THE FOOD CROPS OF THE SUDAN
AND
THEIR RELATION TO ENVIRONMENT

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INTRODUCTION.

Throughout the length and breadth of the Sudan a remarkable variety of food crops is grown. The growing of these food crops is the primary, often the only, purpose of agriculture almost everywhere in the Sudan, and most of the country's agricultural production, by volume, if not by value, is utilized for subsistence and not for trade. Even in the northern and central Sudan where trading is an established tradition food crops are not pooled for general consumption to the extent they are in industrial countries, and in the agricultural areas the staple foods are almost entirely home grown. In the southern Sudan, where internal trade hardly exists, the use of particular crops is often restricted to the region in which they are grown. Thus the Sudan has a wide range of diets as well as a wide range of food crops. For example there are at least four staple cereals each of which is used more or less exclusively by a considerable section of the population. Some communities may be restricted to one or two food crops, whereas others may have scores. Apart from the primitive economy, these variations in food crops and in feeding are due to the Sudan's wide range of natural conditions, and to the variety of its human population.

In the strictest sense a crop's habitat is determined by the place where, and the time when, the farmer sows his seed, and by his methods of husbandry. However, climate and soil impose considerable restrictions on the farmer's choice, and something approaching a true ecological relationship exists between crops and their environment. This is particularly so in the Sudan where practically all agriculture is still primarily carried out for subsistence, and where the experience of generations has established traditions which incorporate types of crops and methods of husbandry specially adapted to local conditions.

It will be appreciated that the economic development and sophistication of the Sudan, which have been progressing so rapidly in recent years, are altering these traditional cropping systems and the ecological equilibrium of which they were part. These changes are fundamental only where organized schemes have been initiated, though in other cases it is not yet certain how far traditional systems can be modified without breaking down. This is a question which
perplexes planners and developers throughout Africa and is fraught with psychological, social and technical problems, all of which are difficult to solve. Here in the Sudan it is perhaps unnecessary to make so obvious a point, but it bears repeating, that a prerequisite for any solution of this critical issue is an adequate understanding and probable interpretation of the traditional way of life and agricultural systems of the community concerned. Development, instead of outmoding the study of these traditions — crop ecology in its widest sense — makes such a study an absolute necessity.

The purpose of this paper is to introduce the food crops of the Sudan, and to consider their relationship with the traditional background and its natural environment. The paper falls into three main parts, first, a descriptive list of the food crops of the Sudan, second a summarized description of the factors affecting agriculture and a classification of agricultural environments based on them, and third the relationship of the crops to these environments. Inevitably much of what follows is no more than the integration of information which is available elsewhere and readers are referred to Tothill’s “Agriculture in the Sudan” (1) and other publications for details which space will not permit here.

**THE FOOD CROPS OF THE SUDAN (2)**

For convenience the food crops of the Sudan are listed here under the following heads:— cereals, root crops, pulses, sugar crops, oil crops, vegetables and fruit, beverages and spices. The list which follows is an exhaustive one, and the following order of importance is given to keep it in proper perspective:—

- **The Main Staple Food Crop** — ‘Dura’
- **Major Imported Foodstuffs** — Sugar, tea, coffee and wheat flour.

It is impossible to give any reliable estimates of the production or value of these crops. Estimates of areas and yields are prepared by agricultural and province staffs, and, in some regions and for some crops, these are fairly accurate, but for the country as a whole any estimate could be little more than a guess. Such an estimate is given by G. H. Bacon in “Agriculture in the Sudan” (op. cit. p. 302). This is a useful guide, but production varies tremendously with the season. Evidence is becoming available which will show the estimates for some southern crops to be too low. In particular, eleusine, cassava, groundnuts, sweet potatoes
and maize are grown in greater quantities than those indicated. Accurate trade returns are available for the small proportion of those crops which pass through recognized markets, but the value per ton as indicated by these returns has little meaning applied to home consumed crops. Crop yields vary tremendously between different parts of the country and different seasons, and any nation-wide average for any one crop would be misleading. However, half a ton per ‘feddan’ can be taken as a fair average for the staple cereal of any particular region, and this amount would be approximately adequate to maintain two individuals for one year. Average yields are, as always, far below the good yields which can be obtained by good husbandry under favourable conditions. In most parts of the Sudan there is a surplus of cultivable land so that yields per acre are less important to the farmer than yield per unit of effort. Thus the importance of food crops in the Sudan depends on nutritional and social values rather than on their productivity or money value, and on the whole statistics are better left out.

Few food crops have originated in the Sudan or, for that matter, in Africa, and most of the important food crops have been introduced into the Sudan at some time or other. The main channels of introduction have been down the Nile Valley and across the Nile Congo divide from Central Africa. Had there ever been real pressure on the land in Africa a larger number of the edible wild products might have been brought into cultivation and evolved into productive crops.

It will be appreciated that the diverse conditions and ways of life in the Sudan not only make the list of crops a long one, but make it impossible to generalise about any one crop or its uses. Thus, readers will realise that the remarks which follow have a limited application, which will be clarified later in the paper.

**Cereals.**

Cereals provide the starchy base of all diets in the Sudan, though in some areas root crops are of considerable importance for this purpose. As with peasant populations everywhere, the proportion of these foods consumed is relatively high in the main rural communities. As the cereals are not refined before use they contribute important amounts of protein and minerals to the diet. In all parts of the Sudan and particularly in the south, the main cereal grains are used for brewing. The ‘merissa’ thus produced is usually unclarified and contains yeast, malted grains etc., which make it an important food, contributing proteins and vitamins to the diet.

Botanically, cereals belong to the Graminae (grass family), though some other crops of minor importance which produce starchy seeds are sometimes classed as cereals.
Great Millet — ‘Dura’ — *(Sorghum spp.)*: Dura is the staple food of the vast majority of the population. As the town dwellers in the Sudan have originally come mostly from the dura-eating tribes it is the main cereal of urban as well as rural populations. There is sometimes a surplus available for export and, with improvements in production methods, this is increasing. Dura is drought resistant and heat resistant. It grows well on a wide range of soils, and suits clays and alkaline soils. Compared with other cereals it is relatively susceptible to store pests. There are many varieties adapted to special requirements or special conditions.

Bulrush Millet — ‘Dukhn’ — *(Pennisetum typhoidesum* Rich.): This is a staple cereal of a proportion of the rural population, particularly in the western Sudan. It is drought and heat resistant and grows best on sandy soil.

Finger Millet — ‘Telebun’ — *(Eleusine coracana* Gaertn.): Telebun is the main staple cereal in the south west region of the Sudan. It has qualities which make it particularly suitable for these regions. It grows well on a wide range of soils.

Wheat — ‘Ganuh’ — *(Triticum vulgare* Vill.): Wheat is the basic cereal of only a very limited number of rural dwellers, but is, of course, the staple food of the non-Sudanese and sophisticated elements of the population. The needs of the latter are met mostly by imported white flour, and as a crop wheat is not important in the Sudan. A small amount is sometimes exported to Egypt. The climate of most of the Sudan is unsuitable for wheat, and even where it grows best yields are lower than those of the main wheat growing countries.

Maize — ‘Aish el Rif’ — *(Zea mays* L.): Maize is grown in several parts of the Sudan, and the total production is probably a good deal higher than that of wheat, although it is nowhere the staple cereal. In some parts it is an essential constituent of the feeding system, while it is exported from others. The climate and the soils of a great part of the Sudan are not entirely suitable for maize, and even where it is grown it does not usually produce the high yields which make it such a popular crop elsewhere.

Rice — ‘Ruz’ — *(Oryza sativa* L.): There are two types of rice — swamp rice and upland rice. The former requires continuous flooding until it begins to ripen. Where these conditions are available and soils are suitable it produces very heavy yields, and for this reason it has become the staple cereal of the overpopulated far eastern countries. Though favourable conditions exist in the Sudan, it is as yet of practically no importance. Upland or dry land rice grows without flooding, provided climate and soil are sufficiently humid, and a little is grown where these conditions exist. The small amount produced is eaten locally, and milled rice is imported to meet the requirements of urban populations.
BARLEY — ‘Sha’ir’ — (*Hordium vulgare* L.): A little barley is grown where conditions are favourable. So far it has been used locally as a food grain and not for brewing.

The following cereals have been grown or tried in the Sudan: Oats (*Avena sativa* L.), Proso Millet (*Panicum miliaceum* L.), Italian Millet (*Setaria italic* Beav.), Japanese Millet (*Echinochloa crus-galli* Beav.), Pearl Millet (*Setaria glauca* Beav.) and Job’s Tears (*Coix lachryma-jobi* L.). Of the non-grasses the seeds of Roselle — ‘Karkade’ — (*Hibiscus sabdariffa* L. Malvaceae) are used as a cereal to a limited extent, and Buckwheat (*Fagopyrum* spp. Polygonaceae) has been tried. None of these has been very successful, and in any case they do not meet any nutritional need which cannot be more efficiently supplied by established crops.

Certain wild grasses and other plants provide cereal foods which are important in small localities or under famine conditions. These include seed of the grasses *Brachiaria obtusiflora* Staff. (‘Umm Chirr’), *Dactyloctenium aegypticum* Willd. (‘Koreb’, Wild Rice (*Oryza* spp.), two species of *Hyparrhenia* (‘Penze’ and ‘Bagau’ in the Zande language), and seed of the non-grasses *Amarantus* spp. (Amarantaceae) and Water Lily (*Nymphaca lotus* L. Nymphaceae).

**Root Crops.**

Root crops do not replace true cereals as the traditional staple food crop anywhere in the Sudan as do yams in Nigeria or cassava in South America, although the latter now does so under certain circumstances in the Southern Sudan. In general, root crops are grown extensively only in the south where climate and soil suit them. The root crops grown in the Sudan belong to several different botanical families, but have the one feature in common that they produce a swollen starchy underground storage organ which may be a modified root, stem, or leaf base according to the crop.

**CASSAVA** — ‘Bafra’ — (*Manihot utilissima* Pohl, Euphorbiaceae): This crop is extensively grown where rainfall is adequate. It is a short term perennial and this gives it a particular value as a readily available reserve foodstuff. It yields eight to fifteen tons of fresh roots per ‘feddan’, but apart from this capacity for high yields has little nutritional merit. There are several varieties falling into two main groups, bitter and sweet types. The former contains prussic acid, which has to be washed or boiled out before consumption. The latter can be eaten without processing.

**SWEET POTATO** — ‘Bambei’ — (*Ipomoea batatas* L. Convolvulaceae): Sweet potato is more widely grown than cassava
as it has a wider climatic range. It is of importance as a reserve crop in some areas, but is not used anywhere in as large amounts as cassava in the south west.

**European Potato** — *(Solanum tuberosum* L. *Solanaceae)*: European potatoes are eaten only by the foreign communities and the more sophisticated sections of the population. The bulky and comparatively perishable nature of this crop has encouraged very limited local production, and they have been tried in several parts of the Sudan. At best they produce poor yields relative to those of temperate countries.

**Onion** — *'Basl'* — *(Allium cepa* L. *Liliaceae)*: Is more correctly a vegetable root crop. They are grown as a major field crop in the parts of the Sudan which suit them. They are widely used for seasoning food, and there is a considerable trade and some export.

**Yams** — *(Dioscorea* spp. *Dioscoreaceae)*: Yams are grown to a limited extent in the Southern Sudan. There are several distinct types including one which produces aerial instead of underground tubers. The tubers of wild species are also eaten.

**Cocoyams** — *‘Oulqas’* — *(Araceae)*: The two types of this crop *Colocasia antiquorum* Schott. and *Xanthosoma sagittifolium* Schott. are both grown in the Sudan on a small scale.

Apart from roots used as vegetables the following root crops have been introduced and tried: Edible Canna (*Canna edulis* Ker. Gawl. *Cannaceae*), *Plectranthus* (Labiatae), Tiger Nut (*Cyperus esculentus* L. *Cyperaceae*) which is an edible type of 'se'ld' grass (*C. rotundus* L.). These have been either unsuccessful or of no special value. A number of wild roots are eaten, especially when other foods are scarce. These include certain wild Aroids, *Tacca pinnatifida* Forst. (Taccaceae), and the wild yams already mentioned.

**Pulse Crops.**

Pulses are the food grains produced by crops belonging to the natural order Leguminosae. By virtue of their ability to fix atmospheric nitrogen these crops have a high nitrogen content, and their seeds are a concentrated source of plant protein. Despite the fact that meat is unobtainable in parts of the Sudan and is not regularly eaten in most of it, and that most tribal diets are low in protein, pulses are relatively unimportant food crops. They are grown and eaten everywhere but are major crops only in the north of the Sudan, where they are grown primarily for local or export sale, and for fodder. Legume crops are valuable rotation crops, and
for this reason they often occupy a more important place in agricultural systems than their use as food or fodder warrants. Groundnuts and soya beans, which are pulses, are dealt with under oil crops.

**Bonavist Bean** — *Lubia 'afin'* — (*Dolichos lablab* L.): This is the main pulse of the northern Sudan. It is grown primarily as a fodder crop.

**Cowpea** — *Lubia heli* — (*Vigna unguiculata* Walp.): Cowpea is grown throughout the Sudan being used both as a pulse and as a vegetable. There are several varieties, some of which have specialized features.

**Pigeon Pea** — *'Ads Sudani' — *Cajanus indicus* Spr.): This is grown in small amounts throughout the Sudan. It is a slow grower and unlike the other pulses can be treated as a short term perennial.

**Bamburra Eartnut** — *Ful Abu Gowi* — (*Veandzeia subterranea* Thow.): Like groundnuts this crop matures its pods underground. A few plants are grown in many localities and in some it is one of the main pulses.

**Haricot Bean** — *Fasulia* — (*Phaseolus vulgaris* L.): This is grown to a limited extent in certain localities. A fair amount is grown in the Northern Province for export to Egypt.

**Chick Pea** — *Hummos* — (*Cicer arietinum* L.): This is a small quick growing legume grown in the Northern Province partly for local use and partly for export.

**Tick Bean** — *Ful Masri* — (*Vicia faba* L.): This pulse of temperate regions is grown in the Northern Province and partly exported.

The following are also grown in small amounts in the Northern Province:— *Lupin* — *Termis* — (*Lupinus termis* Forsk.), *Lentil* — *'Ads Masri* — (*Lens culinaris* Medic.), *Chickling Vetch* — *Gilban* — (*Lathyrus sativus* L.) and *Field Pea* — *'Basella* (*Pisum sativum* L.).

**Lima Beans** — (*Phaseolus lunatus* L.): Climbing varieties of lima beans are commonly grown in some localities in Equatoria where they are the main pulse.

**Green Gram Bean** — (*Phaseolus mungo* L.): This is grown in most parts of the Southern Sudan and is the main pulse in some localities. It has been tried, and is occasionally grown in other parts of the Sudan.

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There is some confusion about the nomenclature of green and black gram.
‘BABUN’ — (Vigna vexillata Benth.) : This crop is grown only on a small scale in one locality, but deserves mention as a crop unique to the Sudan. It produces an edible thickened root as well as edible seed.

Sword Bean — ‘Lubia el Fil’ — (Canavalia ensiformis D.C.) : This is a robust and attractive looking bean which grows well in most parts of the Sudan. It is not popular as it contains a harmful amount of a cyanogenetic glucoside.

A large number of leguminous crops and a few indigenous wild legumes have been introduced for trial in various parts of the Sudan. The primary interest in most of these crops is fodder, but some of them produce seed which may be eaten. These include Black Gram (Phaseolus radiatus L.), Moth (Phaseolus aconitifolius Jacq.), Tepary Bean (Phaseolus acutifolius A. Grav), Phillipesara (Phaseolus irilobus Ait.), Cluster Bean (Cyanopsis psoraloides D.C.) and Horse Gram (Dolichos biflorus L.). A number of these are used as pulses in India, but none of them produce exceptional yields or have any other special merit in the Sudan. *Clitoria ternatea*, which is being multiplied up as a fodder and rotational crop in the Gezira, produces a seed which, though not used as a pulse anywhere, is considered to be edible.

Sugar Crops.

Sugar crops are those crops from which sugar or syrup is extracted. Sugar is an important item of diet, especially in the northern Sudan, but apart from the very limited production of jaggery in Zandeland, all the sugar used in the Sudan is imported. Sugar imports are in the region of 60,000 tons per annum so that the absence rather than the presence of these crops is important. Though not used for manufacture, sugar crops are grown in small quantities throughout the country for use in the raw state.

Sugar Cane — ‘Qassab sukar’ — (Saccharum officinarum L. Graminae) : This is grown in very small amounts in parts of the Sudan where adequate moisture is available, the canes being chewed. The climate or soil of much of the Sudan is unsuitable for sugar cane, but it grows well in some regions, and its cultivation on a plantation scale is under investigation.

Sweet Sorghum — ‘Ankolib’ — (Sorghum spp. Graminae) : This crop is grown in small amounts for chewing throughout the Sudan. No attempt has been made to extract syrup from it. Botanically, sweet sorghums are varieties of ‘dura’ which they closely resemble.

Sugar Beet — (Beta vulgaris L. Chenopodiaceae) : Sugar Beet was tried in the Gezira over a period of years and, though fairly
successful, produced smaller yields than it does in temperate climates; the yield of sugar per ‘feddan’ would be only a fraction of that obtainable from a good crop of sugar cane.

The tapping of palms for syrup is not practised in the Sudan, though this is done elsewhere on the Date Palm — ‘Nakhla’ — (*Phoenix dactylifera* L.) and the ‘Doleib’ (*Borassus flabellifer* L.), both of which are common in the Sudan.

**Oil Crops.**

The fats in most Sudan diets are nearly all of vegetable origin. Oil crops are therefore amongst the most important throughout the Sudan. There are two main types:— annual field crops producing oil seeds, which are by far the most important, and perennial tree crops with oil bearing fruits. Oil seeds are often used raw or cooked in their natural state, and in rural areas a certain amount of these is converted into oil in local native presses (‘’asaras’) in the northern and central Sudan, or by other methods elsewhere. The pressing of oil seeds or fruits on a factory scale is developing in different parts of the Sudan. All communities in the Sudan appreciate cooking oil, and there is a ready market for the produce of mills and ‘’asaras’. A proportion of the oil pressed in the Sudan is used for the manufacture of soap.

**Annual Oil Crops.**

These crops belong to one or two widely different botanical families, but have the one common character, that their seeds contain reserves in the form of oil.

**Sesame — ‘Simsim’ — (*Sesamum indicum* L. Pedaliaceae);** Simsim is grown in all parts of the Sudan, and in some regions on a considerable scale. It is the main source of oil seed for direct consumption, and of cooking oil. Yields are not high, probably averaging less than 400 ‘rotls’ seed per feddan, but this is offset by the high oil content of up to 50 per cent. There is a number of varieties and occasionally the seed of wild species of *Sesamum* is used.

**Groundnuts — ‘Ful Sudani’ — (*Arachis hypogaea* L. Leguminoseae);** Groundnuts are grown in most parts of the Sudan, and in considerable quantity in some areas. This crop is much less of a staple oil seed than ‘simsim’, being usually eaten raw. There is some export and a very small amount is pressed within the Sudan. There are many varieties falling into two main groups — the runner type and the bunch type.

**Soya Bean — (*Glycine max* Merr. Leguminoseae);** This important oil seed has been tried in various parts of the Sudan, but
has not so far been very successful anywhere, and is nowhere established as a crop. There is still a wide range of varieties to be tried in the Sudan.

COTTON — (*Gossypium* spp. Malvaceae): Cotton seed contains about 22 per cent. oil, and as an oil seed is an important by-product of the cotton industry in the Sudan. By far the greatest quantity is exported, but some is pressed in the country, the oil being used for soap manufacture or cooking oil. Raw cotton seed is liable to be poisonous, but it has been eaten in time of famine.

MELON SEED — ‘Battikh’ — (*Colocynthis citrullus*, L., Cucurbitaceae): The ‘battikh’ or water melon produces an oil seed which is eaten raw. It is popular in Egypt, to which there is a considerable export. Besides the seed the water melon fruit is important as a human and animal food in some parts of the Sudan.

GOURD SEED — ‘Kpagu’ (southern tribal name) — (*Lagenaria vulgaris* Ser., Cucurbitaceae): A variety of gourd, it is widely grown in the Southern Sudan for its seed which contains oil and is eaten in the same way as melon seed. Other varieties of gourd are grown for making dishes, spoons *etc.*, but these usually have bitter seed.

Other cucurbits which produce oil seeds occasionally eaten are:— types of Melon — ‘Shammam’ — (*Cucumis melo* L.), Pumpkin and Marrow — ‘Gara’ — (*Cucurbita* spp.), Colocynth — ‘Handal’ — (*Colocynthis vulgaris* Schrad.) and Loofah — ‘Lif’ — (*Luffa* spp.).

KINO — (*Hyptis spicigera* Lam., Labiatae): This crop is called ‘Kino’ by several southern tribes and ‘Kazira’ in the southern Fung region. It is commonly grown in small quantities in regions of higher rainfall. It produces a very small seed eaten in the same way as ‘simsim’.

Other crops producing edible oil seeds which are grown or have been tried in parts of the Sudan are:— Sunflower — ‘Ein al Shems’ — (*Helianthus annuus* L.), Safflower — ‘Gurtum’ — (*Carthamus tinctorius* L.), Niger seed (*Guizotia abyssinica* Cass.) all of the family Compositae; Rapeseeds and Mustards (*Brassica* spp.), Garden Rocket — ‘Girgr’ — (*Eruca sativa* Lam) of the Cruciferae; and ‘Bamia’ (*Hibiscus esculentus* L.) and possibly other *Hibiscus* species of the Malvaceae. ‘Girgr’ and ‘bamia’ are of course commonly grown as vegetables. Safflower and sunflower grow well and are possible crops for the commercial production of oil seeds, local requirements and taste being adequately catered for by the traditional crops.

Perennial Oil Crops.

The wetter regions of the Sudan are suitable for some of the oil bearing trees. In these the oil is found in the kernel (seed) and sometimes in other parts of the fruit.
OIL PALM (*Elaeis guineensis* Jacq. Palmae): The oil palm grows in the far south of the Sudan though there is not yet a large number of trees. Both the pericarp and kernel contain oil. The pericarp oil is easy to extract and this is done by home methods in the south.

COCONUT (*Cocos nucifera* L. Palmae): This has been tried in one or two sites in the Sudan, but conditions are nowhere suitable for it.

OLIVE (*Olea europaea* L. Oleaceae): This has been tried in one or two places but without much success.

The following indigenous trees produce edible oil which is expressed and used where they occur:— Shea Butter, — ‘Lulu’ — (*Butyrospermum Parkii* Kotschy. Sapotaceae), ‘Heglig’ — (*Balanites aegyptiaca* Del. Simarubaceae), and ‘Zawa’ (Zande name) — *Lophira alata* Banks Ochnaceae). ‘Lulu’ is the most important of these, occurring extensively in parts of the south.

Vegetables and Fruit.

In the space available it is only possible to deal very superficially with the large and diverse selection of vegetables and fruits used in the Sudan. Vegetables are important nutritionally as a source of vitamins, and, particularly in the meatless areas of the Sudan, leafy vegetables are also an important source of protein. Vegetables of one kind or another are grown and eaten throughout the Sudan. In certain localities some fruits form a staple part of the diet, but in most regions fruit is not regularly eaten. There is a certain amount of local trade in fruit and vegetables, and export and import of less perishable types. Throughout the rural areas of the Sudan wild plants are used as vegetables, and wild fruits are eaten wherever they occur. A number of condiment crops are grown, and in the remote regions wild or cultivated plants are burned to produce salt. Practically all vegetables and a few fruits are produced by annual herbaceous crops, while the majority of fruits are produced by perennial tree crops. The range of the latter is naturally much more restricted than that of the former.

Vegetable and Annual Fruit Crops.

OKRA — ‘Bamia’ — (*Hibiscus esculentus* L. Malvaceae): This is one of the commonest vegetables throughout the Sudan. The pods are often dried for storage or for internal sale. Bamia leaves and the leaves of other species of *Hibiscus* are also used. There are several varieties including some improved types. Roselle — ‘Kerkade’ — (*H. sabdariffa* L.) is widely grown, principally for its fleshy calyx which is made into a drink
Jew’s Mallow — ‘Mulukhiya’ — (*Corchorus olitorius* L. Tiliaceae): This is by far the commonest leafy vegetable in the Sudan, being grown and used in all parts. It is sometimes dried for storage or sale. Several wild species of *Corchorus* are also extensively used.

Purslane — ‘Rigla’ — (*Portulaca oleracea* L. Portulacaceae): This is widely grown in the northern Sudan and wild species of *Portulaca* are commonly used in all parts of the country.

Amaranths — ‘Bedi Bedi’ (southern tribal name) — (*Amarantus* spp. Amaranthaceae): Several species of *Amaranthus* are extensively used as leafy vegetables throughout the Sudan, but especially in the south. These generally grow wild but are sometimes cultivated or at least protected. In particular one species, probably *A. candatus* L., is usually cultivated and appears to be the same as the American vegetable “tampala”.

Chili — ‘Shatta’ — (*Capsicum frutescens* L. Solanaceae): The small fruited hot perennial variety of the crop is grown wherever conditions are favourable. It is used everywhere to season food and is a valuable export from some regions. The large fruited sweet peppers are sometimes also grown.

Tomato — ‘Tematim’ — (*Lycopersicum esculentum* Mill.) and Egg Plant — ‘Bedingan’ — (*S. Melongena* L.), both Solanaceae, are grown in several parts of the country. Other plants of the same family less extensively grown are Cape Gooseberry (*Physalis peruviana* L.) and ‘Nzuo’ (Zande name) (*Solanum* sp.), a local southern vegetable.

The following Cucurbitaceae are grown and used as fruit or vegetables:— Pumpkins — ‘Gara’ — (*Cucurbita maxima* Dush.) and small cucumbers — ‘Khiar’ — (*Cucumis sativus* L.) in most parts, and Sweet Melon — ‘Shammam’ — (*Cucumis melo* L. and Water Melon — ‘Battikh’ — (*Cucynthis citrinus* L.) in the areas which suit them. Some wild cucurbits are also eaten.

Garden Rocket — ‘Girgir’ — (*Eruca sativa* Mill.) and Egyptian Radish — ‘Figl’ — (*Raphanus sativus* L.): both belonging to the family Cruciferae are extensively grown as salad vegetables in the northern Sudan.

The following plants of the family Umbelliferae are grown as crops in some parts of the Sudan, and are used for seasoning food:— Fennel — ‘Shamar’ — (*Foeniculum vulgare* Mill.), Coriander — ‘Kasbara’ — (*Coriandrum sativum* L.), Dill (*Anethum graveolens* L.), Cumin — ‘Kamun’ — (*Cuminum cyminum* L.) and Caraway — ‘Carawia’ — (*Carum carvi* L.).

Other seasoning plants grown in very limited amounts are as follows:— Garlic — ‘Tom’ — (*Allium sativum* L.), Shallots
and Egyptian Onions (Allium spp.), all Liliaceae; Fenugreek — ‘Helba’ — (Trigonella foenum-graecum L. Leguminosae), and Mint — ‘Na’na’ — (Mentha spicata L. Labiatae).

The leaves and sometimes the flowers of many wild plants (both herbs and trees) and crops are used as vegetables. In addition to those already mentioned, the leaves of Cowpea, Cassava, Pumpkin and other cucurbits are major vegetables where they occur throughout the Sudan.

European Vegetables: These have been grown in most parts of the Sudan to satisfy the requirements of the non-Sudanese. Most types grow in the Sudan, but seldom produce the quantity or quality attained in temperate regions. As a rule these vegetables cannot be propagated in the Sudan, which precludes their general adoption. Nutritionally European vegetables are on the whole inferior to indigenous ones so that there is little point in extending their use. The following are the commonest and most easily grown: — Cabbage, Cauliflower, Turnip, Radish, Kohl Rabi, Kale, Spinach, Chard, Beet, Lettuce, Endive, Chicory, Jerusalem Artichoke, Carrot, Parsley, French Beans. Peas, Onions, Leeks etc., Tomatoes etc., Cucumbers etc.

Two introduced tropical vegetables have grown extremely well where they have been tried in the Sudan. They are Malabar Nightshade (Basella rubra L. Basellaceae) and Chinese Cabbage, (Brassica chinensis L. Cruciferae).

Tree Fruits and Nuts.

Apart from wild fruits of which there are many, there is only one long established tree fruit in the Sudan — the date. However, a very wide selection of fruit trees has been introduced from both tropical and temperate countries. A few of these have become established as locally important crops, but most have no particular contribution to make in the areas where they succeed. Fruits are usually eaten fresh but a little fruit processing is carried out and fruit drinks are prepared at home. Nut trees are of no importance in the Sudan.

Date — ‘Nakhla’ — (Phoenix dactylifera L. Palmae): This is a major food and export crop of the Northern Province, and is the most important fruit crop in the Sudan. Dates in one form or another are eaten throughout the north. A wild date Phoenix reclinata Jacq. growing in some southern regions produces an edible fruit which is occasionally eaten.

Citrus Fruits (Citrus spp. Rutaceae): These grow well in many parts of the Sudan. Limes — ‘Limoon’ — are grown and used in most regions where conditions are suitable. Oranges — ‘Bortugan’, Bitter Oranges — ‘Naringe’, Grapefruit and
Tangerines are grown in a number of gardens and eaten by the more sophisticated. Lemon, Pomelo and less important types of citrus also grow well.

Mango — ‘Manga’ — (Mangifera indica L. Anacardiaceae): Mango is a very important and common fruit in the far south of the Sudan. It is also grown to a limited extent as a luxury fruit in the northern Sudan.

Banana — ‘Moz’ — (Musa sapientum L. Musaceae): Bananas are grown and eaten wherever conditions are favourable and are a subsidiary source of starchy food in the far south. Several types are grown. A wild banana (M. ensete Gmel.) occurs in the south and produces edible seed though not edible fruit.

The following TROPICAL FRUITS are commonly grown and eaten in some parts of the Sudan, though none of them form a staple item of the diet:— Guava — ‘Gawafa’ — (Psidium guajava L. Myrtaceae), Pawpaw — ‘Babain’ — (Carica papaya L. Caricaceae), Pineapple — ‘Ananas’ — (Ananas sativus Schult. Bromeliaceae), Custard Apple — ‘Oishta’ — (Anona squamosa L. Anonaceae) and Indian Mulberry — ‘Tul’ — (Morus indica L. Moraceae). The following is a selection of the tropical fruits which have been successfully introduced, but are not commonly grown:— Bullock’s Heart and other Anona spp., Cashew Nut (Anacardium occidentale), Hog Mango and other Spondias spp., White Sapote (Casimiroa edulis), Bacl Fruit (Acule marmelos), Avocado Pear (Persea gratissima Gaertn.), Grenadilla and Passion Fruits (Passiflora spp.), Prickly Pear (Opuntia dillenti Haw.), Pachira Nut (Pachira sp.), Jujube (Zizyphus jujuba Lam.) and Tree Tomato (Cyphomandra betacea Sent.).

The following MEDITERRANEAN FRUITS are grown to a limited extent where conditions are favourable: Grape — ‘Enab’ — (Vitis vinifera L. Ampelidaccae), Fig — ‘Tin’ — (Ficus carica L. Moraceae), Pomegranate — ‘Roman’ — (Punica granatum L. Punicaceae). Other Mediterranean and temperate fruits have been tried in a few likely places, but have not been really successful. These include peaches, almonds, apricots, apples, pears and plums. Strawberries and types of blackberry, which can hardly be classed as tree fruits, have been more successful.

The list of wild fruits used in the Sudan is a long one. The most important is undoubtedly the ‘Doleih’ (Borassus flabellifer L.) which grows over a large part of the Sudan and provides an important anti-famine food. The following are important throughout large areas of the country:— ‘Heglig’ (Balanites aegyptiaca Del.), ‘Sidr’ (Zizyphus spp.), ‘Tamr Hindi’ (Tamarindus indica L.), Wild Figs (Ficus spp.) and Grevia spp.; and of more limited distribution the following:— ‘Tundub’ (Capparis decidua Pex), Vitex spp., Ximenia americana L., Tebeldi
(Adansonia digitata L.), 'Dom' (Hyphaene thebaica Mart.), Carissa edulis which is sometimes cultivated, and ebony (Diospyros mespiliformis Horkst.). Though these trees are not cultivated, they are sometimes preserved or protected and in places communal or individual rights to them are recognised.

A few tree products are used as vegetables, and include such delicacies as palm sprouts (from 'doleib') and bamboo shoots. The Horse Radish tree (Moringa oleifera Lam.) is grown here and there, but is not much used.

**Beverages and Spices.**

Strictly speaking beverages and spices can hardly be classed as food crops, but are included to complete the picture. Narcotics and medicinal plants are considered to be completely outside the subject and are not mentioned.

Beverages and spices in one form or another are used throughout the Sudan. Some of these are produced from home grown crops, but most are imported. In addition to the beverages made from grains, fruit and other crops already mentioned, a large amount of tea and coffee is used. All the tea used and practically all the coffee is imported.

**COFFEE —** (Caffea spp. Rubiaceae) grows fairly well in parts of the Sudan and a little is grown. **TEA** (Thea sinensis L. Theaceae) has been introduced and promises to be successful in very limited areas. **COCOA** (Theobroma cacao L. Sterculiaceae) and **YERBA MATE** (Ilex paraguayensis A. St. Hill. Aquifoliaceae) are beverage crops which have been tried and failed.

In addition to chillies and other seasoning materials already dealt with, cloves, cinnamon, cardamom, ginger and other spices are imported for use in the Sudan. **GINGER** (Zingiber officinale Rose), **TURMERIC** (Curcuma longa L.) of the family Zingiberaceae, and **CINNAMON** (Cinnamomum zeylanicum Nees. Lauraceae) have been introduced and can grow successfully in a few favourable sites.

**AGRICULTURAL ENVIRONMENTS.**

In plant ecology all environmental factors are usually classed under four main heads, climatic, topographic, edaphic\(^1\) and biotic\(^2\). Of these, climatic factors have the most fundamental influence on the crop pattern of the Sudan. Topographic factors have little direct effect, but are of considerable importance in modifying the climatic and edaphic factors. Edaphic factors affect crops everywhere and in a few localities are more critical than the climate.

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\(^1\) Edaphic factors are those associated with soil.

\(^2\) Biotic factors are those associated with living organisms.
The main biotic factor affecting crops is obviously the human one, but under the primitive conditions of most of the Sudan, human beings themselves are very much influenced by the climate and other natural conditions, and their way of life is the result rather than one of the causes of their environment. The natural vegetation, pests and diseases and both domestic and wild animal life, are other biotic factors affecting crop ecology. The primary causal factor is again the climate. Thus, though the agricultural environments of the Sudan are the result of many interacting factors, climate is the basic one.

**The Climate, Soils and Vegetation of the Sudan.**

As detailed descriptions of climate, soils and vegetation are to be found in Tothill's "Agriculture in the Sudan", these will be reviewed only briefly as a preliminary to considering their effects on food crops and their production.

**THE CLIMATE.**

By virtue of its geographical position the Sudan has a continental tropical climate, but as it stretches from 3° N to 23° N latitude differences in rainfall and temperature are considerable.

Most of the country is within the region of summer rainfall, which diminishes from south to north. The southern Sudan, with a rainfall from 1000 mm. to 1500 mm. *per annum*, lies just outside the equatorial region of almost continuous rainfall, and, along the southern border, the rainy season lasts nearly nine months and two peaks are discernible. The rainfall becomes less in amount, the season shorter and the distribution more irregular till at about 19° N. latitude regular rains disappear completely. From this latitude to its northern border the Sudan is practically rainless, and consequently desert. A rainfall of about 250 mm. which occurs at approximately 15° N. latitude (just south of Khartoum) is about the minimum for regular agricultural production. Diagrams 1 and 2 (provided by courtesy of the Sudan Meteorological Service) give a general picture of the amount and distribution of the Sudan's rainfall, and the rainfall for selected places is given in Table 1.
Diagram 1. This map shows mean annual isohyets. The decrease in the rainfall from south to north is remarkably regular. The deformation produced by the Marra and Nuba Mountains and the Ethiopian Plateau is clear. The map probably under-estimates the local effect of the Marra Mountains for which no observations are available. The reason for the curious deformity south-west of Malakal is not obvious. Unfortunately it is based upon one station only and may not be real. Tentative explanations are that the swampy sudd region has a local effect, or that it is connected in some way with the Rudolf gap between the Ethiopian plateau and the East African highlands.
MEAN ANNUAL RAINFALL DISTRIBUTION (TO 1940)

Diag. 2. This map shows the distribution of rainfall over the year expressed as percentages of the annual total falling in each month. Except in the coastal area the diagrams represent means over 1-degree squares. The increase from north to south in the length of the rainy season inland and the anomalous régime in the Red Sea area are clear. The latitudinal uniformity is notable. In the extreme south the equatorial double maximum can just be detected.
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<tr>
<th>Station</th>
<th>Latitude (North)</th>
<th>Longitude (E. of Greenwich)</th>
<th>Altitude (metres)</th>
<th>Annual Rainfall (mm)</th>
<th>No. of months with more than 50 mm.</th>
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Abstracted from "Agriculture in the Sudan" and from Sudan Meteorological Service records covering the period 1921 — 1950

Because of the higher latitude and lower rainfall there is a marked difference between summer and winter temperatures in the northern Sudan, the summer being very hot and winter relatively cool for a period of three or four months. Moving southwards both the seasonal temperature range, and the daily range become less. Within the Sudan's climatic limits these two ranges are of more importance in agriculture than the mean annual temperatures or even the mean daily temperatures. Table 2 indicates these ranges for the selected stations given above.
### TABLE 2.
MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES FOR SELECTED STATIONS.

Maximum and Minimum Temperatures in °C.

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Abstracted from “Agriculture in the Sudan” and Sudan Meteorological Service.
Humidity, and associated with it saturation deficit, vary according to rainfall and temperature. Airflow and winds, apart from being the cause of other weather changes, have little direct effect on agriculture in the Sudan. Day length is of some importance because of its effect on the flowering of certain crops.

There are a few local variations in the general pattern. The climate of the Red Sea littoral shows maritime characteristics and has a winter rainfall which, however, is too small to be of much agricultural value. Tokar is included in Tables 1 and 2 as representative of this region. Except along the eastern border where the Ethiopian highlands cause higher (and in one region lower) rainfall, mountain masses are not extensive enough to have any marked effect on the neighbouring climate. On the hills themselves temperature falls with increase in altitude and rainfall usually increases. Suni and Gilo are included as representative of higher altitudes, but unfortunately temperatures are not available for these stations.

From the agricultural point of view the rainfall determines whether perennial or annual crops can be grown and whether irrigation is necessary or not. Whether tropical, sub-tropical, or temperate crops are grown depends mainly on temperature. Each crop has a minimum, optimum and maximum temperature for growth, and, roughly speaking, temperate crops are those which have a relatively low maximum, and tropical crops are those which have a relatively high minimum. Diagram 3 shows relative growth rates for maize seedlings over the whole temperature range. The optimum and maximum temperatures for temperate crops are about eight to ten degrees C. lower than those shown for maize. It will be obvious from Diagram 3 that, even though mean temperatures are near the optimum for growth, maximum growth will not be attained if there is a wide range of temperature. Within the growth range high temperatures are more harmful than low ones, and plants take some time to recover from supra-optimal temperatures. Temperature and rainfall jointly determine whether “wet” tropical crops or “dry” tropical crops can be grown, but if saturation deficit were independent of these factors it would also be important in this respect.
Topography and Soils. (4) (5) (6) (7)

Broadly speaking the soils of the Sudan fall into the generic groups associated with the climatic conditions under which they are formed. In the dry northern regions where there is too little rain to cause leaching soluble salts accumulate forming alkaline and salty soils, while in the south leaching by heavy rains has resulted in lateritic soils which are acid in reaction and low in intrinsic fertility.

Topography and geology have also played an important part in soil formation. The Sudan consists of a vast central plain with the Blue and White Nile flowing through it, the Ethiopian mountains, and Red Sea hills and littoral to the east, and scattered hills and plateaux of varying height to the north, south and west. Geologically the plain consists mainly of deep superficial deposits of clay and sand. The hilly regions to the south and east are mostly of basement complex schists and gneisses, although a deep
Legend

- Ironstone red loam
- Ferruginous deposits
- Larger rock masses under thin superficial deposits
- Clays predominant
- Qoz or fixed dunes predominant

Watershed

Scale 1:10,000,000

Diagram 4. Geological Map of the Sudan Showing Superficial Deposits
ironstone blanket of ancient origin covers a large part of Equatoria and Bahr el Ghazal Provinces and forms the plateaux and lower hills. The northern hilly regions are derived partly from Nubian sandstone and partly from basement complex. There are areas of volcanic origin consisting mainly of basalts and lavas in the west and east. The Jebel Marra range is the most important of these. A geological map of the Sudan is attached as Diagram 4 for reference.

The Nile and some smaller rivers have laid down alluvial soils which, though small in total area, are of great importance agriculturally.

The central plain corresponds roughly with the intermediate rainfall belt (250 — 1000 mm.) and includes all the areas to which the term "central rainlands" is applied. The soils of the plain are mainly heavy alkaline clays which, whatever their origins, owe their stability to its flatness. Part of the western side of the plain is covered by fixed dunes of blown sand which form the sandy 'qoz' soils of considerable agricultural importance. In the southern parts of the clay plain higher rainfall and impeded drainage produce swampy conditions for part of the year at least.

The southern clay plains and swamps impinge almost directly on the ferruginous soils which cover a large part of Equatoria and Bahr el Ghazal Provinces. These soils owe their intensely ferruginous character not so much to current laterization as to the deposits of ancient ironstone from which they are formed. Erosion has caused local sorting of these soils so that as a group they are less uniform than the clays or sands. The "catenas" postulated by Greene (8) and Morrison (9) provide a useful and practical interpretation of their variations.

In the hilly and undulating parts of the Sudan soils are recently formed from the underlying rock and are patchy and variable. These soils are best interpreted as catenas. Generally speaking the higher members of the catena produce good soils in the wettest regions where there is adequate vegetation to prevent erosion and to build up organic matter, whereas in the regions of intermediate and low rainfall the slopes become eroded and the best soils are the valley fill, i.e. the lowest member of the catena. Most of these soils are derived from the basement complex, and are often relatively poor. There are only very limited areas of rich volcanic soil, and the Nubian sandstone occurs mostly in the desert region so that few agricultural soils are derived directly from it.

Table 3 gives approximate values to indicate the main differences between the major soil types.
### TABLE 3.
**COMPARISON OF MAJOR SOIL TYPES.**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Coarse Sand %</th>
<th>Clay %</th>
<th>Salts %</th>
<th>PH</th>
<th>Nitrogen p.p.m.</th>
<th>P₂O₅ and K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvium (north)</td>
<td>0—.5</td>
<td>30—50</td>
<td>.05—.2</td>
<td>8—9</td>
<td>700</td>
<td>High</td>
</tr>
<tr>
<td>Clay (north)</td>
<td>0—.5</td>
<td>60—70</td>
<td>.1—.5</td>
<td>8.5—9.5</td>
<td>400</td>
<td>High</td>
</tr>
<tr>
<td>Clay (south)</td>
<td>0—20</td>
<td>40—70</td>
<td>.01—.2</td>
<td>6—8</td>
<td>800</td>
<td>High</td>
</tr>
<tr>
<td>Goy Sand</td>
<td>40—70</td>
<td>0—10</td>
<td>.00—.03</td>
<td>5—8</td>
<td>200</td>
<td>Low</td>
</tr>
<tr>
<td>Ironstone</td>
<td>20—30</td>
<td>20—40</td>
<td>.01—.02</td>
<td>5—6</td>
<td>800</td>
<td>Low</td>
</tr>
</tbody>
</table>

The clays though rich in plant foods have their fertility reduced by high salt content in the north, by bad drainage in the south and in all cases by poor root development. On the other hand, the profuse root development in the sandy soils compensates for their low intrinsic fertility. Soils such as some alluvia and volcanic soils which are both rich and friable are the most productive in the Sudan.

**Vegetation.**

The vegetation of the Sudan ranges from desert in the north to almost tropical rain forest in the south west. The desert and Acacia desert scrub into which it merges, indicate conditions too dry for growing crops except in favoured sites such as valley bottoms.

Acacias are characteristic of the central rainlands, merging from Acacia short grass woodland at the dry end to Acacia tall grass woodland at the wetter end. Small ephemeral grasses and herbs occur on the sands and other soils where rainwater drains away quickly from the surface layers of the soil, whereas on the clay plains, where it is retained, tall, coarse, slower growing grasses occur. In the parts of the clay plains which become waterlogged these grasses occur alone or with only isolated trees. Cultivation, grazing, and possibly natural vegetation cycles have also caused treeless areas specially at the drier end of the central rainlands. These treeless areas are the 'sageas' which have become such important agricultural areas in recent years.

The characteristic vegetation of the ironstone and other hilly regions of the south and along the Ethiopian border is broad leaved grass woodland. Because of the topography there is usually a sharp transition between the grasslands of the flooded southern clay plains and the broad leaved woodland. There is also an area of Acacia grass woodland right in the south east of Equatoria.
associated with the low rainfall of this corner. In places there
is closed woodland with an undergrowth of shade loving herbs
and climbers rather than grasses, and in the depressions and valleys
of the wettest regions in the south there is enough permanent
moisture to maintain true tropical rainforest species. These last
form the depression forests and gallery forests, which themselves
are very limited in extent, but their presence has been taken as
an indication of the area suitable for some perennial crops —
the “Green Belt”. (see p. 31).

In Jebel Marra and other northern mountains rainfall is still
the main factor limiting vegetation so that the vegetation of the
plains also occurs at the higher altitudes except where extra ground
water is available. In the south, where rainfall is adequate,
temperature is a critical factor and a marked altitude zonation of
vegetation occurs. Besides those mentioned there are of course
other local variations in vegetation associated with environmental
differences, but often the development of climax types is prevented
by bush fires which occur throughout the Sudan, and to which the
tree species of the woodland are relatively resistant.

Vegetation affects agriculture in many ways. It can be used
as an indication of climatic and soil conditions and their suitability
for particular crops. The distribution of livestock and their enemy,
the tsetse, is largely determined by vegetation and it affects other
biotic factors such as predators and pests of crops. It plays a
part in determining the system of agriculture practised. For
example, the ephemeral herbs of the sands make clearing easy and
the coarse annual grasses of the clays make ‘hariq’ feasible, both
of which encourage extensive methods of agriculture, while the
thick woodland and perennial herbs further south are difficult to
clear, and encourage intensive methods.

The Human Population. (11) (12)

The people of the northern and central Sudan are Muslim in
religion and culture, and even peoples of widely different
ethnological origins have acquired similar traditions, including the
food preferences and keen trading instincts of the Arabs. Despite
this common culture the tribes of the northern Sudan have widely
different ways of life. In the semi-desert regions away from the
river there are camel owning nomads. To the west of the Nile
these include such famous Arab tribes as the Kababish, and to the
east the Beja tribes of Hamitic origin. Along the northern stretch
of the river itself, there is a settled peasant population of Berberine
and Arab origin. Trade, as well as agriculture, is an important
vocation of the natives of this region. In the middle belt cattle
are the main form of stock and are owned mainly by nomadic tribes
of Baggara Arabs, who mainly inhabit the plains. Irrigation
schemes, in particular the Gezira, and other developments have changed sections of these tribes to a sedentary life. The sedentary tribes in the central belt also own livestock. Some of these are Arabs, specially in the ‘qoz’ country, but most are negroids. The negroid peoples include the Muslims of Darfur and Dar Fung and the largely pagan Nuba, Ingessana, Maban and smaller tribes. These tribes tend to live in or around the hilly outcrops, which are often the only sites of permanent water in this belt. An important element in the population of the central Sudan are the West African immigrants who have established themselves in several places. Other immigrants are few and are confined to the towns.

In the southern Sudan the tribes are negroid and mostly pagan, and have less in common with each other than have the Muslim tribes of the north. Taboos and magic have a place in their cultures, but as far as agriculture is concerned do not often conflict with common sense, though they sometimes do so in the case of their food habits. Several southern tribes who live in tsetse infested areas have no cattle and practically no other livestock. These include the Zande and other Sudanic tribes living mostly in the ironstone country. On the other hand the Nilotic tribes who inhabit the flood plain regions along the White Nile and its tributaries have many cattle which are their main interest in life. These Nilotic cattle owners move from place to place to obtain grazing, but in so far as they maintain a permanent homestead they are not nomadic. The Nilo-Hamitic tribes in the hilly regions of the south and south east also own some cattle, but are entirely sedentary except for the Tapos in the dry south east corner.

In this short review the cultural differences associated with livestock have been stressed as they appear to affect agriculture more than differences more closely related to the ethnological origins of the people of the Sudan. It seems to be an unwritten law with all pastoral peoples that their stock take priority over their crops even in relatively good agricultural areas. The implications of this on their agriculture can easily be appreciated. Some cattle owners have no crops at all and most have a smaller variety of crops and a lower standard of husbandry than non cattle owners. Sedentary communities, whether they own cattle or not, are always better and more productive agriculturists than nomads.

Some tribes have played a particularly important part in introducing and dispersing new crops and new methods of agriculture.

**Important Agricultural Practices**  (13) (14)

Some important agricultural practices which will be mentioned later are described here, but reference to “Agriculture in the Sudan” should be made for further details.
IRRIGATION: Various methods of irrigation are practised. Lift irrigation means that water is raised from the river by pumps or other devices such as ‘sagias’ or ‘shadufs’. This is only possible near the river, where it is commonly used. Free Flow irrigation is water applied to the land without any mechanical lifting. In the Sudan the Sennar dam supplies free flow irrigation for the Gezira, and the dam makes irrigation possible away from the vicinity of the river. Flush irrigation is natural irrigation from the overflow of rivers in flood. In this case land gets a thorough soaking before crops are sown and no irrigation afterwards. Along the Nile several Basins are irrigated in this way and the valleys and inland deltas of various smaller rivers receive more or less flush irrigation annually. The Nile floods in July and from then till the end of December there is plenty of water available. This is the Free or Flood period when there are only minor restrictions on the use of irrigation water. From the beginning of January till July is the Restricted period, when restrictions are imposed to ration the limited amount of water available.

MIXED AND ROTATION FARMING: It is exceptional in the Sudan for livestock to be utilised in any way for the benefit of crop production. Cattle are an integral part of the farming system in the Northern Province and may be used to a limited extent in a few other localities. Rigid crop rotations are adhered to only in the irrigated areas. Use of fertilizers and technical aids of other kinds is also confined to these areas.

SHIFTING CULTIVATION: This system is practised throughout all the rain areas. When one area of land is exhausted it is abandoned and cultivation started on another piece of virgin or rested land chosen in accordance with tradition within the tribal, village, or individual domain. The details of the system vary greatly in different parts of the country, but in most parts there is an area of fixed cropping surrounding each house or near each village. The former is characteristic of African homesteads in most of the Sudan, while the latter, called ‘bilad’, are used generally in the central Sudan. Shifting cultivation is not conducive to the growing of perennial crops.

HOE CULTURE AND MIXED CROPPING: The vast majority of crops in the Sudan are cultivated entirely with hand tools. In the central rainlands crops are grown without tillage of any kind, so that this is not much of a handicap. In the south, tillage is essential, but as this is associated with land clearing it cannot be mechanized except by heavy machinery. The lack of any mechanical aid to cultivation makes uniformity unnecessary so that straight rows, level stands etc., have only an aesthetic value. Under these circumstances cultivators can grow together crops of different habit and different maturation dates. Such associations have certain
advantages and mixed cropping is common practice in much of the Sudan, but especially in the south where there are more reasons for it.

'Terf' Cultivation: This is the sowing of crops on the 'gerf' or river bank while it is still moist following the flood—a form of flush irrigation. This practice is sometimes called 'seluka' cultivation.

'Terus' Cultivation: In the lower rainfall areas on clay soils, banks called in Arabic 'terus' are put up along the contours to prevent run off and conserve rainfall. This practice extends regular rainland cultivation a little beyond its natural limit.

Terrace Cultivation: True terraces are built in some hilly regions in the western Sudan. They were originally constructed by tribes who confined themselves to the hills for security, and had to conserve soil and water in them.

'Hariq' Cultivation: This system of agriculture is practised in regions where there are relatively open stands of well grown grass, i.e. parts of the clay plains. The old dry grass of the 'hariq' area is burned after the first rains have germinated grass and weed seedlings. In this way a clean seed bed is produced and weeds are controlled without any tillage whatsoever. This means that large areas can be cultivated with little effort.

Mechanical Cultivation: The use of machinery in crop production until recently has been restricted mostly to cotton. Mechanical production of other crops is being developed. It will be obvious that mechanization of agriculture involves many modifications in the traditional systems and is still little used outside "schemes".

The Main Agricultural Environments.

With this brief description of the climatic, edaphic and biotic factors which affect the cropping pattern of the Sudan, and with the greater detail available for reference in "Agriculture in the Sudan", it is possible to define distinct agricultural environments. It is obvious that certain parts of the Sudan, in particular the northern deserts, are not, and never will be of any agricultural value, and can hardly be called agricultural environments, though they are included for completeness. In a broad classification of environments covering the whole Sudan there are bound to be many anomalies included in the main regions, which cannot be specifically dealt with here.

The following environments are distinguished:

1. Desert.
2. Semi-Desert Pastoral Environment.
3. Irrigated Riverain Environment.
4. Irrigated Clays.
5. 'Qoz' Sands.
7. Flood Plain Environment.
10. Miscellaneous Irregular Environments.
11. Mountain Environments.

1. DESERT: This is the environment of the northern parts of the Sudan where rain is too rare to produce any vegetation and where no water for irrigation is available. It is useless for crops or stock.

2. SEMI-DESERT PASTORAL ENVIRONMENT. This environment borders on the complete desert. Rainfall is generally too small for crop production, but produces enough vegetation to maintain livestock for part of the year at least. Sources of drinking water as well as rain are very infrequent in regions with this environment, and this tends to limit the livestock to camels. The inhabitants of these regions are mainly camel owning nomads. Pastoral areas lie in a broad belt between the desert and the rainlands, but which stretches into Egypt along the Red Sea Hills and Red Sea littoral. There is another small area of this environment in the dry south east corner of the Sudan. The soils of these areas include clays, sands and miscellaneous types, but rain being the limiting factor these differences are not important.

3. IRRIGATED RIVERAIN ENVIRONMENT: This environment refers primarily to the narrow fringe along the main Nile from Khartoum northwards which can be irrigated from the river. The marked difference between summer and winter temperatures is one of the most important factors affecting this environment. The inhabitants are traditionally cultivators with a genuine peasant outlook. The soils are alluvia of varying quality. Lift and flush irrigation are practised. There are other areas south of Khartoum on the Blue and White Niles and on smaller streams elsewhere where alluvial soils are irrigated, and the important inland deltas of Tokar and the Gash are flush irrigated alluvial areas.

4. IRRIGATED CLAYS: The main difference between this environment and the last is in the soil, which in this case has a higher clay content and usually a higher salt content. As the clay areas occur further south there are also significant differences in climate. The Gezira is by far the most important area of irrigated clay, but many of the pump schemes on the White and Blue Niles are at least partly on the clay. The inhabitants of the Gezira and nearby pump schemes are mostly settled nomads without the traditions of peasant cultivators.
5. **‘Qoz’ Sands**: The sandy ‘qoz’ soils, and enough rainfall to grow annual crops are the characteristics of this environment. In this and other rainlands winter temperatures are not important as crops are grown only during the summer rains period. The main area of ‘qoz’ lies to the west of the Nile merging into the pastoral areas to the north and the clay plains to the south and east. This area is inhabited by sedentary or partly sedentary tribes mainly of Arab origin. Lack of drinking water limits both settlement and pasturage in this region.

6. **Central Clay Plains**: The characteristics of this environment are clay soils on which crops can be regularly grown by rainfall, and which are not subject to flooding. It comprises most of the central plain of the Sudan, and merges into the pastoral parts of the same plain in the north and the swampy parts in the south. There is also an area of this environment to the south east of the swampy region. The soils at the drier northern end have more salt and less organic matter than those further south and east. The vegetation of the region includes several large areas of open grassland suitable for ‘hariq’ cultivation. The inhabitants are partly cattle owning nomad Arabs and partly sedentary tribes of Arab and African origin. Lack of permanent drinking water is a limiting factor in this region also.

7. **Flood Plain Environment**: Excess of water is the critical factor of this environment, which occurs in the areas mainly of clay at the southern end of the clay plains, and along the White Nile and its tributaries. The degree of flooding and nature of the soils vary within the region. The inhabitants are cattle owning Nilotic tribes. Much of the swampy land which is unsuitable for agriculture provides excellent dry season grazing (the ‘toiches’) which in some parts is used by the nomadic Baggara Arabs as well as by the Nilotics. Some parts of this region which lie away from the rivers are completely empty as they are swamp during the rains and waterless tracts in the dry season, thus permitting neither cultivation nor grazing.

8. **Ironstone Environment**: This is characterized by rather poor ironstone soils and their derivatives but has an adequate rainfall for all annual crops. The main ironstone region forms a belt across the south west of the country in the broad leaved grass woodland vegetation zone. Ironstone soils favour the woodland rather than the grass and the former harbours tse-tse so that livestock are practically absent from this region. Soils are generally poor and shallow, but there is a fringe of deeper sandy soil — the colluvial member of its catena — which lies along the north eastern fringe where the ironstone plateau meets the flood plains. The inhabitants of the region are partly Nilotics who graze cattle on the nearby flood plains, and partly miscellaneous non-cattle owning African tribes.
9. **The Green Belt:** The characteristic feature of this environment is that the rainy season lasts long enough to maintain perennial crops without irrigation. The main area with this environment occupies the south west corner of the Sudan, and there is a small patch to the east of the Nile. The country in these areas is generally rather hilly with soils derived from ironstone and basement complex. These are not intrinsically rich, but accumulate fertility under the comparatively rich vegetation and continuously moist and cool climate. These areas are inhabited by African tribes who have practically no cattle.

10. **Miscellaneous Irregular Environments:** This is intended to include types of hilly and broken country with variable soils which are not included in other groups. All such areas have one feature in common — that cultivation has to be carried out in patches according to the occurrence of suitable soils. In the drier regions these lie mostly in the valley bottoms, while in wetter regions they may occur on the gentler slopes or on the tops of small plateaux. Terracing is practised to a small extent in some localities. The main areas placed in this group are western Darfur, the Nuba Mountains, the southern Fung, and parts of Equatoria. Even where they occur in predominantly Arab country, these areas tend to be inhabited by peoples of African origin, partly because they usually have permanent water and partly because they offered natural barriers to the Arab conquests of the past.

11. **Mountain Environments:** These are environments which have been significantly changed by the altitude. In the Sudan they are very small in total area. Two separate areas are included — the Jebel Marra range with a relatively short summer rainfall and the Imatong and nearby mountains where there is a long wet season. There are permanent streams in both these mountains and in Jebel Marra irrigation and terracing are regularly practised. The Red Sea Hills get too little rain, and other ranges are too low to develop any significant altitude characteristics.

**FOOD CROP PRODUCTION IN RELATION TO THE ENVIRONMENT.**

Having briefly described the food crops of the Sudan and defined the main types of agricultural environment, we can now consider the relationship between the two. This can be no more than a survey and readers are referred to the publications listed for more detail.
The Desert and Semi Desert Pastoral Regions.

Nomads depend on their livestock for much of their food. Their unsettled way of life and the short and unreliable rains restrict any cultivation which they do to a quick growing cereal which has to be grown in 'wadi' bottoms where extra ground water is available. This cereal is dukhn, sometimes dura, the former in the hilly and sandy regions, the latter on clays such as the Butana and the south eastern corner. Other quick growing drought resistant millets, such as proso, which are the desert fringe cereals of parts of Asia have probably never been tried, but in any case the climate is too hot for them. At best the little cultivation which is possible is an inadequate and unreliable source of grain and the nomads purchase most of their supplies of dura and dukhn — to a lesser extent dried dates and dried vegetables — from the more sedentary populations of the central belt or the riverain regions through which they migrate.

The Irrigated Riverain Areas.

The Nile North of Khartoum.

The fringe of cultivation along the Nile north of Khartoum is extremely narrow and sometimes non-existent, but nevertheless it makes an important, if not large, contribution to the Sudan's food production. Shortage of agricultural land relative to irrigation water, and continuous contact with the traditional agriculture of Egypt have developed intensive methods of farming and peasant cultivators not met with elsewhere in the Sudan; and this area not only supports a relatively dense population, but exports food as well. The proximity of Egypt has another important influence on the agriculture of this region. With its over-population it provides an easily accessible market for foodstuffs, and there is a regular and profitable export to it of pulses, dates and wheat.

Since the time of the 'Turkiya' and probably earlier, people from this region have travelled the length and breadth of the Sudan and in particular Dongolawi merchants have carried on trade in all parts of the country. There is plenty of evidence that these people have introduced their own crops to practically all parts of the Sudan. Even if the crops themselves failed the Dongolawis often developed a demand for them especially in the Muslim communities with food tradition like their own, or at least within their own colony. These foods, dates, tick beans ('ful masri') and lupins ('termis') are eaten in regions which cannot grow them and are supplied by this riverain area.

The supply of ground water maintained by the annual flood, and the rainless hot summers which occur in this region are the conditions required by dates. In particular, dates require complete
absence of rain and intense heat to ripen their crop, so that the
main date production is in the almost rainless area to the north
of Atbara. Date trees grow well enough further south, but do not
produce satisfactory crops. Briefly, what happens in these areas
is that the normal crop is destroyed by rain and the tree is stimulat-
ed to flower again and to set a crop which tries to mature during
the cold winter weather and again fails. Still further south the
growth of the trees themselves is very poor. There is a tree at
Kagelu in the Green Belt which must be more than twenty years
old and is still not more than ten feet high. Dates, unlike other
perennial crops grown in this region, can be maintained by natural
flooding only. However, irrigation has greatly increased the pro-
duction, partly by widening the fringe of date trees and, if system-
atically carried out, by increasing the yield of individual trees.
Dates are a staple foodstuff of the people of this region and are a
regular item of other northern Sudanese diets. These requirements
are all supplied by this area and in addition about 5000 tons a
year are regularly exported to Egypt.

With irrigation water available throughout the year, crops
can be grown at all seasons. The summer, just before the Nile
flood arrives, is the time when irrigation water is most restricted,
and perennial fruit crops, including dates, have the first call on it.
To a certain extent annual crops can be grown between the dates and
other fruit trees and at this season benefit from the shelter and
shade provided. Some vegetables are grown in this way, though
vegetable production is difficult during the summer. As regards
annual crops, summer temperatures are too high except for heat
resistant tropical crops. Thus dura is the main summer food crop.
It is grown by regular lift irrigation, and, later in the year, on the
first exposed lightly flooded basins and river banks where it is the
best crop because of its drought and heat resistance. Dura pro-
duction is all used locally, much being grown for fodder, and the
rest eaten mainly by the tribes of Arab origin. With the full money
economy of this region it is more profitable to import dura grain
than to grow it.

Maize is grown in considerable amount both as a summer and
winter crop. It is grown in preference to dura because of its
resistance to birds. 'Lubia' is grown at all seasons as a fodder. Oil
seeds are not grown at all as, like grain, it is more profitable to
import these and concentrate on the production of fodder and more
valuable crops.

The winter is just cold enough in this region to suit some sub-
tropical and temperate food crops. Reference to Table 2 (Wadi
Halfa and Khartoum, Nov.-Mar.) shows the wide daily range
during winter in this region, and it will be seen that maximum
growth rate is quite impossible for either tropical or temperate
crops. The deeper basins and lower river banks which are exposed
as the river falls become available for cultivation during the winter period. The moistness of these sites varies a great deal, but as they get no further watering only quick maturing and drought resistant crops suit them.

These last are mostly sub-tropical crops including chick peas ('hummos'), lupins ('ternis'), and haricot bean ('fasulia), while wheat, tick beans ('ful masri') and peas which require a regular supply of water are grown on specially irrigated areas. 'Lubia 'afin' is grown on both areas and being a short day crop it flowers and produces a crop of beans during the winter. Barley is grown mainly where conditions are too poor for wheat, and can be grown as a 'gerf' crop. Lupins, haricot beans, tick beans and chick peas are eaten throughout the northern Sudan and, as they cannot be grown with much success anywhere else, this region supplies this demand. The export of these pulses to Egypt and other near eastern countries is also a regular feature of the economy of this region. Lentils (''ads masri') are very sensitive to heat and to unfavourable soil conditions so that too little of this crop is grown even to meet local needs.

Wheat was the staple cereal of ancient Egypt, and still is in the northern part of this region, which is partly inhabited by tribes of Egyptian ancestry. Most of the production of the region is consumed locally though a little is usually exported to Egypt. Sudan wheat cannot compete in price with imported wheat because it is produced by relatively costly intensive methods and the climate is not uniform or cool enough to obtain the best yields. Thus the wheat flour requirements of the rest of the Sudan are imported and it is only the local preference for the home grown unrefined product which makes its continued production worth while.

The alluvial soils of this region and the winter weather are eminently suitable for most Sudanese and European vegetables, and onions, sweet potatoes and other minor crops. These are all grown on a fair scale for local consumption and to supply urban communities. Vegetable growing is of course a major feature of irrigated areas in the vicinity of Khartoum and Omdurman, and an adequate supply for these centres is maintained, at least during the winter.

Though perennial irrigation is available other conditions are not suitable for many perennial crops. Most of the tree crops of the wet tropics are adapted to uniform conditions of temperature and humidity, and the very high summer temperatures and relatively low winter ones — as well as high saturation deficit and intense insolation — preclude most of these crops. However a few hardy tropical fruits are grown successfully including citrus, mango and guavas, and others such as bananas can be grown with the aid of shelter or shade. There is enough of these fruits to provide a limited local supply and to sell in limited amounts in Khartoum,
Omdurman and other urban markets. As with the date, these crops adapt their fruiting cycle to the climate, flowering during the cold weather and developing their crop as the weather gets warmer. Thus seasonal differences, though possibly unfavourable for vegetative growth, stimulate the production of fruit. In environments further south where there is appreciable rainfall citrus, mangos and possibly other tropical fruits tend to produce two crops a year, flowering once in the winter and again during or after the cool rains period.

The fruits of the Mediterranean region have mostly a distinct vegetative and fruiting cycle adapted to the hot dry summers and cold wet winters of that region. The conditions in the riverain region simulate these just sufficiently for the more heat resistant types to grow and yield. Thus figs, pomegranates and grapes are grown to a limited extent and produce relatively poor and inferior crops which are of no nutritional or economic importance.

While considering perennial crops it is worth saying a special word about sugar cane. The alluvial soils of the riverain areas are suitable for sugar cane and it has been grown in this area. However, yield of sugar cane, unlike that of the fruit crops just considered, depends on maximum vegetative growth and not on the stimulation of a fruiting cycle. To obtain continued maximum growth a uniform temperature near the optimum is required, and it is obvious that this is not available in the northern Sudan. Growth is particularly poor during the hottest weather, and rather than use water on a perennial which gives a poor response to it, it is better to use it on a series of annual crops each grown in its proper season. There is another aspect of water economy in connection with sugar cane. In the rainless northern Sudan this crop requires about twenty five irrigations a year whereas in suitable parts of the southern Sudan it can be maintained with no more than five or six irrigations to supplement the natural rainfall.

Other Riverain Alluvial Areas.

There are irrigated alluvial soils and ‘gerf’ cultivation along the Atbara, the Blue Nile south of Khartoum and its tributaries, and here and there on several seasonal rivers and watercourses. Recent alluvia and ‘gerfs’ do not occur along the White Nile because of its uniform discharge and freedom from silt. Being in the proximity of rain cultivations the Blue Nile alluvial areas are not so thickly settled and do not have to produce staple foodstuffs, as is the case north of Khartoum. The summer is too wet for dates and the winter too hot for some of the pulses grown further north. Where lift irrigation is installed these alluvial areas are used for the production of onions, vegetables and fruit such as limes, bananas and guavas. The ‘gerfs’ and basins are used to grow maize, water and sweet melons, and vegetables all of which are difficult or
impossible to grow on the neighbouring clay soils. The reservoir bottom of the Sennar Dam is an important site of this type and provides large quantities of maize, cowpeas and 'bamia', some of which is exported from the region. The Jebel Aulia reservoir bottom on the White Nile is not as extensively used as that of the Sennar reservoir. There is a demand for the produce of the gerfs and irrigated gardens in urban areas and amongst the prosperous Gezira tenantry.

Isolated irrigated areas such as the Kheiran in Kordofan, Mellit and other places in Darfur etc., though intensively cultivated are far too small to have more than a strictly local effect on the supply of fruit, vegetables and special crops.

The Desert Deltas. (16)

The important agricultural areas of Tokar and the Gash belong to this environment though the latter has clay soils as well as alluvia. In these areas cotton is the main consideration and gets the best watered areas. Poorly watered areas and soil which is unsuitable for cotton are used for dura and dukhn cultivation. Many of the cultivators in the Gash and Tokar are from the neighbouring nomadic tribes and dura and dukhn produced in the deltas are an important addition to that produced in the 'wadis' and other favoured sites in the district. The deltas being flush irrigated, winter crops are not possible, though at Tokar dukhn may be sown following winter rains which supplement the ground water. At the head of the Gash delta ground water is available for irrigation. The supply lasts through the winter and is replenished annually by the flood. This area produces bananas and other fruit, onions and vegetables which are more than enough for local requirements and are exported to neighbouring areas.

The Irrigated Clays. (17) (18)

This environment is typified by the Gezira, which is by far the most important irrigated clay area. Others occur as pump schemes along the Blue and White Niles at the same latitude or further south. Some of the larger irrigated areas north of Khartoum also go on to clay, and pump schemes generally have more variable soils than the Gezira. The relatively high salt content, low nitrogen, impermeability, and poor root development of the clay soils make them entirely unsuitable for many crops and reduce the yield potential of practically all. Food crops which grow satisfactorily on the clays include dura, tropical pulses ('lubia', 'cowpea', pigeon pea), wheat, onions and certain vegetables. They are unsuitable for dukhn, maize, the common oil seeds ('sesame' and groundnuts), all the pulses grown in the Northern Province, all root crops, cucurbits, and certain vegetables, sugar cane, fruit and tree
COMPARISON OF CROP GROWTH ON GEZIRA CLAY & RIVER SILT

(a) DURA

(b) DUKHN

Cont. overleaf
crops generally. Diagram 6 illustrates the comparative growth of crops on Gezira clay and Blue Nile alluvium at the Gezira Research Farm. With special cultural treatments some of these crops can be made to produce reasonable yields, but there is little point in doing this as all of them can be grown elsewhere without any special attention or expense.

An important feature of the climate at this latitude is the rains or ‘kharif’ period when maximum temperatures are relatively low, minimum temperatures relatively high and saturation deficit relatively low. For particulars see Table 2 (Wad Medani). These conditions are nearer the optimum for growth than those at any other season and constitute a summer growth period not found in the Northern Province. This special growth period occurs in July, August and September and coincides with the irrigation free period, so that it is the best time to sow the tropical food crops of the region. Dura, which is the major food crop, is all sown at this time and as much as possible of the main pulse, lubia. Lubia being a short day crop produces only fodder during the summer and does not flower and pod until the winter. Though not grown as rotational crops on the scheme some cowpeas, pigeon peas and groundnuts may also be sown at this time in garden areas.

There is still a fairly cool winter in the Gezira (see Table 2), and in practice it is found that winter conditions are nearly always cool enough to produce a good crop of wheat in the northern part of the Gezira, but elsewhere the winters are sometimes too hot. In the Gezira, irrigation is restricted after the first of January and, as practically all water available after that date is required for cotton, winter crops cannot be grown as main crops. Wheat, onions and vegetables of certain kinds are grown in gardens in the Gezira and to a limited extent as main crops in some smaller schemes. The wheat and onions are grown mainly as cash crops and the vegetables chiefly for home and local consumption. Safflower is a crop which does extremely well in the Gezira in winter, but it is likely to become important as a commercial crop and not for food.

Perennial crops cannot be grown in the Gezira at present because irrigation is not available all the year round. Fruit trees and sugar cane have been tried in the Gezira, and the trials confirm that this stiff, salty, impermeable clay is unsuitable for them. However, with careful husbandry and manure, citrus and guavas give reasonable crops.

Cotton production is the main consideration in the Gezira, and being organized on this basis the intensive food production of the riverine areas would not be possible even were plenty of water, suitable soils, and skilled peasants, available in the Gezira. Nevertheless the scheme has made a most important contribution to the food economy in guaranteeing the dura supply in
an area which was previously a marginal rainland and liable to failure and famine. In its lubia crop the Gezira has also a guaranteed supply of pulse, but, because it cannot grow them, not of oilseeds. In this connection cotton seed oil is a possible additional food product of the Gezira, but in view of the preferences of the inhabitants for 'simsim' and the Sudan's overall sufficiency in this crop, the cotton seed would probably be better used for other purposes. The prosperity which cotton has brought has made the Gezira an important consumer of foodstuffs grown elsewhere in the Sudan.

The 'Qoz' Sands. (19) (20)

The 'qoz' sands are remarkably productive considering the poor­ness of their soil and the relatively low rainfall of the regions. Their apparent fertility is due to the physical condition of the soils and low salt content both of which encourage extensive and efficient root systems. The rains are probably not heavy enough to leach nutrients beyond the reach of the root systems. 'Qoz' soil are easy to clear, need no tillage and little other cultivation so that individuals can cultivate large areas. This has encouraged commercial production which has developed in the more accessible parts of the region.

The growing season in the 'qoz' is limited by rainfall to two or three months in the summer and, as the rains are short and not very plentiful, quick growing drought resistant tropical crops suit this region. Dukhn and water melon ('battikh') are the two crops characteristic of sandy soils which fill these requirements and they are generally grown together on the higher and drier parts of the 'qoz'. Dukhn is the staple cereal and large amounts are produced, supplying the non-cultivating communities of the western Sudan as well as the cultivators themselves. Water melons are of great local importance as a substitute for drinking water, and a good melon crop extends the time that people can remain in waterless areas. Melon seed is an important item of export and comes almost entirely from this region.

'Simsim' by virtue of its extensive root system and the well aerated soil grows extremely well on the 'qoz' and very large quantities are produced. The 'qoz' is the main area producing 'simsim' for other parts of the Sudan and for export. Groundnuts grow well in parts of the region where the rainfall is more favourable, and also form an export crop, but their production is on a much smaller scale than 'simsim'. Dura in fair amounts, cowpeas, 'bamia' and a few other vegetables are sometimes grown at the lower levels of the sand hills or on soils of higher clay content lying between them. The central rainlands ('qoz' and clay) do not have an adequate supply of fresh fruit and vegetables and depend for these
items on cultivated and wild vegetables and fruits during the rains, dried vegetables and dates at other seasons. It is unfortunate that here, where wild products are most needed, they are relatively scarce.

As in all areas dependent on rain, crop failures are liable to occur and the production in different seasons varies tremendously. In this region and in the central clay plains crop plants are widely spaced to minimise water strain. The 'qoz' region in common with the rest of the central Sudan is insured against localised failure by the large areas of crops normally grown, stored grain reserves, the availability of animal transport and the well developed money economy and trade of the Arab and arabised communities. As will be seen later these conditions do not exist in the African communities further south.

The fertility of the 'qoz' sands is maintained by shifting cultivation which is usually fitted into a long term rotation with gum arabic (Acacia Senegal). Pressure of population especially near the railway has caused the shortening of this rotation and over cultivation. To relieve this and to increase production generally new areas are being made available by providing wells and bores for water.

**The Central Clay Plains.** (20) (21) (22)

The soils of this clay region are the antithesis of those of the 'qoz', but its climatic limitations are essentially the same, though it extends over a wider rainfall range. Dura grows well on clays, is salt tolerant, and is not only drought resistant but able to withstand temporary waterlogging, so that it is the ideal crop for this environment. In areas where there are both 'qoz' and clay soils, the former are preferred for cultivation partly because they yield better under poor rainfall and partly because they are easier to work. Like the 'qoz' this region produces food crops surplus to its own requirements, again because extensive and easy methods of cultivation are made possible by the uniformity of the soils and the areas of open vegetation. It is convenient to consider the northern drier part of the region and the southern and eastern wetter parts separately.

**The Northern Clay Rainlands.**

These are the areas getting not more than 500 mm. rainfall and they lie mainly to the north and west of the railway from Kosti to Kassala. The soils are generally more salty, have less nitrate and are less permeable than further south. Dura is the crop best adapted to this soil and climate and is practically the only crop grown. In this area 'terus' cultivation is widely practised to make the best use of the rainfall and because of shortage of rain or
over cultivation the grass is not rich enough for hariq. Never-
theless, little cultivation has to be done, and when there is sufficient
rainfall, individual cultivators can grow very large areas of dura.
As grain storage is easy and universally practised in this region, part
of the bumper crop is stored as an insurance against years of poor
rains which recur periodically. These periodic failures help to
maintain fertility in these nitrogen deficient soils as they prevent
the growing of dura continuously. Further south the better rains
make continuous dura cultivation possible and in some of the
'bilad' cultivations where this is done there are signs of severe
depletion. The accessibility of this region has encouraged the pro-
duction of dura for sale and has resulted in considerable over-
cultivation.

The Southern Clay Rainlands.

To the south and east where there is a higher rainfall the
soils are much less salty, have more nitrogen, and are more
permeable. Dura is still the most important crop but simsim grows
well on the most permeable soils. In particular it is grown on the
fertile clays of Gedaref district and in the Fung area. The dura
and simsim in this area are produced partly on 'bilads' some of
which are rich enough to maintain good yields, and partly in shifting
plots. Hariq cultivation is practised throughout the region and
permits of extensive crop production. The systematic conservation
of hariq areas is an important recent development. The 'sageas'
of the region are also suitable for mechanised crop production and
a start on this has been made. The greatest part of the southern
clay plains is covered by fairly dense Acacia tall grass woodland
which has to be cleared for cultivation, and so precludes the
immediate use of extensive methods. Most of this Acacia as-
association is thinly inhabited and little used because of lack of per-
manent water. It has great potentialities, and, when cleared, is
suitable for extensive agriculture.

The commercial production of dura and simsim has greatly
increased in the whole region in recent years following the opening
up of waterless areas by digging 'hafirs' and by the extension of
roads. These developments also aim at relieving the congestion
further north.

No other crops are grown on a large scale on the clays though
maize, cowpeas, groundnuts, bamia and other vegetables are grown
in limited amounts and often near houses and on patches
of lighter soils which occur here and there. The production of
some of these, and other introductions, may be found to be
technically possible. Trials of new crops, new varieties, and new
techniques are being carried out at the Tozi Research Farm which
is situated in this region. So far Italian millet, soya bean and
some other legumes are the most promising new food crops. The
position regarding the diet and food supply generally is much the same in this region as in the 'qoz' region, the Arab background being common to both. Though West Africans cultivate considerable areas in the clay plains and Nuba and Dinka and other negroid tribes smaller areas, they also come under the influence of the same background.

The Flood Plain Region. (23)

The excess water of this environment is due to the poor drainage and the flooding of the White Nile and its tributaries, and not primarily to rainfall which is about 700 to 1000 mm. per annum. The flood plain region is the southern end of the clay plains centred on the Sudd. The environment as a whole includes higher unflooded areas, varying depths and amounts of flooding, and a variety of soils, mostly heavy clays. Except along the course of the White Nile itself flooding is seasonal, occurring during the rainy season which is also the cropping season. From the point of view of crop production this is unfortunate as large tracts of fertile land are under water and cannot be cultivated, but from the point of view of livestock it is most satisfactory. Rain-grown pastures are available on the higher areas when the plains are flooded and as the former are used up the flood recedes and exposes fresh green pastures of excellent quality. These conditions are eminently suitable for animal husbandry and the Nilotic peoples of these regions are primarily pastoralists whose first interest is their cattle. They may even abandon unharvested crops if their cattle prefer to be elsewhere.

The main agricultural problem of the region is to find enough dry land to provide the region's grain requirements. In the northern part inhabited by Shilluk there are permanently dry ridges which are used for cultivation and round the fringe of the flooded area the dry clay plains or the edge of the ironstone plateau are extensively used for cultivation and habitation. In most of these areas there tends to be over cultivation as the inhabitants wish to stay as near their grazing areas and water supply as possible — the Nilotics are rangers but not nomads. In the central part of the region cultivators have to make the best use possible of the smaller areas of dry land available and to adapt their cropping system to the flood. In one area shortage of land has resulted in the intensive use of animal manure, and another section of the Dinka have practically given up cultivation and live on fish, meat and wild plants, principally water lily seed. Water chestnut (Trapa bispinosa) occurs in this region but although much used in India is not eaten here. The nature of the soil of most of the region makes the growing of crops after the flood impossible.

Dura is the only crop extensively grown in the flood plain region, and though it suits clays and can stand some waterlogging
conditions are often too wet for it. There are two main types; one consists of quick maturing varieties which are sown on lower lands with the first rain and produce a crop before the flood has destroyed them; the other type consists of slower maturing main crop varieties sown on land above the normal flood level. The risks involved in growing the first of these are obvious — late rains, a high or an early flood may mean the complete loss of the crop. A high flood may also destroy part of the main crop and abnormal flooding can cause great hardship in some areas.

It must not be thought that lack of sufficient land and flooding are the only causes of grain shortages. As in the central rainlands drought causes periodic failures, particularly because the need to avoid the flood precludes the choice of the best areas to avoid drought. Even where dry land is available the grasses of the region are usually tufted perennials which are difficult to clear and unsuitable for hariq so that extensive methods of cultivation are not possible, and as most Nilotics tend to look on crops as a necessary evil, they usually grow only the minimum necessary. (It should be noted that this is not the case where cultivation is easy and there is sufficient incentive, as has been shown in the hariq areas of the Northern Dinka district and in the oil seed areas of Bahr el Ghazal). Thus there is little surplus production, and even if there were, conditions in this region are unsuitable for large scale storage so that there is no reserve of grain available. As in all negroid parts of the Sudan surplus grain is turned into beer rather than stored. To add to this, trading is undeveloped, and the Nilotics do not use their animals for transport so that the normal economy of the region is not capable of relieving local shortages. However, changing outlook and faith in public security are encouraging Nilotics to go further afield and barter their cattle (with reluctance) for grain when this is necessary. This picture of the economics of famine is essentially the same in all the pagan African areas of the Sudan and explains why these areas of relatively reliable rainfall suffer acute local famines and grain shortage generally much more frequently than the northern and central Sudan. Another consequence of undeveloped trade is that southern tribes eat only what they grow so that tribal diets often vary greatly. Sugar, tea, coffee and other imported foodstuffs are not used by southern cultivators.

Maize is sometimes sown as an early quick maturing crop and groundnuts, green gram, cowpea and dukhn are grown to a very limited extent, often in the vicinity of houses.

Rice is a crop adapted to flood conditions and is an obvious crop for trial in flood plain regions. Trials so far have been successful, but have not got to the stage where large scale production can be started. It is unlikely to take on as a peasant crop because of the amount of work and skill involved in growing it, and land shortage and over-population have not nearly reached the
stage where this kind of intensive cultivation is necessary. Its possibilities are as a commercial crop which might later have a place as a local foodstuff.

The Alluvial Areas. (24)

Before the White Nile enters the Sudd it has laid down true flood plains of excellent alluvial soil. These are subject to periodical short floods, but not continued flooding for several months. The people living along the fringe of these areas use them for growing small plots of maize, eleusine and bananas, though they are not prepared to risk their main cultivations on them. With some flood regulation these areas could be developed. Sugar cane was tried on such an area near Juba over a number of years and gave excellent results. The alluvial soils and the more or less uniform temperatures and humidity suit it, and not more than five or six irrigations would be needed to maintain optimum growth conditions throughout the year.

Similar alluvial areas also occur along the Sobat and other smaller rivers.

The Development of the Flood Plain Region.

This region has great possibilities for development by the application of modern engineering, irrigation, and agricultural techniques. Some of these have already been suggested by the Jonglei Investigation Team in their Reports (25), though this aspect of the region has still to be investigated per se. One of the most interesting possibilities of immediate value is the putting up of high ridges in the flooded and waterlogged areas to raise part of the land above the water table. Where this has been done experimentally excellent crops of dura and other food crops have been obtained.

The Ironstone Region.

The ironstone soils, which are characteristic of this region, are free draining, and most of the region has a rainfall of over 1000 mm. a year falling during a rainy season of more than six months. Thus it does not suffer either from deficiency or excess of water. The soils are poor and, unlike those of the ‘qoz’, they are often shallow and crops do not develop the very deep and extensive root system which in the ‘qoz’ compensates for the poverty of the soil. The sandier colluvial soils of the fringe are more like the ‘qoz’ and are the most thickly inhabited and most productive of the region. The greater rainfall leaches nutrients out of the zone of crop roots, but they are kept in circulation by the deep rooted tree vegetation of the region, and in this way fertility is maintained by shifting cultivation. With these soil conditions crops do not produce bumper yields,
The vegetation being relatively dense much effort is required to clear it, and tillage is necessary to remove roots. Even after cultivation much preparatory cleaning and tillage has to be done for the next crop. Thus unlike both the ‘qoz’ and clay rainlands, much work is involved in the preparation of land and an individual may expend more effort in preparing one ‘feddan’ than his northern counterpart would in clearing ten or even, under some conditions, a hundred. As a result the area of cultivation is restricted to the essential minimum, certain intensive methods of agriculture are practised, and crops are given careful attention. With adequate rainfall a cultivator can judge fairly accurately the area of crops he requires for subsistence and allows little margin for contingencies. This is why large surpluses of grain and other crops are not produced in this region and why the food economy of the south is so easily upset. Mixed cropping is the rule in this region and even where a single crop is grown it is sown very thickly. The plentiful rainfall makes these practices possible and they are probably necessary to make the best use of the poor shallow soils and to help prevent erosion. These practices, together with the characters of the soil and the crop rooting system, make the crops of the region susceptible to relatively short dry spells and abnormalities in rainfall distribution, and cause fluctuations in yields and sometimes partial failures under conditions which would be considered entirely satisfactory further north.

The long growing season with uniform moderate temperatures and relatively high humidities favours a wider selection of crops than in the rainlands further north. The range is further widened by soil variations. The permeable soil and long growing season favour root crops; and this is the first region so far considered where these crops are an important item of food.

Dura is the main cereal of this region, but dukhn, ‘telebun’ and maize are all grown on the varieties of soil which suit them. Sesame and groundnuts are the major oilseeds, with hyptis and gourds of secondary importance in all areas. Sweet potatoes, cassava and a few yams are grown, though not very extensively in the northern part. Cowpea, green gram and bambara earthnut are the main pulses and bamia and ‘mulukhiya’ the main vegetables though a lot of wild plants are also used. All these crops are primarily grown for subsistence, but there is usually a surplus of sesame and groundnuts, and sometimes dura which is sold. These surpluses generally come from the sandier areas along the north and east fringe, and these areas are developing as commercial producers of simsim and groundnuts. An interesting difference between pastoral tribes and purely agricultural tribes is illustrated in this region. The latter grow a bigger variety of crops, though not usually a bigger area. Whether this is due to the instinctive nutritional needs of a vegetarian diet, to the relatively greater importance and interest of their cultivations, or to their more
sedentary way of life, it is a difference which is consistent in all parts of the Sudan.

The higher humidity of this region increases the susceptibility of cereal and pulse grains to store pests and moulds. Telebun, green gram and bambarra earthnut are resistant to these and this is one reason why these crops increase in importance with increase in rainfall. Dura, maize and cowpeas are susceptible and are often eaten soon after harvest, and if stored are always kept unthreshed. Grain stores are constructed with considerable ingenuity — for instance the Dinka who grow mainly dura build their grain store with a latticed floor above their kitchens so that the grain gets dried and fumigated by heat and smoke. There is no inter-seasonal storage, surpluses being sold or turned into extra beer. Incidentally this is sometimes done too soon and may lead to a shortage later in the season. The Nilotic tribes are particularly guilty of this form of improvidence. Even intra-seasonal storage is difficult and this is got over by having crops mature at different times of the year. For example maize which is quick maturing is sown in favoured sites with the first rains to produce the earliest harvested cereal, then follow quick maturing dura or possibly dukhn, then telebun, then late maturing dura, and if this or stored telebun do not last out, cassava or other root crops maintain the food supply till the next harvest. Cassava and sweet potatoes are also an insurance against the failure of any of the main cereal crops, cassava being particularly valuable in this respect as it is a perennial, and its roots remain in edible condition for a relatively long period.

Some of the hardy tropical fruits manage to grow in this region without irrigation and, though they are not general, mangos, pawpaws and a few citrus are grown by the people. Bananas and sugar cane are also grown in selected sites. A bigger selection of fruit is grown in government and other gardens sometimes with the help of irrigation. In this region there is a plentiful supply of wild fruits which are more extensively used than in the wetter regions where cultivated fruit is commoner. The 'lulu' tree occurs extensively in this region and provides some communities with an important accessory source of oil of which there is sometimes a surplus for sale.

The Green Belt. (25)

This environment has a higher rainfall and longer rainy season than the last. It can be considered to start where the ironstone plateau merges into the slightly higher country of the Nile-Congo Divide region with altitudes between 2000 and 4000 feet above sea level. The foothills of the Imatong and other mountains east of the river also belong to this environment, and the whole of the
Imatongs could be included in it. The altitude and rainfall make the regions of this environment considerably cooler than the last, but the rainy season occurring between December and March is sufficiently long to cause a marked hot dry spell. The soils of the greater part of this environment are from ironstone but in some of the hillier parts there are soils derived direct from the underlying rocks. The latter are usually the richer.

A detailed ecological study of the agriculture of the Zande area of this and neighbouring environments has been made by P. de Schlippe and is under publication.

Though the climate can maintain perennial crops, nearly all the food supply is provided by annual crops. As far as these are concerned this environment is little more than an extension of the last. The selection of crops is larger and there are many varieties often with specific functions. The Zande and associated tribes who have never owned cattle have the biggest selection of both annual and perennial food crops and keep introducing new varieties from the territories to the south and west. The Zande themselves immigrated from these regions and undoubtedly brought with them many crops from nearer the west coast where they had originally been introduced. It is obvious from a study of the native crop names that there has been an eastward drift of introductions, and tribes who own or used to own cattle are having their crop resources enriched from this source. These areas have also benefited from introductions by government bodies from the time of Emin Pasha onwards. The inhabitants of the wet regions east of the Nile are of cattle owning stock and have not this accessible source of new crops so that they have a much smaller selection of annuals and practically no perennials. The longer rains allow more latitude in the use of the growing season, and amongst other things it is common practice to take two crops a year off the same area. Mixed cropping and other intensive methods are also practised.

Telebun is the principal cereal of this region though dura is more important in a considerable part of it. Maize is grown in all parts on a considerable scale. Telebun appears to be the best suited to the region, being able to produce excellent yields in cloudy wet weather on poor soil, and being resistant to store pests. Nutritionally it is also a satisfactory grain for this meatless region. Temperatures are too low and sunshine not enough for dura and dukhn, though local varieties are well adapted to local conditions; and the soils are rather poor for maize. The last is consequently grown on better sites, e.g. in valleys and near houses. Hill rice is an additional cereal well adapted to this region which is now grown on a small scale. Root crops are relatively more important in this region than the last and in Zandeland cassava is supplanting telebun as the major food because of the ease with which it can be grown.
and prepared. Sweet potatoes are also extensively grown, yams widely grown on a small scale and cocoyams, which could not be grown in a drier region, occasionally. As in the last region the various cereals and roots fulfil the function of providing a supply of freshly harvested food throughout the year. All of these, particularly telebun, are stored for short periods, but never into the next season. Mangos and to a very small extent bananas also help to fill gaps in this cycle, the former crop being particularly valuable as it ripens during the period of shortage from March to July. The introduction of cotton as a crop in south western Equatoria does not appear to have upset the food pattern much, though the disturbances due to development are partly responsible for the increase in cassava consumption amongst the Zande.

The same oilseeds as in the last region are grown, and some districts produce occasional surpluses of simsim, others of groundnuts. With the addition of lima beans and haricot beans the same pulses are grown. A wider selection of vegetables is grown and leaves of crops and wild plants are extensively used.

Several perennial food plants are widely grown in small quantities, but shifting cultivation, which in this region means shifting homesteads, is against the widespread use of perennials. Mangos and bananas have already been mentioned. Chilies are partly cultivated and partly grow wild, and are an important commercial product of this region. Pineapples, pawpaws and a few citrus are grown throughout the western part of the region. All these and several other introductions are grown in government and other gardens. Experimental farms at Kagelu, Yambio and Maridi have played an important part in the introduction and trial of both perennial and annual crops. There is a plentiful supply of wild fruits which are eaten occasionally.

Although the weather is relatively cool here the temperature is never low enough to grow temperate crops, though wheat and potatoes have been tried. There is probably also too little sunshine for these crops — a twelve hour day compared with fifteen in a European summer. There is too much rain and not enough seasonal difference for sub-tropical crops and fruit.

This is the one environment in the Sudan where tropical plantation crops could possibly be grown. Oil palms, coffee and sugar are already being grown on a small scale partly as plantation and partly as peasant crops, and tea and cocoa have been tried. In general the dry season is too severe and most of the soils too poor for these crops. The better sites which exist in the gallery forests, valleys, depressions and higher hills are very limited indeed and most of them must be protected in their natural state to conserve soil and water supplies. If the green belt occurred in a wet tropical country and not in a dry one it would be considered unsuitable for the above crops. However, the Sudan is fully
justified in attempting to grow these important products within her own boundaries.

Considering these crops individually:— Oil palms are fairly hardy and there is little difficulty in growing them, but the poor soils and lack of dry season water certainly reduce yields. Sugar cane practically fails on ironstone soils and that now grown in plantations or by peasants is on special sites. It is unlikely that in this region there are single areas of suitable soil large enough to establish a sugar plantation of economic size. Coffee is benefited by a short dry season, but in this region it is often too long and the plant, which flowers in the dry season, often does not get enough moisture to establish its crop. Tea needs relatively cool conditions with a very short dry season. Except at higher altitudes the dry season is too hot and too dry. Cocoa requires continuously moist weather and is a typical tropical rain forest crop. These conditions do not exist in the Sudan.

Miscellaneous Hilly and Broken Areas (19) (62)

Any one of these areas generally contains several distinct environments. Thus they tend to have a wider range of crops than the major environments with the same climate. There is also generally a greater variety and abundance of wild products. Jointly these areas support a considerable population and make minor contributions to the food economy of other areas. Though they have many features in common it is easiest to describe the main areas separately.

Western Darfur.

The rainfall in this area is not high and consequently the main cultivation tends to be in depressions and valley bottoms, on what are in fact, alluvial soils. These alluvial soils are of mixed origin and some of them contain volcanic material from the Jebel Marra range. The largest and most important valley is the Wadi 'Azum. It receives a relatively good rainfall which is supplemented by flood water. Very large areas of excellent dura are grown in the Wadi 'Azum and it is the main source of this grain in Darfur. Dukhn and groundnuts are also grown in patches and sweet potatoes and other crops in small amounts. There are several valleys of this type. Those towards the north grow mainly dukhn, sometimes simsim, dura and bamia. Crops are grown on other favourable sites and to a small extent on terraced hillsides. In many of the valleys ground water occurs near the surface and tobacco, and to a lesser extent vegetables, can be grown on some of these without irrigation. Elsewhere lift irrigation is carried out on a small scale. The winter in the area is cold enough for temperate crops and onions, wheat, chillies and a variety of vegetables are grown to
a very limited extent by irrigation. Fruit trees are grown in a few gardens.

THE NUBA MOUNTAINS.

This area lies in the midst of the clay plains, and clay soils occur within the hilly area. The soils of the hills are lighter and grow a wider variety of crops than the plains, including all the common central rainland crops. These are often grown on steep hillsides, and terracing used to be widely practised but more crops are now being grown in the plains. The introduction of cotton to this area did not upset food production much as it is practically all grown on clay areas which were not used for food crops. A little water is available for winter irrigation and is used to grow chillies, onions, some vegetables and a few fruit trees.

THE SOUTHERN FUNG.

In this area there is a wide variety of soil conditions. The rainfall is higher than in the two previous areas and conditions are much more like those of parts of Equatoria. The general cultivations of the area are carried out on the patches of deeper soil in depressions, on level tracts, and on the aprons round the base of some of the hills. Dura, dukhn, simsim and groundnuts are commonly grown and to a less extent cowpeas, hyptis, 'babun', bamia, chillies and other crops. In special alluvial sites maize and vegetables are grown and onions and other crops in a few very small irrigated areas. The Maban of this region grow cassava and cocoyams in favoured alluvial sites.

PARTS OF EQUATORIA.

Most of Torit district and similar country just west of the Nile come into this category. The cultivation is done on areas of level soil, the aprons of hills, and depressions. The crops and methods of agriculture are similar to those of the neighbouring ironstone areas and not unlike those of the southern Fung. This is in general not a very productive area, but a considerable amount of dura, groundnuts and simsim is grown, some of which is available for sale.

The wetter hilly areas of Equatoria have been included in the ironstone region or the green belt.

The Mountain Regions. (10)

The feature common to the two main mountain regions, Jebel Marra and the Imatongs, is that at higher altitudes the temperatures at all seasons are significantly lower than those of the surrounding plains.
JEBEL MARRA.

Jebel Marra has rich volcanic soils which are deep enough for cultivation along its foothills, in its valleys and on some of the hillsides. The rainfall though greater at higher altitudes falls during the short rains period of about three months, but there are perennial streams which make a limited amount of perennial irrigation possible. The mountain is inhabited to about 9000 feet and methods of agriculture not seen elsewhere are practised at the higher altitudes.

In the foothills dukhn is grown year after year on the same land in some places. Very small areas of other tropical crops are grown, climatic conditions being similar to those on the plains. This continuous cropping is only made possible by the depth, richness and friability of the volcanic soils. The hillsides on Jebel Marra are extensively cultivated even at high altitudes and to do this whole hillsides have been systematically terraced. The crops grown are dukhn in large quantity, dura and wheat at the higher levels, and some minor crops. Undoubtedly a number of other temperate, sub-temperate and tropical food crops would grow at some level on Jebel Marra, but none of these have any virtue not possessed by the present crops.

At higher levels there are a number of mountain valleys with sedimentary and alluvial volcanic soils and usually a limited amount of running water. During the rains dukhn is grown in these valleys and sometimes, at a higher level, wheat. Wherever water is available intensive irrigation agriculture is practised. Plots are levelled up by terracing and provided with irrigation water by gravity flow from streams. These plots are manured and carefully tended, and are kept almost continuously under crop. Wheat, chillies and onions are the main crops, and miscellaneous vegetable crops are grown in small amounts. A number of other food crops would grow successfully if there were any point in introducing them. In several of these valleys there are government or privately owned fruit gardens with citrus, bananas, mangos, grucas and other tropical fruits at the lower levels, and temperate and Mediterranean fruits being tried at higher levels. Arabica coffee which is adapted to hilly regions with a definite dry season has also been tried under irrigation in these valleys. Were the humidity higher and insolation less intense conditions would suit it well. However, any marked extension of irrigation in Jebel Marra would deprive the irrigated annual food crops of part of their supply, and careful consideration would have to be given to the extension of coffee or any other plantation crop. Olives have been tried with and without irrigation at high altitudes.

IMATONG MOUNTAINS.

The Imatongs are nearer the equator and have a much higher
rainfall than Jebel Marra so that their temperatures and environment generally are much more uniform throughout the year. Only the foothills and lower slopes of the Imatongs are cultivated and the conditions there are those of the green belt. The cooler conditions at higher levels and plentiful rainfall suit both tea and coffee and both crops are being tried. A large number of temperate, subtropical and tropical crops would suit the conditions at different altitudes, but the Imatongs are the source of water supplies for the plains below and agriculture should be kept out, or most strictly controlled to protect these.

Temperate Crops in the Mountains.

It is often assumed that given conditions which are superficially like an English summer any temperate crop can be grown. This is more or less true in the case of annual crops, but the position regarding perennials such as fruit trees is much more complicated. Temperate fruit trees have their vegetative and fruiting cycle adapted to a cold wet winter and a warm wet summer. These are not the climatic conditions of Jebel Marra and the application of irrigation water during the winter cannot alter the relatively high day temperatures, the intense insolation, and the low humidity which occur at this time. The shortness of the rainy season also means that there are spells of hot weather before and after it. Temperate fruit trees cannot adapt their periodism to these conditions. For example apple trees in Jebel Marra do not become fully dormant, and flower spasmodically. The first flush is in March which is about equivalent to a European May, but this flowering either does not set, or the fruits are shed. A second minor flush occurs in May or June which is the springtime of the countryside as a whole, and this flush may ripen a small crop. A third flush may be stimulated by the rise in temperatures after the rains in October. Peaches, apricots and olives follow a similar pattern, and other temperate and Mediterranean crops are likely to behave in a similar way. In the Imatongs conditions are more favourable in that the cool season is also the wet one and the hot season the dry one. However, the differences in temperature between the two may not be enough to establish the cycle completely.

Some Salient Points of the Sudan’s Food Crop Production.

To integrate and summarise what has been said above the following points are stressed:

(1) At a conservative estimate, two thirds of the country’s population are unobtrusively growing most of their own food. This production and not the commercial production of food contributes most of the nation’s food supply.
(2) Overall food production is usually adequate and the Sudan has not suffered a serious famine for very many years. Seasonal and local shortages are liable to occur, and many diets are nutritionally unbalanced.

(3) Commercial production of most food crops is practically always adequate for the Sudan's non agricultural communities. After all requirements are met there is still a large potential available for improvement of local food supplies or for commercial production.

(4) The food producing regions fall into three main groups. The irrigated areas where intensive agricultural methods are necessary and cost of production high; the central rainlands where conditions of soil and vegetation permit extensive agricultural methods for the major basic food crops of the Sudan; and the southern regions where the vegetation and other factors discourage the cultivation of large areas and necessitate expensive intensive methods of production.

(5) The northern and central Sudan have a common religion, trading traditions, and transport facilities both mechanical and animal. This has resulted in an interzonal trade in food products which in turn has made possible a degree of specialisation in food production. In particular the irrigated areas have developed production of the most costly products which require that particular environment and intensive methods to produce and exchange these for basic food-stuffs produced more cheaply elsewhere. Specialised commercial production is also encouraged by the needs of urban and other non-food producing communities, which obtain their basic foods mainly from the extensive cultivation of the central rainlands and their luxury foods from intensive irrigated areas.

(6) In the southern Sudan, without a common religious tie, without indigenous trade and with no animal transport, each community produces its own requirements of all its foodstuffs. With reliable rainfall, difficult storage, and costly production, cultivators leave little margin for contingencies in their food production. This results in the absence of a food crop surplus and makes communities very susceptible to famine or to any strain on their economy. This situation is further aggravated by lack of indigenous trade and transport.

(7) The central rainlands, both sands and clays, are the part of the Sudan where cheap production of basic foods is possible.

(8) Certain parts of the southern Sudan have conditions which, to some extent at least, suit the Sudan's three most important imported food products — sugar, tea and coffee. These are crops which usually pay for intensive methods of production.
REFERENCES.

In addition to the publications listed below there is a great deal of information not readily available in unpublished reports. These are of especial value in providing regional detail. At least two important reports are under preparation at present — Sir Alexander Gibb’s report and the Final Report of the Jonglei Investigation Team.

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GLOSSARY OF ARABIC TERMS

'Agwa
Soft dates, picked when ripe, stoned and pressed into a mass.

Andat
Agonoscelis versicolor, the ' dura ' bug.

Babun
Vigna vexillata Benth.

Baggara
A group of several cattle-owning nomadic tribes centred mainly in Kordofan Province.

Bamia
Okra—Hibiscus esculentus L.

Basturma
Meat cut into thick slices, dried and salted.

Beladi
Country-bred or local.

Berseem
Lucerne—Medicago sativa L.

Bilad
Village perimeter lands, cultivated annually without rest.

Buda
Striga hermonthica, a parasitic weed, attacking ' dura ' and some other grasses.

Deim
Third class urban residential area

Diwan
Men's quarters of a house

Dom
The branching palm—Hyphaene thebaica Mort.

Dukhn
Bulrush Millet—Pennisetum typhoideum Rich.

Dura
Great Millet—Sorghum vulgare Pers.

Fassikh
Dried Nile fish

Fasulia
Phaseolus vulgaris L., the Haricot bean.

Feddan
Unit of area equal to 1.038 acres or 4200 m².

Feriq
A herd of camels or cattle, or the encampment of their nomadic owners.

Feterita
A popular local variety of ' dura ', forming the main grain crop of the Gezira area.

Ful Masri
Tick bean—Vicia faba L.

Garad
Pods of the Sunt Tree, Acacia arabica Willd.

Gardud
Soils formed near the base of hills by the weathering of rock: hard, gravelly soil with good surface, not cracking when dry.

Gassab
Stalk of ' dura ' or ' dukhn ', usually when dried.

Gbaria
Clan; clan area.

Ghaifir
Watchman

Gizu
A waterless area in the north western Sudan where camels are taken for winter grazing and where the peculiar vegetation supplies the only moisture.
Hafir  A pit or reservoir dug to collect rain water.
Hakuma  Government.
Hariq  A type of cultivation involving burning off an old stand of grass before sowing.
Helba  Fenugreek—Trigonella foenum-graecum L.
Kantar  A measure of weight, usually 100 'rotls'. A kantar of seed cotton is 315 rotls, the amount needed to produce 100 rotls of lint.
Keila  A measure of capacity equal to 16.5 litres.
Kharif  The rainy season.
Khor (pl. Kheiran)  A seasonal water course.
Kisra  A paper thin cake of millet flour, baked crisp.
Lubia  The term used mainly for the pulse crop, Bonavist Bean, Dolichos lablab L. or for the Cowpea, Vigna unguiculata Walp.
Lulu nut  The seeds of the Shea Butter tree, Butyrospermum parkii var. niloticum Kotchy.
Malwa  Local dry measure of capacity equal to 4.125 litres.
Meloda  A hoe.
Merissa  Beer made from various grains, but mainly 'dura'.
Mulukhiya  Jew's Mallow—Corchorus olitorius L.
Murara  A dish prepared from offal and consumed uncooked.
Naga  A female camel
Oke  A unit of weight equal to 1.25 kilograms.
Ombaz  Oilecake remaining after the oil has been pressed from 'simsim' seeds, Sesamum orientale L.
Qoz  Sand dune fixed by vegetation.
Rotl  A unit of weight equal to .99 lbs. or 449.28 grms.
Sagea  An open grass plain occurring in the Acacia forest vegetation belts of the eastern Sudan.
Sagia  Native wheel, worked by animals, for lifting water for irrigation.
Saj  A platter, often of enormous dimension.
Se'id  Sedge grass—Cyperus rotundus L.
Seluka  A digging stick provided with a foot rest.
Semn  Clarified butter with the water driven off by boiling.
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Shaduf</td>
<td>A hand operated device for lifting water for small irrigation areas—a seesaw arrangement whereby a leather bucket is counterbalanced by a lump of clay.</td>
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<tr>
<td>Sharmut</td>
<td>Meat cut into small strips and sun dried for indefinite storage.</td>
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<tr>
<td>Sheil</td>
<td>Advances in cash or kind against crop prospects.</td>
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<tr>
<td>Simsim</td>
<td>Sesame—<em>Sesamum orientale</em> L.</td>
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<tr>
<td>Suq</td>
<td>Market</td>
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<tr>
<td>Telebun</td>
<td>Finger millet—<em>Eleusine coracana</em> Gaertn.</td>
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<tr>
<td>Toich</td>
<td>A treeless clay plain seasonally flooded and producing dry season grazing.</td>
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<tr>
<td>Toria</td>
<td>A digging hoe.</td>
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<tr>
<td>Turkiya</td>
<td>The period of Turkish-Egyptian rule in the Sudan.</td>
</tr>
<tr>
<td>Umtakashu</td>
<td>Dried ‘mulukhiya’ leaves.</td>
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<tr>
<td>Wadi</td>
<td>Seasonal or dry water course, generally wider than a ‘khor’.</td>
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<tr>
<td>Weika</td>
<td>The dried fruits of okra, <em>Hibiscus esculentus</em> L.</td>
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