplies at single points, which discouraged villagers from living on their holdings, was the crux of the situation. It has been said that all might have been well if there had been enclosures on the English pattern, but this is an oversimplification and hardly possible in view of the lack of water and fencing.

What signs are there that anything is amiss ?

There is the appallingly low level to which annual yields per unit area have, in many areas, been reduced. Recent investigations have shown that the average yield from such land is in the region of one-eighth

of a ton per *feddan*^(b); it should be around half a ton per *feddan*. In these areas village cultivation is contiguous for long distances and fallow plots are accidental rather than intentional. These things are almost unrealised outside cultivating circles, and even there their true significance goes unheeded. Declining yields are attributed to bad seasons or any cause other than the true one, or are even not accounted for at all. Nowhere does any suggestion make itself heard that planning in the past could have saved the situation. Cultivators and rural notables seem unable to take a critical view of trends developing under their own eyes or to offer constructive plans for the future. One of the greatest difficulties of any reform is that the rural populations have to be cajoled and persuaded into accepting measures for their own good, and it is sad that they never seem able to act spontaneously without governmental goading. Here is a tough and practical problem for adult educationists, for certainly those whose business it is to carry out the technical details of new settlement schemes have not time to act in this capacity in addition to their own work.

Again, the steadily rising price of grain since controls were removed is another ominous sign of the conditions in producing areas. This rise in price is attributable to several other causes and some would argue that these are wholly responsible for it. It is not so, and I firmly believe that the true cause is the steady decline in yields from the nearest producing areas. Other contributory causes may be removed by different means, but the deterioration of the land is relentlessly forcing upwards the basic minimum price.⁴

A third sign of the worsening conditions is that so low are yields that villagers are unable to make their living from their land and, as soon as cropping time is over, they have to seek supplementary employment elsewhere, in areas such as the Gezira Scheme. Driving through the areas they have left is a dismal business; the half-empty villages are occupied only by caretakers, old men, and women with families too young to work. House repairs are neglected, there is no social life, and shops and schools are absent for there is no demand for them.

In America a migrant population of 30,000 souls is regarded with apprehension, but the Gezira has a migrant population of over 100,000. Not all of these come from depressed village areas; some are Westerners working their passage to the pilgrimage, but it is an ominous sign if the proportion of non-Westerners is too high. Equally it will be bad for

(b) One feddan equals 1.038 acres or 4,200 sq. metres.

the cotton crop if remedial measures in the rainlands are successful, unless special steps are taken to maintain the labour supply.⁵

A visible sign of trouble is the extensive banking or *teras* system which extends far south of the point where it is necessary. Where rainfall, though uncertain, is adequate for general crop production each year, the soil when managed properly will absorb enough rain to grow a crop. Banks are unnecessary here, and in any case a good soil has almost no surface run-off. In areas further north, where crops cannot be grown yearly but only in years of heavy showers, banks hold up flood water and crops can be grown in the area covered by the water standing against the bank.

As explained above, if good rainland soils are over-cultivated they lose their water-retaining power, rainfall is wasted by run-off and crops die of drought. Cultivators who cannot apply the correct remedy of fallowing seek to force surface water into the soil by preventing run-off with contour banks, so these contour banks or *teras* are an accurate visible sign of soil impoverishment. At present their use has extended down through about one-third of the commercial rain-belt and more are being made annually. Often a lazy cultivator prefers to bank his land rather than take the trouble to clear new land, in spite of loss of yield. In many cases men and women too old and feeble to cope with weed growth on new land take over old abandoned plots and so prevent their regeneration. Usually a new area does not reach its maximum yield until its second or third year; in the first year the weed growth is heavy, and this is one reason why lazy men prefer to stick to old plots and avoid the work of opening new ones.⁶

There are certain reasons why the deterioration of village agriculture has been obscured from public notice. One—the alternative source of livelihood in the Gezira cotton fields—has been mentioned. Further, the development of *harig* areas during the war and several successful seasons for this type of cultivation have temporarily offset declining yields from village lands. Price controls also have hidden normal price rises which would have shown up increasing shortages; the rapid increase in price after their removal was a strong indication that something was wrong.

Lack of consumer goods during and after the war reduced the effort put by cultivators into their crops, for there was nothing to buy with extra money; this slowed down the evil process by relieving the pressure on the land. Similarly merchants, finding profitable war contracts, were not free with loans to cultivators or with the personal agricultural ventures to which they had been accustomed in peace time.

Again, during the war the cultivating population was thinned out by men going into the army or to profitable work on army contracts. It is true that these men still ate *dura*, but they only required from the land enough to feed themselves whereas had they been cultivating, they would have demanded this and a saleable surplus to supply them with other necessities of life.⁷

The fact that there is still new land available for exploitation by persons from overworked areas also mitigates the loss of the land's productive power.

What areas are most affected by the process described? Briefly, those where water supplies are easiest and therefore settlement has been most dense. The main "depressed area" is that adjacent to and south-west of the Gezira irrigated plain. It contains the centres of Wad el Haddad, Sabil, Mikashfi and many other lesser towns and villages. Banking (*teras*) is universal here and extends southwards to the large settlement of Maiurno at the southern end of Sennar district, enclosing the whole of Sennar Town and satellite village areas to about twelve miles westward, which is the limit of the local well field.

Across on the White Nile there is an area known as the Qafa el Mahdi. This contains probably over thirty villages which are only used for cultivation in the rains, the cultivators being inhabitants of Aba Island. Here there is no lack of land; only lack of forethought prevents planning of agricultural operations and much of the land is banked.

Gedaref district contains a great deal of worn-out land round numerous villages within a small radius of the town itself; practically all this land is banked. Suggestions have been made by local agricultural authorities, in the Rural District Council, that villages should adopt a simple rotation for their lands, but they fell on the deaf ears of the traditionally minded members, who were in the majority, and nothing was done.

Even further south than the top third of the main *dura* belt evidence of over-cultivation is easy to find round almost any large village or town. Principally such examples are found near settlements based on the Blue Nile; west of Singa, however, on the way to Jebel Dali, is a large agricultural area with ample land and even here some *teras* are made. Everywhere in fact it is evident that neither the cultivators nor their sheikhs and omdas have any inkling of a planning sense by which to assure their own future as a sound peasantry or to found a thriving grain and *simsim* producing industry which can play its part in the development of the rest of the country. By this attitude the rural population are condemning themselves to a future as miserable squatters

and dibblers, as soon as unplanned development has eaten up the available fallow land. One must remember—the cultivator does not—that the available fallow does not extend as far as the eye can see but only to within three miles of a water supply, and this severely limits resources.

Some would include the Manaqil area in the short summary given. This I think is not quite right as Manaqil borders on the area where rainfall does not guarantee an annual crop, and banks are justified to produce any crop with what rain there is. This certainly applies to the area round Rufa'a and the hinterland between Rufa'a and the Butana. People in this area do not expect annual crops and every cultivated plot is on a *teras*.

Let us see how the individual cultivator fares in a depressed agricultural area. Medical authorities agree that the correct ration of *dura* for a working man is two *rotls* ^(c) daily; this is the amount issued to soldiers and police. A recent survey in the Wad el Haddad vicinity showed that the average size of a man's holding was about 4.2 *feddans* and that the average yield in the 1947/8 season was about one-eighth of a ton or 275 *rotls* per *feddān*. This gives 1155 *rotls* per plot and if there is a family of four it works out at .75 *rotls* daily for each member. But even from such a small ration the cultivator contrives to sell something to get money for essential goods; indeed much of the crop is sold to merchants in advance, before harvest, to raise loans. In this particular year some 30,000 able-bodied cultivators sold 6000 tons of grain from the area; this reduced the family ration by 440 *rotls* or by .3 *rotls* per head, so that the final amount available was .45 *rotls* per head. One can understand that feeding at this level rural populations have not much initiative either to work hard or to plan operations intelligently. If the head of the family goes away to work, his share is probably left to swell that of the rest of the family, but the net result is that by purchasing his food elsewhere he acts partially as a consumer of grain instead of a producer and increases the general price level by his additional demand—which, of course, may include some *dura* in the form of *merisa* (millet beer).⁸

Supposing it were possible to fallow half the area of land now under perennial cultivation in the Wad el Haddad and Sabil areas and to bring it back under cultivation after, say, ten years, when it had become regenerated under bush and natural grasses, and then to fallow the other half—what would be the cultivators' position? The average plot would be 2.1 *feddans* and might reasonably be expected to average half a ton

(c) One rotl equals .99 lb. or 450 grammes.

per *feddan* or 2310 *rotls* per plot. This would give the family of four 1.6 *rotls* daily basically, and 1.3 *rotls* per day if the same amount were sold outside as to-day. It is not suggested that this is a practical proposition: it would meet with overwhelming local opposition; but it is given as an example of the difference in outlook in an area which uses its land properly and one which does not. The 1.3 *rotls* per day per head of the family is still short of the ideal ration of 2 *rotls* per day but on the other hand it is far more than the maximum which it was ever possible to issue to the civilian public in the time of controls and rationing. This was .8 *rotl* per day per head—a figure not to be forgotten, for it shows what efforts are necessary before the nation's food supply can be considered sound.

We have seen how the individual cultivator and his family are affected. Let us see how the grain market which feeds the public is being affected.

Assuming that the fertility position in the grain belt is half-way between that of new land and of land which has reached its lowest production level, the average yield over all would be 5/16 ton per *feddan*. In, for example, a year when 100,000 tons of grain come on the market, roughly 50,000 tons come from the village lands. Should all these lands deteriorate to the last degree, or to an average of 1/8 ton per *feddan*, there would be a drop of 30,000 tons in marketable *dura* by simple proportion. In fact we might lose more than this, because the proportion of grain reaching the market from land in the last stages is less than that reaching the market from land still possessing some of its original fertility. We might easily lose up to 40,000 tons, and this would reduce the ration of the town-dweller to about half a *rotl* per day; and Heaven knows what it would do to the price!

So far the picture of the future of the Sudan's grain supply would seem black. Provided, however, that the public can be made to appreciate the problem and take a lead from Government pilot schemes, it is not black at all. Indeed it is bright; for the Sudan, with its vast resources of land which become available with new water supplies is in an almost unique position to repair agricultural mistakes of the past. Anyone who has read that absorbing survey of world soil erosion. "The Rape of the Earth," will realise just how remarkable this position is. Communities, nations and even empires have fallen because agricultural mistakes, if realised at all, were realised too late, when remedial measures would have entailed great social upheavals which were—with one exception—impossible to face. That one exception was the Tennessee Valley episode in America.

In this country the lines upon which action is being taken to remedy the situation are, at the moment, three. First come the pilot schemes for new settlements whose agriculture is planned on sound lines under governmental supervision ; secondly, control of development by private individuals ; thirdly, repair and maintenance of water supplies in old areas is given low priority in an effort to encourage migration to new areas. Some of these measures may be described in detail.

There are at present in operation three major pilot measures : the Khor el 'Atshan, the Jebel Moya and the Jebel Dali Schemes. Beside being of agricultural interest these are also most interesting from the point of view of the rural water supply engineer, for each one employs a different principle for securing its water supply.

The Khor el Atshan Scheme.—Think of an inverted Y with a long tail and with the right hand branch about three times the length of the left, in the inverted position. Place this between two parallel lines which just touch the ends of the branches of the Y, and you have a sketch of the essential natural water system from which the Khor el 'Atshan Scheme will derive its improved water supply. The left-hand parallel represents the Rahad river, the right-hand one the Dinder river, the long tail and the right-hand branch of the Y the Khor el 'Atshan itself, and the short left-hand branch the Khor Wachawish¹.

Until about ten years ago the area of the Khor el 'Atshan was practically unsettled. The reason was that mosquitoes and noxious flies made the place highly uncomfortable for man and beast for about five months of each year, and as the adjacent district was inhabited by nomad Arab tribes they did not willingly go to a place where they could not take their animals. There were two or three decrepit outposts of Arab villages but they did not prosper.

About 1938 the Khor el 'Atshan appears to have been discovered by Westerners who had got tired of the ordered life of the Gezira and who decided to carve new homes for themselves in this place, despite discomforts. In a way they were helped by the bad conditions, for these kept the Arabs and their animals—always the foes of the cultivator—at bay. By 1944 there were about sixteen villages containing some 1600 houses, and it was at this time that the movement came to the notice of the Agriculture and Forests Department. It was soon clear that here lay a golden opportunity for starting off planned agriculture on a fair scale, with the minimum of expense and with a hard-working and co-operative people.

¹ Author's spelling.—*Ed.*

While a survey of the land and villages was in process, planning propoganda was carried on to the villagers, and in the 1946/7 winter season the land of all the villages was laid out for a three course rotation for each village, in three strips. The rotation was settled on two plots under grass or trees and one under cultivation for each village. The total area laid out was 54,000 *feddans*, which means that 18,000 *feddans* may be cultivated annually. The allowance for each cultivator was ten *feddans* and the limit to the size of the villages was set by the amount of land which could be included on a ten *feddans* per head basis if the furthest distance to which a cultivator was to go to his plot was eight kilometres. The greatest number of cultivators to be included in the original layout is 1,800. Probably however up to 2,500 will easily be accommodated as it is doubtful whether the villagers will use all the ten *feddans* allotted to them ; much of their effort will go to the adjacent *harīg* cultivation. The 1947/8 season was the first one worked by the Khor el 'Atshan villagers under the new rotational layout and it must be said that the response to the regulations made was good.

The duration of the rotations has not yet been decided upon ; observation of the progress of the first will have to decide this. Probably it will be in the region of six years since this land will stand a longer period under crop than that with lighter rainfall. Actually this area is almost out of the area of unreliable rainfall, and not far south of the northern end of the Khor el 'Atshan the *kitr* bush ceases to occur.

An interesting point in connection with the rotational arrangement is that the change from one rotation to another will not be made in a single season. The grass growth here is too heavy to allow of new cultivation being opened up directly on to any given piece of land in a given year. New cultivation is always started here by the *harīg* method and in order to enable cultivators to find a suitable piece of *harīg* in the new rotation, up to three years may have to be allowed. That is to say that any two rotations will overlap by three years, the optimum period of rotation for the old land occurring in the middle of the three. Thus if six years were decided upon as correct, the second rotation would start during the fifth year and be completely in hand by the seventh, at which time all the cultivated area in the original rotation would be abandoned. In order to ensure there being as much *harīg* as possible within the village plots, all village areas are being firelined yearly by the villagers.

Hand in hand with measures for assuring the fertility of the land in perpetuity, go measures to improve the water supply and public health of the area, although these measures are at present in a rudimentary stage.

The country between the Rahad and Dinder rivers suffers from a surfeit of water during the rains and from a drought during the summer, since wells are few and surface water is the main source. The reason for the surfeit of water is that the Rahad river overflows its banks annually, mostly to the west, and floods the country in that direction. This flood water fills many large depressions near to the Rahad itself and even reaches the Dinder river about 40 miles away. This it does mainly through the Khor Wachawish and the Khor el 'Atshan after its junction with the Wachawish. In years when the Rahad is high, about every fifth year, it overflows into the Khor el 'Atshan well south of its junction with the Wachawish, and in these years the water below the junction is about double that of ordinary years. There is one other way by which the Rahad flood can reach the Dinder, and this is through a *khôr* called the Khor el Zeraf; it is about twenty miles north of the Wachawish-'Atshan junction but this only happens in very exceptional years.

If a true picture of the area is to be seen, one thing must be understood: this is that all these channels called *khors* are not *khors* in the normal accepted sense. The country here is not a flat plain but undulating in places and having what would appear to be reflections of small faults in the substrata, though I do not say that this is actually the case. The *khors* are really fortuitous junctions of depressions rather than channels carved out by water. They do not have steep banks or sandy beds and the water flows in them slowly, so that it is quite clear and silt-free. They are wide and shallow and often have large *sunt* trees growing in their beds. This type of *khôr* by its nature possesses both advantages and disadvantages. An advantage, which is the *raison d'être* of present settlement in the area, is that it acts as a reservoir well into the winter and even early summer, since not being purely a channel there are many depressions along its course which do not drain with the cessation of the flood. The writer has had fresh fish out of a pool in the Khor el 'Atshan in early April and indeed these *khors* are a centre of a steady dried fish industry, the fish being caught in traps built across the connections between one depression and another at the time when the last of the flood is draining out. The bed of the Khor el Atshan varies from about 80 metres to about 200 in width.

Disadvantages of these *khors* are that having a slow stream and containing large pools they harbour bilharzia and mosquitoes and provide a great attraction for birds. These, the grain-eating weaver birds, roost in the *sunt* trees of the *khôr* at night and eat cultivators' grain by day. In recent years a good deal of investigation has been done on the

problem of the grain-eating weaver bird.^(d) The majority of the birds breed in the east and their line of migrations is one of the major seasonal factors affecting the country's *durra* supply. The line of migration is mainly affected by the distribution of standing water in the country over which the birds have to pass, the route with the most standing water being chosen.

Clearly the engineering problem in the Khor el 'Atshan area is the prevention or draining of surplus water on the one hand and the provision of good water supplies on the other. Happily, preliminary investigations show that these two objects can be achieved jointly. By regulating the flow from the Rahad river into the Khor Wachawish this *khor* and the Khor el 'Atshan can be used as canals to fill deep reservoirs, and as drains to escape excessive quantities of Rahad flood water if their beds are deepened in certain places. The deep reservoirs would have filter wells and settling tanks against bilharzia and would be sited along the sides of the present Khor el 'Atshan. Deepening of the Khor el 'Atshan in certain places would prevent formation of pools after the flow was cut off.

Altogether the Khor el 'Atshan is a most promising area and all it needs to develop into a sound asset to the country is careful nursing of the cultivators during its first two rotations and the necessary improvements to water supplies and public health.

The Jebel Moya Scheme.—Jebel Moya is an irregular outcrop of fine granite, roughly elliptical in shape, about 5 kilometres long and about two wide. It is about 20 miles west-south-west of Sennar, and although in an area which has about 425 mm. rainfall the hill itself almost certainly gets much more—possibly up to 500 mm., and this of much more certain degree than that of the surrounding country, due to the effect of the rocky mass upon the local climate. Such a large mass of smooth rock at once suggests catchment possibilities for rainwater, and these have been confirmed by a survey of the Jebel plinths and the *khors* flowing away from the hill. Fortunately it is very difficult for local small scale enterprise to exploit the catchment areas of the Jebel, and this has left its development almost free for the government; but, more important, it has meant that large areas of first-class soil around the hill have been unspoilt by uncontrolled agriculture.

Why it is difficult for local villagers to make use of the catchment on any scale is easy to understand. The only practical way to use run-off water is to store it in reservoirs of sufficient depth to allow for

^(d) See *Sudan Notes and Records* Vol. XXVIII (1947) and Vol. XXIX (1948) Part 2.-Ed.

evaporation losses. This means at least six metres. Except in a few places this depth of soil only occurs some two or more kilometres away from the hill, and the villagers are not prepared to live on the black soil, preferring the granite sand at the foot of the rock. They are also not prepared to go this distance for their water and of course it is hard work digging a hole six metres deep by hand labour.

Development at Jebel Moya was favoured by its soil and water but more important is the fact that the Jebel is near to the "depressed" agricultural areas of Sabil and Wad el Haddad. A relief scheme was first thought of about 1945, but active steps, other than survey, were held up owing to lack of machinery until 1947.

The drinking water problem was solved by digging a large reservoir near one of the outlying outcrops of Jebel Moya called Jebel Fangugu. This lies about 5 kilometres to the south-west of the main *massif*. The discharge from seven *khors* running southwards from the Jebel is brought to the reservoir by two short canals. Travellers by rail to Kosti from the north may have noticed these *khors*, as they are bridged by the railway. The capacity of the reservoir is about 60,000 tons of water and this is enough for 1000 families on a generous scale, even allowing for evaporation losses.

The digging of the reservoir, which is six and a half metres deep, and about 110 x 90 metres on the surface, was done by six carryall scrapers in only 21 days.

This reservoir, or the Hafir el Eris (as it was named on its completion about the time of the Royal wedding in November 1947) is in the nature of a pilot scheme. If catchment, rainfall and other data come up to expectations, then it is estimated that Jebel Moya could support at least another four such reservoirs. This would mean that a total of 5,000 families could eventually be resettled, and this would be no small step in the solving of the "depressed area" problem. It would also place 150,000 *feddans* of first-class rainland under permanent sound agriculture.

The land to be cultivated by settlers at Jebel Fangugu will in the first place total 30,000 *feddans*, and will be used under a three-course rotation of two natural fallow to one cultivated under *dura*. Each settler will have ten *feddans* for his family; this is more than enough for to-day's needs but the possibility of introducing machinery into the scheme has to be allowed for. The layout of the land is interesting; it will not be in simple strips as at Khor el 'Atshan but in a chequerboard plan. The cultivated areas around Jebel Moya are definitely in an area of uncertain rainfall: if all the year's cultivation were in one strip it is

quite possible that an unfortunate distribution of rain might fall mostly in this one strip. Therefore the cultivation has been separated into several random blocks to even out the chances.

Any rotation will be comprised of several squares in the total area. To start with, at any rate, when there will be more than enough land, cultivators will have a very generous choice as to where to concentrate their main effort for the year. It is hoped that if the whole of the Jebel Moya catchment is used and 5,000 cultivators installed and a modest average yield of half a ton of *dura* per *feddan* obtained, at least that number of extra tons of *dura* will be available for the general market after deducting the present contribution of the settlers and the *dura* used to feed the average family of four at two *rotls* per day.

This gives a glimpse of what planned agriculture can do. In order that this dream may come true the most necessary thing is a co-operative desire amongst the people for its success. To instil this desire there must be widespread knowledge of the problem being tackled; and this must come about, not through governmental pressure, but by study and discussion amongst the Sudanese intelligentsia and leading families, who are the only effective channel through which this knowledge can reach the cultivator.

Of course there are difficulties in starting such a settlement, in overcoming the traditional attitude to the land and persuading settlers to stick to rotational boundaries. The barring of the land and water-supply to outsiders and the allotment of plots are bound to cause jealousy and discontent, but given adequate staff, and the co-operation born of knowledge anticipated above, the thing should be possible—and worth while.

The Jebel Dali Scheme.—Jebel Dali is a single outcrop of mixed rocks about 800 ft. high above the surrounding plain. About two kilometres long and lying south-east and north-west, it is 45 miles south of Jebel Moya, 50 miles west of Singa and about half-way between the two Niles. Altogether it is a very solitary spot. There is a good catchment area on both sides of the razor-back of the hill; this is nothing like so extensive as at Jebel Moya, but the rainfall is greater. There are several special reasons which make a planned agricultural demonstration scheme desirable at Jebel Dali.

The surrounding land is excellent and unless a planned scheme is placed in the area soon much good land will be lost to sound agriculture through local squatting. Some demonstration of the benefits of planning is highly desirable here in the Fung for large areas of first-class land nearer the river are in imminent danger of suffering the same fate as

those at and near Wad el Haddad. Further, the future inhabitants of Jebel Dali are in the centre of a fine *harīg* area which could be extensively developed. As at Jebel Moya there is already some settlement; it is limited for similar reasons yet it threatens a larger proportion of the surrounding land than does the settlement at Jebel Moya. At Jebel Dali the available depth of soil anywhere near the hill is small; hence local *hafīrs* are very shallow and usually run dry by the New Year. By March all the villages are evacuated, the cultivators having returned to their permanent homes near the river. In the interval, during the *harīg* harvest season, water is brought out by lorry.

Fortunately the existing villages are not scattered round the base of the hill. They have developed only on the north-west side where catchment and storage are easiest, and the south-east is virtually free for planned development. It is hoped that by showing a successful planned agricultural community on one side of the hill, the villagers on the other side will be easily persuaded into accepting a layout for their own lands, at a later date and with the probable inducement of a good permanent water supply. There should certainly be enough water for 500 families and possibly for 1000, or—if conditions turn out to be very favourable—for 1,300. There is water storage for 80,000 tons of water, but it remains to be seen if the catchment can fill it.

The land at Jebel Dali is laid out in the same way as that at Jebel Moya, in a chequer-board plan with several squares randomized throughout the whole comprising each rotation. The rotation will probably be the same at both places — a five-year period under crop with two consecutive five-year periods under grass and bush. At least one ton of extra grain should accrue annually for the general market for each family settled, allowing for the amount they would have produced in the old way.

The catchment and storage system is interesting. Nowhere was sufficient depth of soil found for underground storage of all the water. Therefore above-ground storage had to be used, and this was obtained by using the excavated soil for high banks, so that there is about 4 metres storage below ground and $2\frac{1}{2}$ above. The reservoir was sited very near to the hill on a steep slope so that the banks of a short entrance canal soon ran out to near ground level about 250 metres away from it, thus containing the depth of water in storage. The end of the entrance canal away from the reservoir connects with two lateral canals extending some distance in either direction, whose function it is to catch water flowing from the hill in various small gullies. The reservoir itself is divided into two halves. The intention is that when, through use and evaporation, the total water has been reduced to half, the water of one

half will be pumped into the other. This will reduce the evaporating surface by half and will save up to 12,000 tons of water or sufficient for about 400 families for a year.

Controlled Village Development.—This sounds like just one more piece of governmental interference with the freedom of the individual on purely theoretical grounds. In so far as new villages were never supposed to be created without authority from someone, there is no change from past practice, but in fact control of rural development will henceforth be more carefully and strictly applied. Again there are two solid advantages, from the new villagers' point of view, in the new interest taken in their activities. Firstly they stand a fair chance of assistance for the construction of their new well, and secondly the local authorities use their influence to preserve the land allotted to a new village for that village's exclusive use and thus prevent future overcrowding by squeezing from outside.

Before a new settlement is allowed, the local Agricultural Office carefully investigates the question whether there is sufficient land available for a village, also collecting any data available on the subject of water supplies in the locality. Administrative interests are of course taken care of and proposers have to be men of approved character. The village being approved, the local Agricultural office lays out the new land on a simple three strip system. The area enclosed is usually a square, five kilometres by five, which gives an area of 5,000 *feddans*. As the villages are not intended to exceed 200 families, ten *feddans* are available for each family per year, twenty *feddans* being under bush or grass. This fits in with the simple three-course rotation of five years cropping and ten recovering. In return for these services the new village sheikh undertakes to keep to the agreed rotation and to prevent outsiders from cultivating within the village bounds.

The question has not yet been broached of some form of formal registration of new village lands, but it is probable that this will in the near future be necessary to prevent and settle the disputes which are certain to arise.

To obtain a balanced view of the country's rural economy it is helpful to consider whether we are progressing away from a state of overall soil deterioration or retreating before the factors causing it. We must ask ourselves whether the area lost annually to continuous cropping is greater or less than that put under rotational cultivation, and to what extent we are successful in recovering lands which have reached their end-point of soil exhaustion for the purpose of planned

regeneration. Until the counter-measures described were started we were losing the struggle out of hand and it is yet too early to congratulate ourselves on successes, although we have accomplished the engineering groundwork for the Jebel Moya and Jebel Dali schemes and the survey lay-outs for these and the Khor el Atshan scheme. We now have 120,000 *feddans* available for rotational agriculture in these schemes and some 18,000 *feddans* in planned village lands. This gives us a good chance of securing 138,000 *feddans* under sound agriculture in perpetuity. If we can continue to get one 30,000 *feddans*, or 1,000 family scheme going every two years, and ten new villages of 6,000 *feddans* each every year, we shall advance at the rate of 75,000 *feddans* annually. While this development is going on there should be little or no loss to unplanned development, since the staff in the field will be in close touch with areas and will easily spot any unauthorised new villages. Additionally the provision of soundly engineered new water supplies should in itself short-circuit the desire for privately constructed ones.

We can now make a guess at the time it will take us to put the whole of the important rainlands on to sound agricultural practice. The value of this guess must be qualified by the knowledge that our supporting statistics are only rough, but nevertheless we can still get an idea of the nature of the answer.

If we take the total area of the lands to be treated to be 2,000,000 *feddans* of actual cultivation, we must replace this by an included area of 6,000,000 *feddans* to give enough space for three course rotations; if in one block this would occupy an area square of side 158 kilometres. We should allow an extra 20% to allow for probable increase in population, making 7,200,000 *feddans* or a square of side about 173 kilometres. At the above rate of operation it would take 96 years to accomplish the complete agricultural revolution.

Clearly we do not want to wait for this time; about one quarter of it would seem reasonable, or 24 years, in which case we should have to quadruple our efforts, encompassing 300,000 *feddans* annually. In order to elaborate the picture I shall give the reader three further estimates: firstly an estimate of the mechanism through which I visualize this agricultural revolution might take place; secondly the probable cost; thirdly the probable economic return to the nation.

The mechanism.—I believe that the operation should be undertaken by a team divided into six sections and operating as a branch of the present Soil Conservation Board, for this is surely soil conservation. In the order of their appearance on the scene these sections would be:—

an exploratory section to locate and define potential areas for development and their water supplies ; a field engineering and survey section to provide water supplies and land layouts ; a propaganda section to provide intimate adult education amongst those whose lives were to be affected ; a legal/political section which would arrange for any expropriation compensation and adjustment of tribal boundaries, for instance, in the probable case of a clash of interests between cultivators and nomads ; a field agricultural section to supervise the early years of each component project which would be progressively withdrawn as the projects found their feet and were left in charge of the local administration ; and lastly an accounts section. Each section would, of course, contain the necessary experts for its job and I would suggest that the whole should be directed by a small, active, whole-time triumvirate, covering agricultural, political and civil engineering matters. If the members of this were carefully selected for their ability to work together and see each other's problems, the whole plan would have an enhanced chance of success.

The probable cost.—Very roughly, I should put the annual requirements of the various sections thus :—the exploratory section £E. 25,000 ; the field agricultural section £E. 50,000 ; the field engineering and survey section £E. 250,000 ; the propaganda section £E. 20,000 ; the legal/political section £E. 20,000 out of which claims would be settled ; the accounts section £E. 10,000 and lastly the headquarter triumvirate at £E. 10,000. These figures are intended to include all costs such as transport and leave allowances, housing etc., which are sometimes considered as a free service. The total is £E. 385,000. Over the period of 24 years estimated necessary to complete the job, the total expenditure would be £E. 9,250,000. I have not included a figure for maintenance but this, I suggest, could be recovered directly from new settlers as the operation proceeded, and I believe something around 50 P.T. annually per head of cultivating unit or family would suffice. In the case of the Jebel Moya scheme this would bring in £E. 500 yearly, and probably it would be more than enough.

I do not anticipate starting off at this level in the first year, but taking up to five years to reach it. Thereafter it would probably be possible to make up for the delay by working at a higher level, particularly if several extra-large schemes were used. A possibility here would be the " Abu Na'ama Scheme " which, briefly, is to develop a large area south of Jebel Moya by providing drinking water from fresh-water canals which would have their source at Abu Na'ama on the

Blue Nile and be filled by pump. The levelling and tentative siting of canals have already been carried out.

The return to the nation.—First of all let us think of the final effects. If we assume that the present-day situation regarding grain yields is half-way to the final deterioration of the soil, we get an average of between one-eighth and one-half of a ton per *feddān*, or 5/16 ton. We hope that in the end we shall have raised all the land to a yield of half a ton per *feddān*; therefore if the present total yield off 2,400,000 *feddāns* is 750,000 tons, at the end of the operation it will be 1,200,000 tons—an increase of 450,000 tons, worth at £E. 5 per ton £E. 2,250,000. This figure means that the annual cash expenditure of the scheme will be equalled by returns in produce many years before it is complete.

Those who care to draw a graph of the functions will see that the annual return of increased produce value exceeds annual cash expenditure in the fifth year at £E. 468,750, and that the total expenditure is actually covered by the fourteenth year, when the total excess production of new over old had reached a value of £E. 9,843,750. This does not, of course, mean that this sum has arrived back on the credit side of the ledger, but it should not be a difficult matter for inland revenue experts to collect enough cash to pay for the scheme from its products before it is complete.

Thereafter the scheme is sheer profit to the nation. One reason why results should come so quickly is that whereas expenditure is at a fixed level annually, the income, as reckoned by value of produce, increases each year by the figure of £E. 93,750 attaining to £E. 750,000 in the eighth year. In all cases I have deducted the equivalent value of produce from old land from the products of the new in calculating the profit figure.

Before we leave this aspect I should like to satisfy the very conservative and sceptical. Suppose that the average yield of properly used land does not attain a half ton per *feddān* level but only one-third of a ton; and supposing that the yield of worn out land does not fall to one-eighth of a ton per *feddān* as I have assumed but only to one-sixth: the final position then is that the annual yield from the whole area is 733,300 tons as against 366,600 tons—an increase of 366,700 tons, worth at £E. 5 per ton £E. 1,833,500. Obviously even with these figures the scheme is still very well worth while.

It would be possible to quote almost *ad nauseam* permutations and combinations of figures covering different aspects of this subject but all would point to the same answer. I think enough has been

said to make it quite clear what is in store for this country if action is not taken. Let the reader be under no misapprehension : here is the key to the safety of the Sudan's grain supply. No amount of controls, partial or total, of reserves held and released with a view to price stabilisation or any other palliative measures, can remove the inexorable effects of wrong agricultural methods. The vast spaces of this country are deceptive, creating an illusion of illimitable resources. The fact is that these resources are almost illimitable, but only if properly farmed, and the problem should be appreciated now before delay makes the solution even more difficult. I will not readily enter into discussion over the details of my figures, for the situation can be likened to an algebraic equation ; it is the proportions which matter and I would be prepared to take issue over these.

The position of machinery in the Scheme.—In my view, the first function of machinery will be to bridge the gap between the results of the maximum effort of the cultivator operating by hand methods and the desired level of *dura* consumption for the nation. The second will be to develop an export trade in *dura*.

I do not think that the time is anywhere near in sight when all village cultivation will be mechanised. I see machinery being applied to perhaps one zone of planned villages. It will be large machinery owned and run by the government, which will perform certain fixed operations for cultivators, and the whole zone will have to be well organised with ample supervisory staff. I do not think that we shall see each village or even each cultivator owning private small machines : maintenance difficulties would prohibit this and there could never be a great enough change in the cultivator's attitude to machinery to make it practicable. However if the development of mechanised farming goes ahead faster than is expected, the new village operating with proper rotations will be in a good position to co-operate, since the land will be laid out in even blocks suitable for mechanical treatment.

A very brief mention of the difficulties besetting the use of machinery on the Sudan rainlands will not here be out of place. They all spring from a central cause ; that is, as it is impossible to clean black soil from weeds while it is carrying a crop, cleaning must be done before the crop is put in. Of course a small amount of weeding can be done while the crop is on the ground, but not much. This leads to two alternatives : either the land must be cleaned immediately before the crop is put in or it must be cleaned in previous years. Till now there has not been sufficient time to experiment fully with the latter method.

The former presents two unpleasant problems of its own. Firstly it usually appears necessary to weed the land twice before putting the crop in, and this means delaying its sowing until late August, or later, which especially in a season of short rains is cutting things very fine. Secondly, the very action of machines in the soil seems to have an effect of its own, in causing weed seeds which would have otherwise germinated in later years to come up. The problems for solution are formidable but their solution would bring great benefits to the Sudan; there are enormous areas which could be utilized by machinery, particularly if those further south than at present contemplated are brought in.⁹

It should not be thought by those who are engaged upon the development of mechanised rainland agriculture that this aspect of the whole picture is being dismissed too lightly. On the contrary I certainly believe that the use of machinery is essential to raise the Sudan from a more or less subsistence level to what might become a considerable factor in the world's sorghum market. But this article was not primarily concerned with machinery and there are others better qualified than I to enlarge upon the subject. Whether or not we find the key to the use of machinery we must go ahead with the layout of a new rural system upon the lines mentioned, fervently hoping that while we are doing this the mechanical problem will be solved.

Let no one think that these suggestions for a remedy hold up an impossible target or offer a glittering millenium. I have tried to show what will certainly happen if action is not taken and what can certainly be done if it is. The result should put the internal grain supply on a sound footing. It will not provide a surplus or even completely attain the desired level of two *rolls* daily per head. If by the time the scheme is complete there are 5,000,000 consumers in the area under consideration, they will need 4,550 tons per day or 1,660,000 tons a year at two *rolls* per head daily, as against my estimate of 1,200,000 tons available at a half-ton per *feddan* level. There will still be a gap to fill and now it appears certain that only the use of machinery can fill it.

NOTES ON Mr. JEFFERSON'S PAPER

By Director of Agriculture and Forests.

1. It is not a remarkable fact that *dura* is grown in the conditions most suitable for it. Rather it is a remarkable that irrigation water is still being used to produce *dura* which can be grown on rainland.

2. The potential grain belt is wider than this and may be said to stretch south to the edge of the Upper Nile swamps. The country lying between the Bahr el Arab and the Nuba Mountains may be a part of it.

3. Fallows are in fact respected over most of the area at least until a point of real pressure on the land is reached. Even then the effect of this is usually to shorten the fallow period all round without impairing the individual's right to return and reoccupy fallow.

4. I am unable to subscribe to the opinion that decline in yields of accessible areas is the main cause of price increase. The country is growing much more grain than it ever did before. It is eating much more grain than it ever did before. It has more money with which to eat more than it has ever had before. Nevertheless the conditions Mr. Jefferson describes can be found in the pressure zones of Rufa'a, Sennar, Kosti and in Eastern Kordofan, in the strip near the railway.

The evils of continuous cultivation with Sorghum *dura* have yet to be conclusively proved. *Anis* grass is a Sorghum too, but continuous *Anis* appears to be less harmful than continuous *dura*.

5. The movement of labour seasonably from employment to employment is an excellent feature of any country's economy and is not to be condemned here any more than in the orchards and hop gardens of Kent.

6. *Teras* as such are not evidence of soil deterioration any more than irrigation is evidence of the same. *Teras* can cause deterioration but fallowing of *teras* is a common practice in well-managed areas. It is certain that this type of banking was practised formerly over much wider areas than it is today.

7. With most of the preceding paragraphs I am in disagreement. The Gezira Cotton Scheme has increased the country's *dura*. There is no evidence over the past 50 years that the price of grain has risen at a rate faster than the fall in the value of money. The present price of grain has been reached after a long run of years of very high production. General price levels have far greater effect on grain prices than has the production level.

If the rise following removal of control proves anything, it proves that the controlled prices were out of line with other commodity prices.

8. The rain belt is divisible into a dry third where only Sorghum can be grown, a middle belt where oil seeds, especially Sesame can be added, and a wet third where American cotton and some pulses can be added to Sorghum and Sesame. The money motif is more difficult to satisfy in the dry third, which is in the main the area with which Mr. Jefferson is dealing. This population *must* seek work outside its Sorghum crop on present methods if it is to have both a diet and cash.

9. It cannot yet be said that mechanical interrow cultivation is impossible. But every effort is being made to develop a technique dispensing with it.

Conclusion.

With the general theme of Mr. Jefferson's paper the Ministry is in complete agreement.

The intensity of supervision which can be paid for by grain crops is not a high one. In the long run it must be public opinion which enforces conservative farming in these areas. For this reason also Mr. Jefferson's paper is very welcome.

وزارة الزراعة

حكومة السودان

مذكرات قسم الزراعة

عدد ١

موارد محصول الذرة بالسودان

المؤلف

ج. ه. ك. مفرس

لجنة النشر الزراعية

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