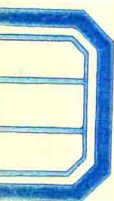


Natural Resources and Rural Development in Arid Lands: Case Studies from Sudan

Edited by H. R. J. Davies



THE UNITED NATIONS UNIVERSITY

NATURAL RESOURCES AND RURAL DEVELOPMENT IN ARID LANDS: CASE STUDIES FROM SUDAN

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ARTICLE I

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1. The United Nations University shall be an international community of scholars, engaged in research, post-graduate training and dissemination of knowledge in furtherance of the purposes and principles of the Charter of the United Nations. In achieving its stated objectives, it shall function under the joint sponsorship of the United Nations and the United Nations Educational, Scientific and Cultural Organization (hereinafter referred to as UNESCO), through a central programming and co-ordinating body and a network of research and post-graduate training centres and programmes located in the developed and developing countries.

2. The University shall devote its work to research into the pressing global problems of human survival, development and welfare that are the concern of the United Nations and its agencies, with due attention to the social sciences and the humanities as well as natural sciences, pure and applied.

3. The research programmes of the institutions of the University shall include, among other subjects, coexistence between peoples having different cultures, languages and social systems; peaceful relations between States and the maintenance of peace and security; human rights; economic and social change and development; the environment and the proper use of resources; basic scientific research and the application of the results of science and technology in the interests of development; and universal human values related to the improvement of the quality of life.

4. The University shall disseminate the knowledge gained in its activities to the United Nations and its agencies, to scholars and to the public, in order to increase dynamic interaction in the world-wide community of learning and research.

5. The University and all those who work in it shall act in accordance with the spirit of the provisions of the Charter of

the United Nations and the Constitution of UNESCO and with the fundamental principles of contemporary international law.

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ARTICLE II

Academic freedom and autonomy

1. The University shall enjoy autonomy within the framework of the United Nations. It shall also enjoy the academic freedom required for the achievement of its objectives, with particular reference to the choice of subjects and methods of research and training, the selection of persons and institutions to share in its tasks, and freedom of expression. The University shall decide freely on the use of the financial resources allocated for the execution of its functions. . . .

PREFACE

In 1975 the Council of the United Nations University identified three priority areas for its concern — world hunger, human and social development, and the use and management of natural resources — and directed that a programme should be organized in each of these areas. Each of these programmes is closely related to the others. For example, better use and management of natural resources would help to solve the problem of world hunger and so release more resources and human energy for human and social development.

By early 1977 the Programme on the Use and Management of Natural Resources had itself identified a series of specific problem areas for its investigation — viz. environmental deterioration in the humid tropics, rural energy supplies,

and the ineffectiveness of attempts to apply knowledge to the management and development of arid lands — and sub-programmes were developed in response to each of these.

In October 1977 it was decided to base the Arid Lands Sub-programme (the Sub-programme on the Assessment of the Application of Knowledge to Arid Lands Problems) in Africa — at the University of Khartoum, in Sudan. In October 1978 a workshop took place in Khartoum as a result of which a first series of five studies was initiated in Sudan during 1979 under the overall heading "Obstacles to the Application of Existing Knowledge in Arid Lands". By 1982 the four studies reported on here had been completed.

INTRODUCTION

H. R. J. Davies

The need for development in African drylands cannot be gainsaid. Africa contains some 10 per cent of the world's population on 22 per cent of the earth's surface. All indices of development are at best broad generalizations, but nevertheless the following indicate something of Africa's underdevelopment. In energy measured in coal equivalents Africa uses less than 3 per cent of the world's consumption, consumes some 2 per cent of the world's steel, has less than 2 per cent of the world's passenger vehicles and only 3 per cent of the commercial vehicles, flies less than 5 per cent of the passenger and freight air kilometres, consumes 1 per cent of the newsprint, has little more than 3 per cent of the world's radio receivers and less than 1 per cent of the telephones (most of which do not work), and in spite of great efforts it has less than 5 per cent of the world's teachers and just 7 per cent of the world's students. As soon as comparisons are made with the industrialized countries of the world, the yawning gap is even more clearly spelt out. Thus the GDP per capita in Africa as a whole is US\$460, compared with \$5,260 for the EEC countries and \$7,148 for the United States. The highest in the world is \$15,089 in the United Arab Emirates, based solely on oil wealth. Similarly, life expectancy at birth is almost everywhere in Africa less than 50 years, compared with 71 in the United Kingdom and 73 in the United States.

The importance of the agricultural sector may be judged from the fact that in Africa 65 per cent of the economically active population in 1980 were employed in agriculture compared with 45 per cent for the world as a whole. Yet in spite of this Africa consumes only 2.7 per cent of the nitrogenous fertilizers consumed by the world every year and has only 2.1 per cent of the world's agricultural tractors. It is also clear that the agricultural situation is worsening. Between 1970 and 1980 world food production per capita increased from an index of 100 to 104, whereas in Africa it fell from 100 to 88, the worst record for any continent in the world. Out of 47 countries in Africa making returns to the United Nations in both years, 38 showed a falling per capita food production, and only 9 recorded an increase. Of these 38, there were 5 that actually produced less food in 1980 than they did in 1970. This predicament was brought about by the rapid population increase of 2.7 per cent per year in Africa, compared with 1.8 per cent for the world as a whole and 0.5 per cent

for Western Europe. Another problem is low yields in Africa, which for most food crops are about half those of the world average. In the case of sorghum and related millets world yields in tons per hectare increased by 6 per cent during the 1970s but were completely static in Africa, where the yield was only 53 per cent of the world average and would have been very much lower if irrigated sorghum in the Nile Valley had been excluded. Similar situations may be discerned in the livestock industry, where Africa has 14 per cent of the world's cattle but produces only 2.4 per cent of the world's cattle milk.

The need for agricultural development in the African drylands is even more dramatic than in Africa as a whole. In the six countries of Chad, Mali, Niger, Senegal, Sudan, and Upper Volta more than 75 per cent of the economically active population is engaged in agriculture, and the figure falls below 80 per cent only in Senegal and Sudan. In 1970, however, all of these countries exceeded 80 per cent and three exceeded 90 per cent, whereas today the highest, Mali, reaches 87 per cent. All of these countries showed considerable falls in food production per capita during the 1970s. The best record is that of Upper Volta with a fall from 100 to 97, whereas the worst is Senegal with a drop to 76. For Mali, Sudan, and Upper Volta agricultural products account for over 90 per cent of their exports. Only in Niger are they comparatively unimportant (29 per cent) because of uranium production. Each of these countries suffers from a severely adverse trade balance. Yet in spite of their overwhelmingly agricultural economies all except Mali find themselves paying more for imported foodstuffs than they earn from foodstuff exports. The position is clearly worsening, for in 1970 only Senegal, Sudan, and Upper Volta were net food importers. Furthermore, these countries have very few tractors. Africa averages one tractor for every 1,000 persons, whereas in these countries it is one for every 4,000. Similarly, the use of nitrogenous fertilizer in Africa as a whole averages 3.3 kilograms per head of population, whereas for these six countries it averages 1.5 kilograms. On a broader basis all six have low GDPs per head of population. In Mali and Upper Volta the level is less than 20 per cent of even Africa's low figures.

Of the six countries, Sudan has probably done more than any of the others to develop its agriculture, especially

through government-sponsored and semi-sponsored schemes. In the 1950s a large programme of well and borehole sinking and excavation of *hafirs* (hollows to store rainwater excavated by modern earth-moving machinery) was begun to make it possible to open up wide areas of the unused savannas of central Sudan where there was a chronic shortage of drinking water for people and animals, and at the same time a programme for the development of mechanized agriculture on the clay plains in this areas was also undertaken. These attempts to extend rainland agriculture were paralleled by a programme to increase the number of irrigated pump schemes along the Niles and the 350,000-hectare Manaqil Extension to the Gezira Scheme was undertaken.

During the 1960s and 1970s a great many other projects were carried forward to boost agricultural development. Rainland cultivation was greatly extended through the Mechanized Farming Corporation, regional development bodies such as the Western Savannas Development Corporation and the Nuba Mountains Agricultural Production Corporation, and other programmes to develop ranching on the savannas. The development of rural water supplies in the desert margins and savanna zone continued apace. Irrigation was greatly expanded. The Khashm el Girba Dam enabled 200,000 hectares to be irrigated from the Atbara River, and the Roseires Dam enabled the 125,000-hectare Rahad Scheme to be developed and made possible a large increase in pump schemes along the Niles, of which the spectacular Kenana Scheme is said to be the world's largest sugar plantation. To these schemes for agricultural development within Sudan's drylands may be added the programmes for improved rural health care, rural electrification in the Gezira region, the beginnings of a tarred road network, and the development of industries based on agricultural products, in particular cotton textiles. Of the 1982/83 development budget of £S 502 million, 35 per cent is earmarked directly for agricultural development, with a further 18 per cent for the railways, which carry virtually all Sudan's agricultural exports, which account for 95 per cent of the country's exports.

The fruits of these efforts over the past 35 years may be judged from a fivefold increase in the area under both rain-fed and irrigated cultivation, whereas over the same period the population has increased by only 76 per cent. However, it is plain that all is not well. In spite of all these efforts, Sudan still has a considerable net food deficit. In 1981 it had the smallest cotton crop in 40 years, and ground-nuts actually displaced cotton as the main export earner. The current trade deficit is running at US\$1,000 million per year. Total foreign debts amount to US\$5,200 million, and rescheduling of the debt repayment has been necessary. If Sudan had to buy oil at full international prices, the bill in 1981 would have amounted to nearly 90 per cent of its foreign earnings. In spite of efforts to expand

industry, it only accounts for 10 per cent of Sudan's gross domestic product, and hardly any factories run at anything approaching full capacity; the largest group, textiles, averaged 30 per cent in 1981.

In the agricultural field specifically the picture is most unhappy. The Mechanized Farming Corporation's state farms ceased operations during 1981 because of unsupportable financial losses. The Gezira Scheme has been in severe trouble for the last five years and has been the subject of a commission of enquiry. Neither the Khashm el Girba nor the Rahad Scheme is currently making a profit, and the area first brought under mechanized agriculture near Gedaref has now been abandoned. The constant theme of agricultural investigation has been declining yields. Official figures suggest an overall decline of 14 per cent in sorghum yields per hectare during the 1970s.

Much of the effort for agricultural development in Sudan, especially in the north, has been in large schemes. Carr wrote despairingly of such schemes in 1977: "The more you spend on them, the less likely they are to succeed." The point he makes is that large projects imply "revolutionary" rather than "evolutionary" change, and so people find it much more difficult to identify with them. Furthermore, rural development to be successful must be not only environmentally and economically sound but also socio-culturally acceptable and within the capabilities of management and administration as well as existing infrastructure. Unfortunately, De Wilde's comments of 1967 are still rarely taken seriously enough: "Successful development of agriculture often requires an intimate understanding of the society within which it is to take place — of its systems of values and customary constraints."

Success of course may depend on the viewpoint from which a project is judged: At the widest level there is an international and ecological viewpoint; but within the country the government may be looking for increased exports or more cheap food for the towns, the region may hope to obtain raw materials for processing at competitive prices, the local community may be looking for increased local taxes and stable food supplies, and individuals may be hoping to improve their life-style. The Gummuiya pump-irrigation scheme of some 3,500 hectares situated on the west bank of the White Nile between Omdurman and Jebel Aulia is an excellent example. From the government planners' point of view it is an abject failure. It was planned to produce fruit and vegetables for the 1.5 million people living in the Three Towns capital (Khartoum, Khartoum North, and Omdurman), an environmentally and economically sound prospect. Instead, the scheme is one large irrigated sorghum field — from the local farmers' point of view a perfectly sound proposition. Sorghum has been grown here under rain cultivation time out of mind. Irrigation assured the sorghum crop, which could be allowed

to fully mature to provide the farmer's basic food, or cut green for animal feed. Surpluses are sold in the town to produce a modest cash income, and the crop requires little labour, an important factor in an area where life is hard and demanding on the desert margins.

Thimm (1979) examined eight diverse schemes in Sudan within the arid/semi-arid zone for the United Nations University. Three were concerned with large-scale mechanized rain-fed cultivation of sorghum in eastern Sudan; one was a large-scale irrigation scheme (Khashm el Girba); one was a scheme to "modernize" traditional farming in the Nuba Mountains; two were pilot schemes for the settlement of nomads in western Sudan; and the last was a small-scale irrigation scheme in Northern Darfur. He tried to evaluate how successful they were under eight headings in two groups of four.

Under the first group, "permanence of cultivation", he suggested that six out of the eight schemes had failed to lead to "permanency of cultivation"; five schemes had serious "organizational shortcomings"; five had serious shortcomings in terms of "social acceptance"; and five were clearly economically unviable.

Under the second group, four of the schemes generated significant private income; none generated significant public (national or local) income; four could be seen as successful in creating significant employment opportunities; and four had been successful in involving local people in the development process. Thimm's conclusions briefly summarized: "No project can be called economically sound from the private and public point of view." "Wherever possible plans must be prepared *with* the people, not *for* them."

In 1966 at a conference in Zaria in northern Nigeria on the question of agricultural development in the area, Professor Darling, then Director of the Institute for Agricultural Research, expressed the view that most of the scientific problems of crop production in northern Nigeria were either solved or about to be solved, that sufficient was known of economic factors to render this aspect solvable, but that the socio-cultural problem of getting the scientific solution accepted had hardly even been formulated (Sjo et al. 1967). Darling's comments may have been rather too hopeful regarding the first two groups of factors, but he has been certainly proved right on the third, as the title theme of the Arid Lands Sub-programme — "the ineffectiveness of attempts to apply knowledge to the management and development of arid lands" — implies.

The problem is complex, for, though for convenience the various factors are analysed separately, they are in practice closely interrelated. Certainly, many factors can be raised: insufficient finance leading to inadequacies in the agri-

cultural extension service and agricultural education programmes; inadequacies in the infrastructure and shortage of foreign exchange leading to breakdowns in water pumps and agricultural machinery and the non-availability of fuel at critical times; inadequacies of management caused by shortage of trained manpower in view of the large number of projects being developed within a short space of time, and exacerbated by rapid re-postings of the more competent managerial personnel, which leads to poor supervision and malaise in scheme organization; political and regional pressures leading to inconsistencies and irregularities in resource allocation for the various sectors of the economy, for the regions, and for the main thrust of development within the various sectors.

Such deficiencies are of great importance and provide a serious brake on the successful acceptance of scientifically proven innovations; however, even if all these could be put right, there are more fundamental problems. First, as in all countries of the developing world, there is a duality between the "modern" and the "traditional", between "urban" and "rural", between those imposing the system and those submitted to it, and those wanting to initiate change and those having to accept and co-operate with it. Of themselves these constraints encourage a disharmony between a government with a development programme with headquarters in the Three Towns and the traditional rural cultivators. Inevitably agricultural development and change are perceived quite differently, but without the willing co-operation of the traditional rural cultivators none of the government's plans can succeed.

A further dilemma of Sudanese society is the status of the cultivator and the services offered to rural areas. Because modern amenities of electricity, medical services, educational possibilities, entertainment, etc. are better provided for in towns and because wages, if a job can be procured, are higher in towns, people perceive that, to enjoy a pleasanter life-style and to stand a chance of getting on, it is advantageous to go to town. Inevitably the more enterprising and the more energetic move and the less so stay behind in the countryside. At the same time, because of the inadequacy of services and the lack of good communications such as tarred roads and an efficient telephone service, few of the educated people wish to work in the countryside, and so the provision of medical and similar services is held back in rural areas. Even those with agricultural qualifications look towards desk jobs as administrators or research appointments on well-serviced government research stations. Few wish to make a career as farmers or rural extension workers, with the result that even agricultural research becomes divorced from the farmers' needs. The poor returns from agriculture, the failure of modernization of agriculture to take place, and the failure of many agricultural projects to be viable means that few graduates will take up farming and that the status

of farming is low. You become a farmer merely because you cannot become something different.

Yet this situation will not do, for Sudan is heavily dependent on its agricultural sector to provide a livelihood for most of its people, to provide food for its rapidly expanding towns, and to furnish its essential imports. Without a healthy agricultural sector there seems little likelihood of material progress in the immediate future for many of its people, and this will remain true for the more distant future even if oil provides a temporary respite.

The four studies presented here were financed by the United Nations University, through the good offices of the University of Khartoum and especially of its Institute for Environmental Studies, and each tackles a current problem in the use of natural resources in the semi-arid lands and looks at how and why the people involved reacted in the way in which they did to a particular change or aspect of the environment.

The first study, by Bebawi, El Hag, and Khogali, is concerned with the problems of dura (*Sorghum vulgare*) cultivation, concentrating particularly on those associated with the parasite buda (*Striga hermonthica*). As already indicated, official figures suggest a decline of 14 per cent in overall sorghum yields per hectare during the 1970s. Given the right conditions, dura has great potential for development in the desert margin areas, an important factor for Sudan's food supplies.

One of the great achievements in Sudan since the Second World War has been an improvement in rural water provision. The second study, by Al-Awad, Mohammed, and El-Tayeb, is concerned with the impact on the

environment of this programme in part of south-eastern Kordofan.

An increasingly important environmental problem is being created by demands for wood, particularly for firewood. Firewood is used either directly or as charcoal for cooking and other purposes. At present firewood is being brought to Khartoum from as far away as the Nuba Mountains. Yet, in spite of the difficulties and costs involved, investigations in the Three Towns confirm that charcoal is still the preferred fuel, especially for the poorer classes, because of its price, ready availability, and familiarity. Babiker, Shaddad, and Musnad investigate the firewood problem in the Nuba Mountains.

Lastly, the conflict between the planners' and participants' perception of natural resources and their potential is investigated by Abu Sin in the Khashm el Girba irrigation scheme, a scheme which was also investigated briefly by Thimm (1979).

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I. THE PRODUCTION OF DURA (*Sorghum vulgare*) IN SUDAN AND THE PARASITE BUDA (*Striga hermonthica*)

F. F. Bebawi, G. A. El-Hag, and M. M. Khogali

Dura (*Sorghum vulgare*) is the staple food of most of the population of arid and semi-arid Sudan and constitutes on average two-thirds by weight of the cereal production in the country. It does well on the clays in the desert margin, while its rival dukhn (*Pennisetum typhoideum*) surpasses it in importance only on the sandy qoz of western Sudan. Dukhn accounts for 15 per cent of Sudan's cereal production. Wheat, the other important cereal, accounting for another 15 per cent, is a crop of the riverain lands of the far north, with significant quantities now being grown also in Khashm el Girba and the Gezira.

Buda (*Striga hermonthica*; English: witchweed) is a parasite or semi-parasite, Sudan's varieties of which attack millet, sugar-cane, and possibly maize and rice as well as dura (Parker and Reid 1979). Varieties of buda seem to be specific to dura or dukhn, and possibly some strains of buda specific to dura flourish most successfully on some varieties of dura rather than on others (Bebawi 1981a). The effect of an attack by buda on a dura crop can be devastating — certainly much more serious than that of non-parasitic weeds. Bebawi and Farah (1981) conclude that a serious attack of buda will reduce yields by up to 65 per cent. Farmers often claim much more severe damage, but buda infestation is often allied to other factors such as soil exhaustion and rainfall fluctuations. El-Hiweris (1979) suggests that buda causes a drastic reduction of growth in dura, akin to the effect of growing the crop under unfavourable environmental conditions, in particular of a shortage of water.

Buda attacks dura throughout the whole of the semi-arid region of the Sudan in varying degrees. It is important, therefore, that buda should be controlled. However, although methods for control are known — the use of trap crops, chemical sprays, and various husbandry methods such as early and constant weeding and intercropping with ground-nuts — certain key problems remain. Firstly, movement of people and animals is a potentially serious source of re-infestation; secondly, the methods so far developed are really more suited to advanced societies and experimental stations than to peasant cultivation; thirdly, the methods are expensive in labour and material inputs and therefore are hardly feasible under current conditions; and, fourthly, one of the reasons for the increase in buda infestation is soil exhaustion due to a reduction in fallows

caused by a rising population. Some of these difficulties might be overcome by the wider use of nitrogenous fertilizers, but Bebawi (1981b) has shown that, unless you get the applications right, you are likely to stimulate buda as much as the dura. Fisyunov (1977) concludes that the only really satisfactory way to control *Striga hermonthica* and its associates is to keep them out!

If buda then presents problems very difficult for a dura-based peasant society to solve by conventional control methods, the question arises whether some use of it within the peasants' purview can be found. Livestock and their feeding is a source of perennial difficulty in northern and central Sudan, and the possibility therefore exists of using buda for this purpose.

The first part of this paper deals in more detail with the interaction of dura, livestock, and buda in people's lives in Sudan, and the second part deals with the possibility of using buda as a livestock feed, bearing in mind that livestock are also potential agents for the dispersal of buda both via their coats and through their faeces.

— H.R.J. Davies

1. Dura and Buda

Nearly 80 per cent of Sudan's working population is engaged primarily in either crop production or livestock rearing. The two activities are not necessarily incompatible since most of the settled cultivators raise some animals whenever that is possible, while the nomads always like to cultivate some crops, mainly grains for their subsistence. Although traditionally competition and conflict between cultivators and nomads over land use may take place, some co-operation between the two groups also occurs. Some settlers send part of their livestock with the nomads to graze in distant grazing areas, and some nomads buy dura stalks (*gassab*) from the cultivators as feed for their animals. In the Gezira the cultivators, as an incentive to the seasonal cotton pickers, allow their livestock to graze the cotton plant residues after picking is completed. In fact throughout Sudan, though the livestock of both the settled and nomadic population subsist mainly on natural grazing, they

also derive a substantial part of their feed from crop residues, including the grazing of crop remains in the field after harvesting. It is not surprising therefore that a relation often exists between grazing and movement and the dispersal of certain agricultural weeds that adhere to the skin of the animals or pass through their digestive systems: buda (*Striga hermonthica*) seems to be a good example of this.

Research Outline

The main aim of the present study is to assess how far success or failure in the campaign to control the spread of buda may be hindered or enhanced by the prevailing socio-economic conditions in Sudan.

The material is based not only on previous research and field work in Sudan and on library studies but also on field work specific to the purpose between November 1980 and February 1981 in four distinct areas in the country

TABLE 1. Field-work survey

Location	Number of villages	Number of persons interviewed
Gedaref (Kassala)	5	108
Singa and Abu Na'ama (Blue Nile Province)	3	97
Gezira Scheme (Gezira)	2	86
South and south-west of El Obeid (Northern Kordofan)	3	91
Totals	13	382

(table 1). Surveys were taken in 13 randomly chosen villages, and 383 interviews were held.

The study concentrates on the central zone of Sudan, the area where most dura is cultivated within the remit of the UNU Arid Lands Sub-programme.

The Importance of Dura in Sudan

Dura is the staple diet for most Sudanese (table 2). It is the staple in the rural areas in the central zone, being only challenged for supremacy on the sandy *qoz* lands of western Sudan by dukhn, and among urban areas it is challenged in some of the large towns where wheat bread is consumed. Furthermore, dura production takes up more land than any other crop (table 3).

The importance of dura in Sudan can hardly be overstressed. Ever since the establishment of the Anglo-Egyptian Condominium in 1898 it has been considered a strategic crop by all governments, and expansion of production and the maintenance of a sufficient supply to meet the needs of a rising population has been a primary consideration in all government policy and action in the agricultural sector. The Gezira Scheme when it was opened in 1925 was seen as a great step forward in Sudan development, not only because of the incomes to be derived from cotton export but also because of its contribution to home food production through the more secure dura production made possible by irrigation. The most important single development, however, took place after the Second World War when the mechanical crop production schemes (MCPSs) were started in Gedaref. Today, MCPSs account for over half the total area under dura. (Table 4 indicates the relative significance of the various modes of production in various parts of Sudan today, and table 5 shows the expansion of the areas under dura during this century.)

TABLE 2. Cereal consumption in Sudan

	Total supply ('000 metric tons)	Share of each cereal (%)					
		Wheat	Dura	Dukhn	Maize	Eleusine	Rice
1973/74	2,450	17.5	67.6	12.2	0.8	1.3	0.6
1974/75	2,597	13.7	66.4	16.4	1.9	1.4	0.2
1975/76	2,812	12.4	71.2	13.8	1.9	0.4	0.3
1976/77	2,770	15.3	64.1	18.3	1.6	0.5	0.2
1977/78	3,119	17.2	63.4	16.9	1.5	0.5	0.5
Average	2,750	15.2	66.5	15.5	1.5	0.8	0.4

Source: Sudan Government 1979

TABLE 3. Major crops in Sudan (thousands of feddans)

	1975/76	1976/77	1977/78	1978/79
Cereals				
Dura	6,311	6,287	6,662	7,194
Dukhn	2,701	2,773	2,948	3,078
Wheat	690	639	602	586
Maize	210	149	139	145
Rice	17	23	28	20
Other subsistence crops				
Horse beans (<i>ful masri</i>)	43	38	42	31
Haricot beans (<i>fasulia</i>)	13	5	5	6
Essentially cash crops				
Cotton	981	1,007	1,112	1,036
Ground-nuts	2,321	1,880	2,661	2,328
Sesame	2,216	2,288	2,349	2,057
Castor	46	11	17	34
Sugar-cane	30.5	39.0	35.8	*

Source: Sudan Government 1979

* Area under sugar-cane has since increased dramatically due to the opening of four new major sugar schemes since 1978.

Despite the great expansion of the area under dura, the situation of the crop, as compared to the needs of population, is not yet fully secured. Usually the local production meets domestic demand with a small surplus for export (table 6). However, with a population increasing at the rate of at least 2.8 per cent per year and the possibility of an increased demand as a feeding stuff with the expansion of the livestock industry, more dura will certainly be needed in the future. This can be met by an increased area under the crop and by increasing yields per hectare. One step in the latter direction, besides control of insect pests, vermin, and diseases, is to combat weeds, the most serious of which is buda. On the other hand, if satisfactory control of buda is not possible, then it may be possible to use buda as animal fodder in one way or another to produce more animal protein.

Systems of Dura Production and Buda Infestation

The system of dura production varies from one region to another. However, there are some features common to all regions. First of all, a large labour force is engaged in dura production, because most of the agricultural operations, even under mechanized cultivation, are done by manual labour using primitive tools. This is especially true in the weeding operation, which is directly related to the question of buda. Secondly, neither fertilizers nor manures are usually applied. A third feature is that in most cases animals play a role in the income of the farmers.

The System of Dura Production in Western Sudan

It may be more appropriate to refer to systems rather than one system in western Sudan. However, throughout western Sudan, except in the Nuba Mountains, cultivation is mainly confined to the sand soils of the *qoz*. Here dukhn tends to replace dura as the dominant subsistence crop, under rain-fed cultivation. Here also cultivation is essentially a family affair for each family's own requirements, and animal raising plays a more important role in the domestic economy of the region than in the other regions under study.

Western Sudan is a land of cultivators and pastoralists. The northern part is occupied by camel nomads (rearing camels and sheep), the southern part by cattle nomads (rearing cattle and sheep), with settled cultivators in the zone between the two (Davies 1966). Both the camel and cattle nomads regularly graze their animals in the middle zone; and some nomads, especially from among the cattle nomads, have settled and taken up cultivation in addition to animal raising. (One of the villages in the survey, Gallabi, is occupied by settled nomads from the Misseiriya Zurg tribe.) Cultivation as practised in this zone follows a system of land rotation or bush fallowing with the villages permanent and compact. Cultivation is usually practised around the village. Normally each family has two types of cultivation: a small plot of a few metres square in the immediate vicinity of the house, and the main cultivation some distance further away and much larger.

TABLE 4. Dura production in Sudan by region and mode of production (thousands of feddans)

	1975/76	1976/77	1977/78	1977/79
Irrigation				
<i>Gravity</i>				
Gezira Scheme	341	324	353	344
Tokar and Gash Delta	78	28	60	88
<i>Pumps</i>				
Northern and Nile provinces	86	40	45	50
Blue Nile Province	56	48	50	57
White Nile Province	67	31	101	44
Total irrigated	628	471	609	583 (8.1 %)
Rain-fed				
<i>Mechanized</i>				
Gedaref (Kassala)*	2,000	1,910	1,848	2,076
Blue Nile Province	499	524	507	502
Khartoum Province	7	10	17	18
White Nile Province	51	110	125	150
Southern Kordofan Province	182	209	319	231
Southern Darfur Province	6	7	6	10
Southern Region	317	258	265	314
Total mechanized	3,062	3,028	3,087	3,301 (45.9 %)
<i>Traditional</i>				
Gezira Province	90	210	225	260
Blue Nile Province	535	460	455	683
White Nile Province	288	89	270	200
Northern and Southern Kordofan provinces	700	972	930	985
Northern and Southern Darfur provinces	393	342	427	452
Southern Region	610	715	729	730
Total traditional	2,621	2,788	3,036	3,310 (46.0 %)
Total rain-fed	5,683	5,816	6,123	6,611 (91.9 %)
Sudan total	6,311	6,287	6,732	7,194 (100 %)

Source: Sudan Government 1979

* No figures are given for traditional rain-fed production in Kassala Province; the data may have been included here.

TABLE 5. Areas under dura in Sudan in selected years (thousands of feddans)

	Area	Remarks
1911	1,193	
1928	1,545	Effect of Gezira Scheme
1938	1,659	
1959/60	3,251	Advent of MCPSSs
1979/80	6,349	

Sources: Sudan Government (various years, to 1938), 1961, 1979

Near the houses quick maturing crops, including some cereals and vegetables, are grown. These small farms are cultivated almost every year, but, being close to the house, they receive manure from the village animals.

The main cultivation is carried on away from the village. In May before the start of the rainy season, the farmer clears a plot of land, usually between 8 and 15 feddans (1 feddan = 0.42 hectare), but the size of the farm will depend on the family labour supply. A few rich individuals may hire labour and are able to cultivate areas of 40 to 50 feddans. As the rain starts, the farmer sows the land using simple tools. Weeding is done once or twice depending on the intensity of the rainfall and weed growth, and on the labour supply available. Soon after the end of the rainy season the crops are harvested; subsistence crops are stored and the cash crops are taken to the nearest market.

A plot of land is cultivated for from four to six years, until it loses its fertility, and then another plot is cleared and cultivated. The first plot reverts to bush, and through selection during the clearing of the vegetation *Acacia senegal* (*hashab*) is left to dominate in more or less pure stands. The farmer may return to this land after 10 to 25 years depending on the pressure of population. The hashab is a nitrogen fixer and thus gives fertility to the land. At the same time gum arabic is tapped from it as a supplementary source of income to the farmer. Tapping is done between November and February after the crop harvests.

In the El Obeid area of Northern Kordofan three main crops — dura, dukhn, and sesame — are cultivated in the ratio of 5:3:7 and are rotated. In the past only dura and dukhn were important, and sesame, if cultivated at all, occupied a subsidiary place. But this began to change in the El Obeid area with the building of the railway in 1912. Later factors included the introduction of lorry transport, initiation of market places, and improvement of rural water supplies. However, in recent years the most important incentive to sesame production has been the high prices for oil seeds during the 1970s. The result has been that areas under

TABLE 6. Sudan production, consumption, and trade in dura (thousands of metric tons)

	1975/76	1976/77	1977/78
Production	1,991	1,801	2,017
Consumption	1,941	1,665	1,937
Imports	—	—	—
Exports	50	136	80

Source: Sudan Government 1979

sesame for cash have expanded dramatically to surpass the subsistence cultivation of both dura and dukhn. The farmers are helped in their decision to increase the area under sesame by the availability of comparatively cheap dura brought in from Gedaref and the southern Gezira region of Blue Nile Province to supplement their own production.

One farmer who cultivated 17 feddans in 1980 (10 under sesame, 4 under dura, and 3 under dukhn) explained his rationale as follows: One feddan yields four sacks of sesame, worth £S 17 per sack, or one to three sacks of dura of dukhn, worth £S 10 or £S 15 per sack.

4 sacks of sesame @ £S 17	= £S 68
1-3 sacks of dura or dukhn @ £S 10 or £S 15	= £S 10-£S 45
Differential per feddan in favour of sesame	= £S 23-£S 58

With these prices it is plainly advantageous to grow sesame, provided dura is readily available. However, the farmers cannot risk giving up their dura and dukhn cultivation, because if they did so they could be faced with a shortage of dura or very high prices for supplies brought in from other parts of Sudan.

Buda is plainly present in the area within the survey, but its intensity is light. Of the farmers interviewed

- 5 per cent reported no buda infestation;
- 51 per cent reported light infestation;
- 44 per cent reported medium infestation;
- none reported severe infestation.

This low intensity is related to the agricultural practices and in particular to (a) the type of land rotation practised, with the land under cultivation for about four to six years and then abandoned for a long period, during which hashab trees establish themselves; (b) the rotation of crops, as sesame is not affected by buda, and dukhn appears to be affected here only to a small degree and certainly less than dura; and (c) the increase of the sesame area at the expense of dura and dukhn.

The System of Dura Production in the Irrigated Gezira

The Gezira Scheme is representative of agriculture in the large gravity- and pump-irrigated schemes of the White and Blue Niles as it was the blueprint for them.

The Gezira started to come under gravity irrigation in 1925, when 300,000 feddans were cultivated. It now totals nearly 2 million feddans. Annually some 400,000 feddans are put under cotton, 380,000 under dura, 500,000 under wheat, and 250,000 under ground-nuts. (The areas fluctuate somewhat from year to year; these figures are for 1978/79.) The main crop in the Gezira is cotton, modern Sudan's traditional commercial crop. Dura is also cultivated for subsistence to ensure the supplies for the feeding of the tenant, his family and his cotton pickers. In the past an eight-course rotation was practised: cotton, resting, dura, resting or lubia (hyacinth bean), resting, cotton, resting, resting. This system was considered an extremely lavish use of land. As returns from cotton decreased with falling world prices, the government wished both to maintain the earnings of the tenant and to grow more wheat for the increasing urban population. The old system of rotation was replaced by a more intensive and diversified land use. In the two villages in this survey the rotation on a 30-feddan tenancy now is 10 feddans under cotton, 10 under wheat, and 5 under each of dura and ground-nuts. There is no fallow. This is the general rotation throughout the Gezira Scheme, although in certain areas some small plots of land are put under rice or vegetables. Animals are not catered for in the Gezira, though most of the tenants' own livestock are sent to distant grazing areas during the cultivation season from June to March. These animals and some of those owned by cotton pickers are allowed into the fields in March to graze the crop residues after cotton picking is completed.

The cash earnings of a tenant from cultivation in the Gezira Scheme may be estimated at £S 660, of which over half comes from ground-nuts and a further £S 60 comes from the sale of *gassab* (dura stubble).

Originally it was thought that the tenants and their families could provide the needed labour except for picking cotton, for which hired pickers would be employed on a seasonal basis. This theory did not work out in practice, as females were reluctant to work in the fields and children began to go to school. This in turn meant that educated children and their parents developed off-scheme interests, and so hired labourers came to be used on a wide scale on either a wage or a crop-sharing basis. Furthermore, the existence of off-scheme interests led to neglect of some of the agricultural operations, in particular the weeding of dura.

The old eight-course rotation, extravagant in the use of land as it may have been, gave little chance for buda to appear,

but with the intensification of cultivation the buda problem began to increase. Hardly a tenancy is totally free from buda. Eighty-six tenants were interviewed; of these

- none reported no infestation;
- 9 per cent reported occasional infestation;
- 61 per cent reported light infestation;
- 21 per cent reported medium infestation;
- 9 per cent reported severe infestation.

Two factors may have contributed to saving the situation so far: firstly, the crop rotation and use of fertilizers in connection with cotton has prevented the soil from reaching the stage of exhaustion; and secondly, the cultivation of ground-nuts, a nitrogen-fixing crop, helps to maintain soil fertility.

The Mechanized and the Traditional Rain-fed Systems of Dura Cultivation on the Central Clay Plain

The central clay plain of Sudan extends eastwards from the White Nile to the foothills of the Ethiopian plateau. It includes much of the Gezira and Blue Nile provinces as well as the Gedaref region of Kassala Province. The striking physical characteristics of this plain are its flatness to the naked eye except where occasional hills rise out of it, the lack of drainage lines of any importance over extensive areas, and the dominance of cracking clay which is suitable for cultivation of many crops such as cotton, dura, wheat, and sesame. Since the last century the plain has had the reputation of being the "granary of Sudan," and this has been reinforced since the 1940s with the introduction of extensive semi-mechanized cultivation. Today this region accounts for over 55 per cent of the area devoted to dura cultivation in Sudan. If the irrigated dura areas of the Gezira and the Blue and White Niles are added, then the central clay plain accounts for about 65 per cent of all areas under dura in the Sudan (table 4).

The rain-fed dura cultivation can be divided into traditional and mechanized. As these have some important common features as well as the main implied difference in the methods of production, they have been brought together here.

The main difference between the mechanized and traditional cultivation is in scale of operation due to the use of modern agricultural machines in some but not all the field operations in the former type. The traditional type, long established in the region, uses simple tools and depends on family labour; it is undertaken mainly for subsistence purposes. As the cracking clay is not easy to cultivate, the size of a normal traditional farm is small, between 15 and 50 feddans. Some of the better-off families may hire some labour and/or tractors and may be able to cultivate up to 250 feddans. Mechanized cultivation, on the other hand, creates large farms, usually between 1,000 and 1,500 feddans, though the actual cultivated area may range