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Sudan: Policy Reforms and Prospects for Agricultural Recovery After the Drought

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ABSTRACT

Economic problems and a severe drought negatively affected Sudan, a largely agricultural country. Prior to the drought, the Government enacted a series of policy reforms to improve agricultural productivity and increase exports, including adjustments in exchange rates, higher producer prices, institutional changes in the irrigated subsector, and reduction of consumer subsidies on wheat bread, petroleum products, and sugar. The structural diversity of Sudan's agricultural sector in terms of locus of decisionmaking, input and output price determination, and use of imported inputs, however, worked against across-the-board reform. The severity of the drought also blunted the effects of policy changes--reducing agricultural production, increasing food dependency on foreign suppliers, and causing massive population dislocation. After the drought, policy options remaining open to the Government focus on achieving higher export earnings and a greater degree of food self-sufficiency.

Keywords: Sudan agriculture, policy reform, devaluation, cotton, sesame, groundnuts, gum arabic, wheat, sorghum, food aid, cropping patterns, producer incentives, foreign exchange earnings, debt servicing.

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FOREWORD

This report is the first in a series of research reports on the agricultural sector of Sudan. Data and information used in this and subsequent reports were collected when the author was resident at the University of Khartoum, Sudan, under a Ford Foundation grant. This report presents an overview of the agricultural economy of Sudan and delineates areas for policy research, especially after the drought. Reports that follow will present analysis of specific topics referred to in the present report.

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INTRODUCTION

Sudan, the country with the largest land area in Africa, has long been viewed as the potential breadbasket of the Middle East (fig. 1). Its agriculture is divided into three subsectors: irrigated, mechanized rainfed, and traditional rainfed. Sudan's irrigated subsector, the largest irrigated area in Sub-Saharan Africa, produces primarily cotton for export. The rainfed areas, which produce both food and export crops, exhibit the most potential in Sudan. However, the last 4 years have illustrated the variability in food production that could take place in the rainfed areas. Production of sorghum, the staple food crop which reached 3.3 million tons in 1981/82, fell to 1.22 million tons in 1984/85; this required Sudan to import over 1 million tons in food.

Before the drought, crude oil prices increased and agricultural productivity declined. Sudan experienced such economic problems that increasing negative trade balances reached US$1.3 billion in 1981 and external debt service obligations exceeded US$1 billion in 1984. Because over 90 percent of Sudan's export earnings come from agriculture, economic recovery was linked to agricultural recovery and improved export performance.

A series of donor-initiated policy reforms have been initiated since 1979 to address the economic problems, focusing on exchange rate adjustments, producer price incentives, and a change of production relations in the irrigated subsector. Although production increased in the irrigated areas, the complete expected results have not yet taken place, primarily due to the structural differences among subsectors and the drought.

In light of the drought, increased debt service obligations, and reduced export earnings, one should examine what the objectives of policymakers are and what their policy options are. Achieving food self-sufficiency and increasing agricultural export earnings could be viewed as a necessary precondition for Sudan's economic recovery.

This report presents an overview of the country's agricultural economy and the effects of policy changes enacted prior to the drought, and examines policy options for agricultural recovery in the aftermath of the drought. The second section of this report presents an overview of the economic crisis, policy responses to date, and the role of agriculture in generating foreign exchange earnings. The third section analyzes the structure of Sudan's mixed-economy

agricultural sector, focusing on the physical production potential and changes in agricultural production before the drought. The fourth section discusses the effects of the 1984 drought on all three subsectors and the role of food aid in meeting emergency food needs. The fifth section presents policy options and areas for policy analysis. Prospects for agricultural recovery are discussed in the sixth section, and the last section contains conclusions.

SUDAN'S ECONOMIC PROBLEMS AND POLICY RESPONSES

Sudan has suffered a trade deficit since the early seventies which peaked in 1981/82 and has since declined due to import restrictions, lack of commercial credit to finance imports, and contraction of the economy. Exports, which in 1981/82 were at their lowest level since 1974/75, also increased prior to the 1984 drought because of increased agricultural production.

Agricultural Exports

Since over 90 percent of exports are agricultural commodities, the production and export performance of these commodities need to be analyzed in order to determine ways to generate foreign exchange. While the production performance will be analyzed by crop in the next section, the changing composition of agricultural exports is shown in figure 2. The share of cotton has varied from a high of 62 percent in 1978/79 to a low of 18.15 percent in 1981/82, when a sharp decline in production and difficulties encountered in marketing reduced foreign exchange earnings from this source. Other agricultural exports include sorghum, sesame, groundnuts, gum arabic, and livestock. Although these exports individually rank below cotton in importance, their cumulative level has increased by 75 percent since 1978/79.

Cotton is an irrigated crop, so its production is less affected by drought than production of sorghum, sesame, groundnuts, gum arabic, and livestock (dependent on pastures), which are primarily produced in the rainfed areas. However, timing of agricultural operations, availability of inputs, remunerative prices, and marketing infrastructure affect production of both irrigated and rainfed crops.

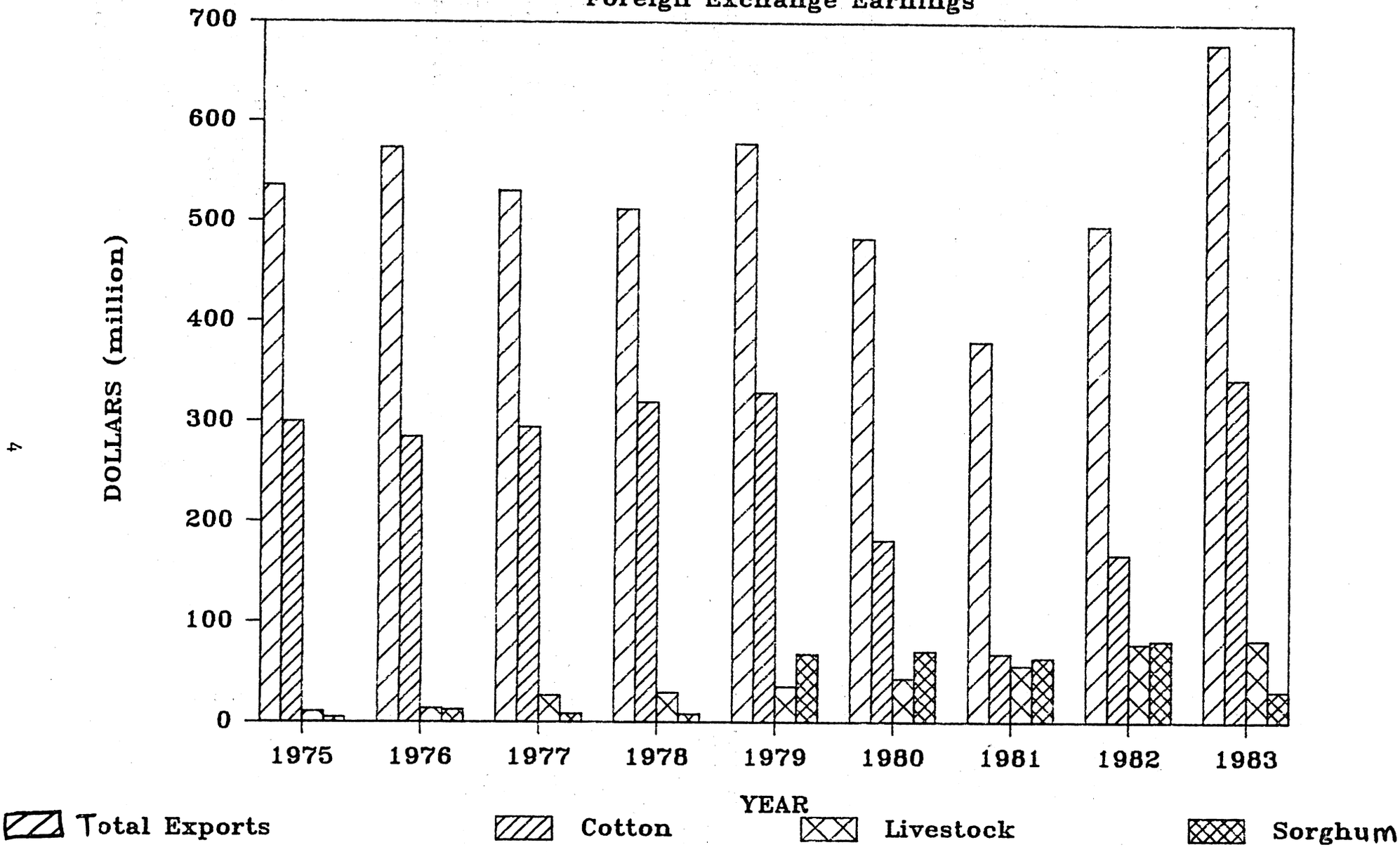
Policy Changes and Public Investment Programs

Sudan's current economic condition is characterized by a severely uneven balance of payments, which originated with the oil price shocks of the seventies and government policies encouraging consumption over investment in productive activities (such as consumer subsidies). Not only was Sudan faced with a widening trade gap, but also with an external debt that approached US$9 billion and debt servicing over US$1 billion in 1984 (fig. 3).

The Government of Sudan enacted major economic policy reforms and encouraged public investment in the agricultural sector to move the economy toward production and consumption decisions made on the basis of world prices as well as providing producer incentives to increase agricultural production. A major objective of the public investment program was to rehabilitate existing productive capacity in the irrigated subsector and to reduce production and infrastructural constraints in the rainfed areas.

Figure 1 : SUDAN

Figure 2: SUDAN



Policy reforms enacted by the Government of Sudan fell into three broad categories: exchange rate changes, producer incentives, and reduction of consumer subsidies. An enumeration of these policy changes and their expected effects on farmer income, agricultural sector income, consumer prices, foreign exchange earnings, and Government revenues are shown in tables 1 and 2, respectively. A combination of policy reform and public investment led to increased production since 1981/82, especially of cotton. But the expected results of the policy changes and the investment program did not materialize completely due to the severity of the recent drought, fuel shortages, civil strife, and an uncertain economic environment (resulting from the imposition of Islamic "Sharia" law in September 1983). Institutional rigidities within the agricultural sector and a change of government in April 1985 compounded these difficulties. Improving the performance of the agricultural sector through policy reform is a complex task, not only in Sudan but also in other African countries.

Policy reform and the design and implementation of the projects in the public investment program were initiated through the assistance of both bilateral and multilateral donors. The International Monetary Fund (IMF) and the World Bank are the major multilateral donors involved in this process, and the United States and Saudi Arabia provide a majority of the bilateral economic assistance.

Figure 3: SUDAN

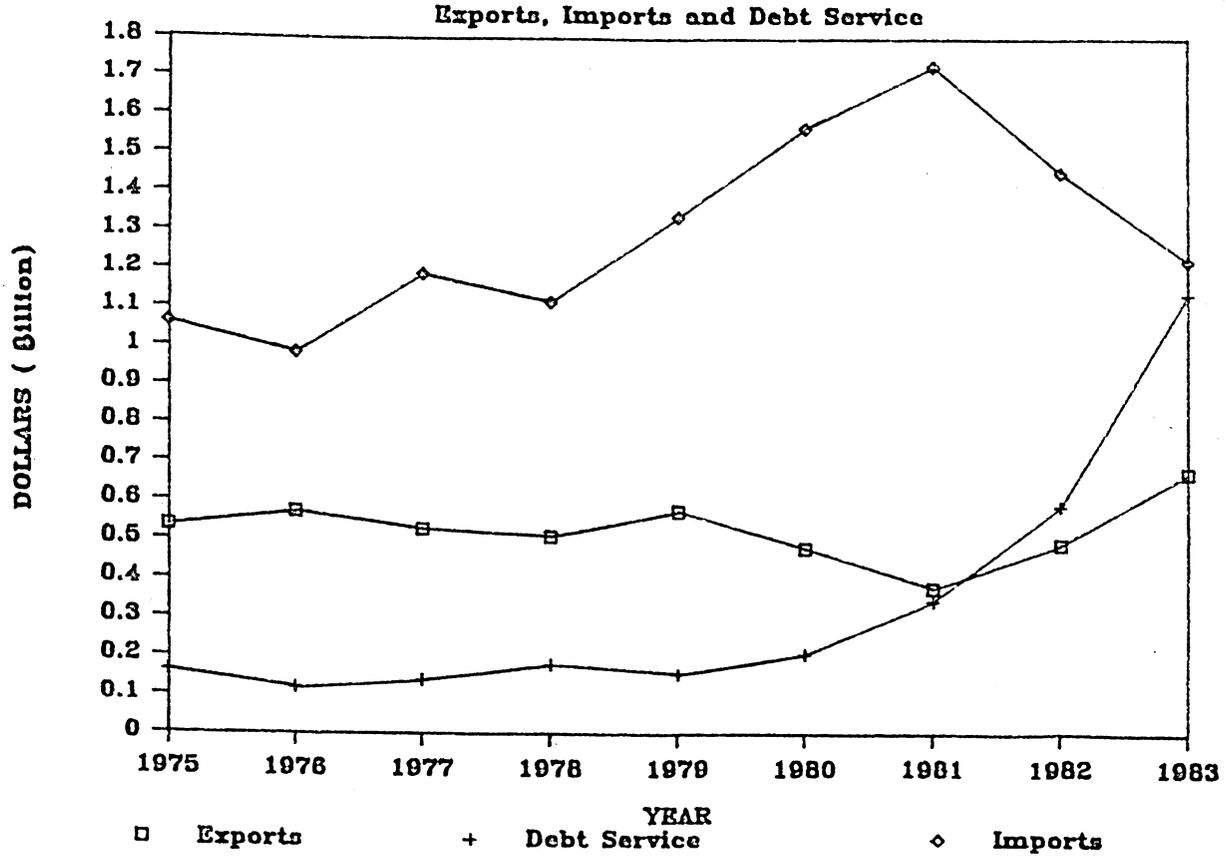


Table 3 summarizes the originally proposed 1982/83-1984/85 public sector investment program in agriculture. About 60 percent of the total estimated cost of US$1,121 million was targeted toward the irrigated subsector, suggesting a continued emphasis on the irrigated subsector.

A discussion of exchange rate reforms and removing consumer subsidies helps illustrate the complexity of the problem of improving the performance of the economy with the help of policy changes.

Exchange rate reforms. Devaluations, through exchange rate changes, were used to improve the competitiveness of Sudan's agricultural exports and to increase the cost of imported goods. Although Sudan devalued its currency, it maintained multiple exchange rates. Among these were an official rate, a commercial "bank" rate, and, until recently, a legal "street" rate. Each of these rates was used to value different commodities. For example, prior to March 1985, agricultural exports (except cotton) were valued at a combination of the official and commercial rates, while cotton exports and agricultural inputs were valued at the official rate. Beginning in the 1985/86 season, cotton exports and agricultural inputs will be valued at the commercial rate.

Table 1--Major economic policy changes enacted since 1979, Sudan

Policy change	Year enacted
1. Abolition of marketing monopoly of Oilseed Corporation for sesame and groundnuts--Reforms of oilseed marketing	1980
2. Reforms of cotton pricing and marketing	1981/82
3. Institution of land and water charges and individual system account in the irrigated subsector	1981/82
4. Exchange rate reform--Currency devaluations	1979, 1981, 1982, 1983, 1984, 1985
5. Phasing out of subsidies--Reduction of consumer subsidies for sugar, bread and petrol	1982, 1983, 1984, 1985
6. Reduction of export taxes	1981/82

Source: (9). (Underscored numbers in parentheses refer to literature cited in References section.)

Table 2--Likely effects of policy changes, Sudan

Change in policy	Likely effect on:				
	Farmer income	Agricultural sector income	Consumer prices	Foreign exchange earnings	Government revenues
	Movement				
Exchange rate changes:					
Devaluation	Increase	Increase	Increase	Increase	Decrease
Movement toward unified exchange rate	Increase	Increase	Increase	Increase	Increase
Valuation of agricultural export earnings at commercial rate	Increase	Increase	None	Increase	Increase
Valuation of remittances at commercial rate	None	None	None	Increase	Increase
Producer incentives:					
Increase in producer prices 1/	Increase	Increase	None	Increase	Uncertain
Reduction in export taxes	Increase	Increase	None	Increase	Decrease
Removal of government monopoly in groundnuts and sesame marketing	Increase	Increase	None	Increase	Decrease
Reduction and removal of consumer price subsidies:					
Bread	None	None	Increase	Increase	Increase
Petroleum products	None	None	Increase	Increase	Increase
Sugar	None	None	Increase	Increase	Increase

1/ Cotton, gum arabic, and wheat.

Table 3--Summary of proposed public sector investment in agricultural projects, 1982/83-1984/85, Sudan

Project	Subsector	Area	Estimated project cost	Purpose and duration
		Feddan 1/	Million US$	
Gezira rehabilitation	Irrigated	2,000,000	360	Rehabilitation and modernization of existing project (1983/84-1989/90)
White Nile pump scheme rehabilitation	Irrigated	447,000	55	Rehabilitation and strengthening of infrastructure (1982/83-1986/87)
Blue Nile pump schemes rehabilitation	Irrigated	292,000	67	Rehabilitation and building of infrastructure (1982/83-1986/87)
New Halfa rehabilitation	Irrigated	330,000	128	Rehabilitation (1981/82-1985/86)
Southern Region Agricultural Develop.	Traditional rainfed	2/	56	Research and infrastructure (1980/81-1984/85)
Northern Region Agricultural Schemes	Irrigated	95,000	50	Rehabilitation (1983/84-1988/89)
Gash Delta rehabilitation	Flood irrigation	400,000	11	Rehabilitation
Rahad irrigation completion	Irrigated	300,000	20	Completion (1982/83-1984/85)
Jonglei canal	Irrigated	2/	190	Increase in water availability (1978/79-1987/88)
Mechanized Farm III	Mechanized rainfed	5,000,000	21.5	Strengthening of existing mechanized projects (1979/80-1985/86)
Agricultural services	Traditional rainfed	S. Darfur	31.5	Pilot project for crop and livestock development

See footnotes at end of table.

Continued--

Table 3--Summary of proposed public sector investment in agricultural projects, 1982/83-1984/85, Sudan--Continued

Project	Subsector	Area	Estimated project cost	Purpose and duration
		Feddan 1/	Million US$	
Livestock and Meat Marketing Corporation	Traditional rainfed	Western Sudan	63.1	Improvement of transport and marketing of livestock by traditional producers (1978/79-1984/85)
Western Sudan agricultural research	Traditional rainfed	Western Sudan	33	Increase in agricultural research capabilities on production systems in Western Sudan (1979/80-1985/86)
Agricultural services	Traditional rainfed	Northern and Southern Kordofan	35	Agricultural inputs, credit availability to smallholders (1982/83-1986/87)
Total cost	All	NA	1,121	

NA = Not applicable.
1/ 1 feddan = 1.03 acres.
2/ Cannot be determined.

Source: (5).

When the legal street rate existed, the divergence between the official rate and the legal street rate approximated the overvaluation of the Sudanese currency, indicating the excess demand which existed for foreign currency (usually U.S. dollars). As the legal street rate fluctuated daily, this divergence also fluctuated--affecting decisionmaking which required use of foreign exchange for imports. The existence of differential exchange rates, especially in the valuation of earnings of export crops also was a disincentive to producers and exporters, thereby affecting the country's foreign exchange earnings and government revenues. Sudan's experience illustrates the importance of moving to a unified exchange rate and allowing the complete effects of a devaluation to be transmitted through the economy to realize the incentive effects.

Removal of consumer subsidies. A major reason for reducing consumer price subsidies on wheat bread, sugar, and petroleum products was that these three items constituted over 60 percent of the country's import bill during 1975-80. The Government determines the retail price of wheat bread. Pricing policy is an important policy tool because 50 percent of the wheat consumed

was imported and the Government determined producer prices of wheat. Increasing producer prices could lead to increased domestic production, while increased consumer prices could lead to reduced consumption and hence imports. As a result of donor-initiated policy reform, Sudan moved to import parity pricing for domestic wheat production and wheat bread. However, the Government still determined prices of both wheat and wheat bread.

Sorghum, a substitute grain for wheat, and traditionally kisra (a sorghum bread) have been consumed in both rural and urban areas, while wheat bread has been consumed in urban areas. The producer prices of sorghum and consumer prices of kisra are market-determined. Reduction in wheat bread subsidies (or increases in retail wheat bread prices) led to relatively similar wheat and sorghum bread prices in 1983. The drought of 1984 severely reduced sorghum production. Wheat production, however, was reduced even more as a consequence of an administrative decision made by the Gezira scheme management board. 1/ As sorghum prices are not controlled, the drought led to increased prices of both sorghum and kisra. The reduction in wheat production, while partially offset by increased wheat imports, did not lead to similar increases in wheat bread prices due to government controls on retail bread prices. This resulted in the price of kisra rising to six times the price of wheat bread in Khartoum in early 1985.

A price rollback in April 1985 negated the brief attempt made at increasing wheat bread prices in March 1985. Thus, the relative price differential only succeeded in increasing the demand for wheat bread (especially from urban consumers) and further increased import dependency (75 percent of the wheat bread was produced from imported wheat).

Projects such as the Gezira rehabilitation could not be completely implemented because the Government had difficulties repaying its external debt in 1984 both to bilateral donors and multilateral aid agencies. This reduced the effectiveness of rehabilitation projects in the irrigated subsector and affected planned agricultural production and export earnings targets.

The outbreak of hostilities in southern Sudan in May 1983 increased in intensity through 1984, affecting completion of the Jonglei canal and leading to a curtailment of investment projects in southern Sudan. The drought most severely affected western Sudan in production of food and export crops, thereby reducing local food availability and export earnings. Projects to increase agricultural and livestock production and exports from western Sudan (like the agricultural services and livestock and meat marketing projects) could not be completely implemented.

Hence, while the Government of Sudan has attempted to improve its agricultural and economic performance through policy reforms and public investment programs, the drought and less than complete implementation of policy reforms led to an economic crisis as severe as that in the late seventies.

1/ See section on changes in structure and performance, 1975-83, for wheat. National wheat production fell by nearly 70 percent compared with that of the previous year.

Sudan, however, unlike other African countries, has a generous amount of land and water resources. And with already existent complementary policy changes, Sudan could once again increase agricultural production and export earnings.

SUDANESE AGRICULTURE

Potential

Sudan has a total land area of 4 million square miles, of which 207.4 million acres could be cultivated with crops. Of the cultivatable area, less than 10 percent is actually cropped (18 million acres), with a majority of the cropped area under rainfed conditions (4). Of land not considered cultivatable for crops, nearly 50 percent is in forests or is utilized for pasture. From a land-use viewpoint, a large percentage of Sudan's land resources are directed towards agricultural uses.

However, the existence of a viable agriculture requires more than cultivatable land. It requires soil capabilities, water availability (either through irrigation or rainfall), and infrastructure such as roads and markets. Sudan's vast size causes considerable variability in its soil, water, and infrastructural resources. Based on existing soil and water resources Sudan can be divided into six broad natural-resource regions: northern Sudan, eastern Sudan, western Sudan, Central Clay Plains, Southern Clay Plains, and Ironstone Plateau (fig. 4). There is considerable variation in water availability and soil type within these broad regions.

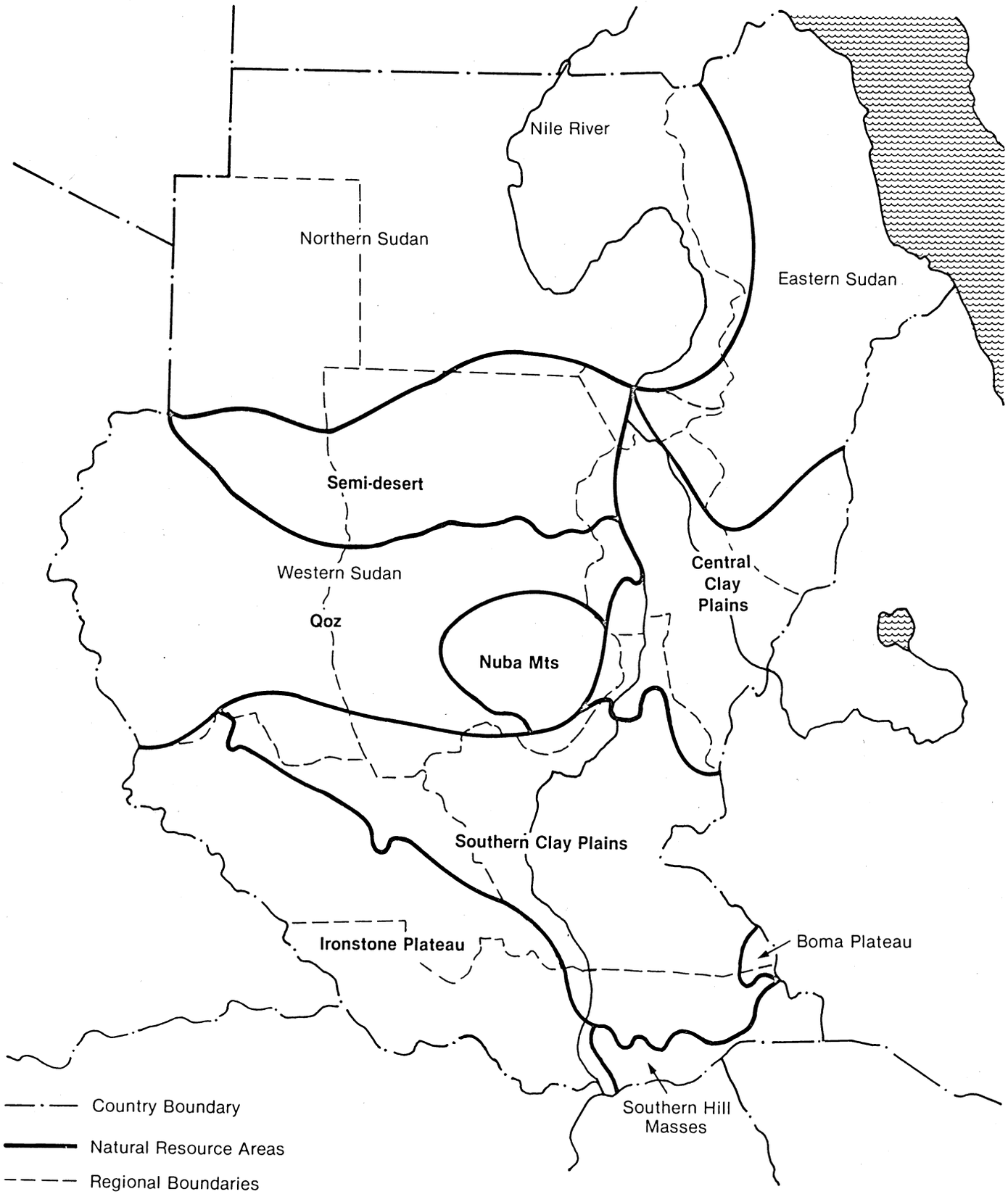
A recent agroclimatic inventory of the Sudan undertaken by the Food and Agriculture Organization of the United Nations (FAO) calculated the distribution of available agricultural land by length of growing period as a result of available rainfall. Nearly 19 percent of the available agricultural land lies in an area where the growing period is less than 90 days, while 40 percent has a growing period varying from 90-300 days and the rest a zero-day growing period. These growing periods are, however, related only to the availability of rainfall and do not consider the effects of irrigation water on duration of growing periods. For example, the areas depicted as having zero-day growing periods includes areas in the northern region which are irrigated by pump schemes from the River Nile. Furthermore, the length of the growing period varies within irrigated schemes due to their vast areas, such as in the Gezira scheme.

The wide variation in rainfall causes difficulty in accurately identifying regions (according to soil type) appropriate for cultivation. Some regions where rainfed agriculture would be possible are the southern part of the Qoz soils in western Sudan, the Central Clay Plains, the Southern Clay Plains, and the Ironstone Plateau. Of these areas, the Central Clay Plains and the Qoz soils have long histories of cultivation both under rainfed and irrigated conditions (2).

Within the Qoz soils of western Sudan, there is rainfall variation from 250 mm per year to 600 mm per year. This variation in rainfall has given rise to different cropping patterns. Furthermore, a decrease in average rainfall over the last decade has been documented in the northern Qoz soils, suggesting a decrease in the length of the growing season in the area (fig. 5).

Figure 4

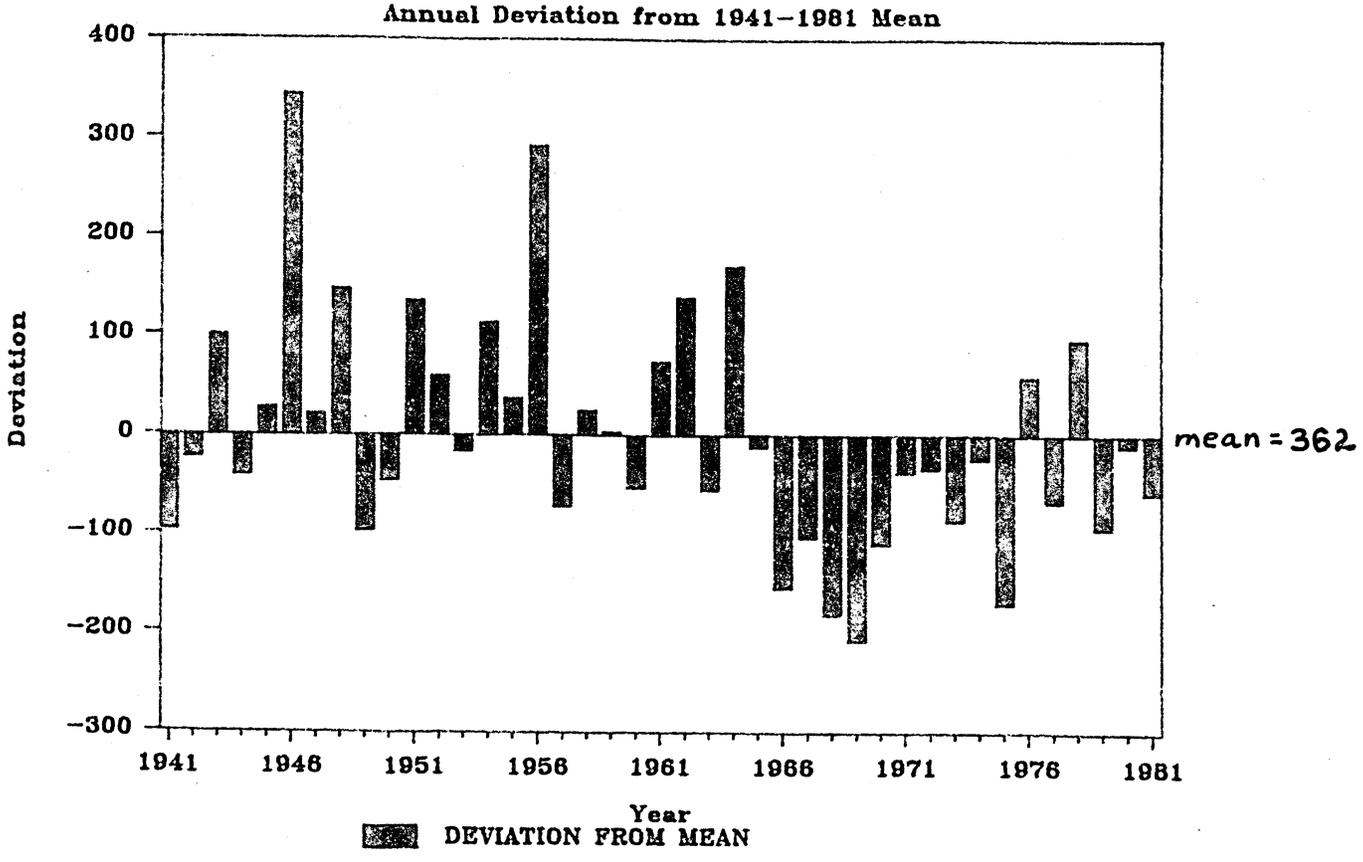
Natural Resource Regions of Sudan



In the Central Clay Plains, both mechanized rainfed and irrigated agriculture are predominant. The type of agriculture in the Central Clay Plains could be called predominantly modern, while that in the Qoz soils is traditional. 2/ Irrigated agriculture as manifested by the large modern schemes (such as Gezira, Rahad, Blue Nile, and White Nile Pump schemes) depend upon the Nile river system for water. Hence, a dualism exists in Sudanese agriculture, a condition which will probably exist well into the next century.

The allocation of the Nile waters between Egypt and Sudan is based upon the 1959 Nile Waters Agreement, which allocated the estimated 74 billion M3 of water between Egypt (which receives 53.5 billion M3 of water) and Sudan (which receives 20.5 billion M3). Under present methods of water allocation and estimation of water requirements, Sudan could have used nearly all of its share of the Nile waters by 1984 (the total estimated area of land irrigable from these waters is 4.1 million feddan). This situation exists if one assumes that there are no changes in cropping patterns and there are no claims to the water from source states such as Ethiopia.

Figure 5: Rainfall Variation: El Obeid



2/ Modern agriculture refers to the use of inputs such as tractors and fertilizers in the production process, while traditional agriculture means that no inputs like fertilizer or tractors are used.

The possibility of Sudan and Egypt running out of irrigation water has been recognized since the early fifties, when plans for overyear storage of water were discussed (and as a result of which the Aswan Dam was constructed). In 1955, the Jonglei Investigation Team also proposed the feasibility of construction of the Jonglei canal in southern Sudan to increase water availability from the White Nile (3).

The beginning of construction on the Jonglei canal also demonstrates that additional water will be available for irrigation in the Central Clay Plains and in the Jonglei area. 3/ The Jonglei canal will also pass through the Southern Clay Plains and could, through its drainage effect, provide opportunities for cultivation of the Southern Clay Plains, which are formed of cracking clays. These soils, when wet, have problems with drainage and are often impermeable. Cultivation of these soils also requires some form of mechanical tillage operation (3). Hence, the construction of the Jonglei canal could increase land potentially available for cultivation in the irrigated and rainfed sectors of Sudan. At present, construction work on the Jonglei canal has stopped due to hostilities, and its resumption requires a political accommodation.

The gradual shift in rainfall patterns southward and use of Sudan's share of Nile waters for irrigation indicate that agriculture is gradually moving southward. For example, the most recent expansions in area under mechanized farming have occurred in the southern part of the Central Clay Plains where mechanized farms are found all the way to the Ethiopian border in the Blue Nile region. In addition, increases in area under cultivation could be possible in the Southern Clay Plains rather than in the Ironstone Plateau. This does not imply that other areas of the country are not potentially cultivatable. For example, nearly 25 percent of the soils in western Sudan are hard clays, known as gardud soils, which have not been cultivated because of a lack of mechanical tillage technologies. In western Sudan, expansion of mechanized farming is already taking place in the cracking clay areas of South Kordofan.

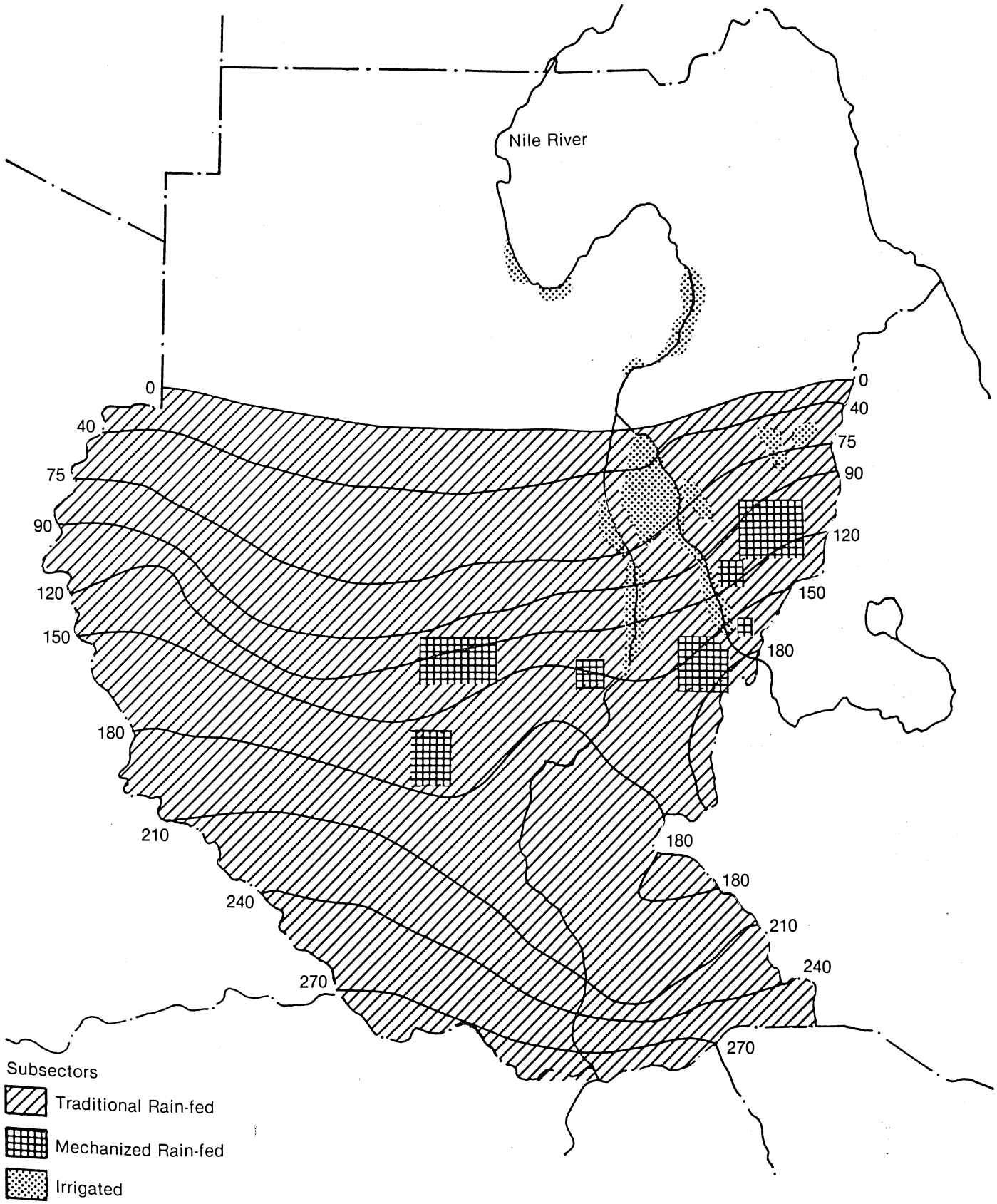
Agriculture is the mainstay of Sudan's economy, providing nearly 40 percent of the gross domestic product (GDP), 90 percent of export earnings, and between 60-70 percent of the country's employment. Yet Sudanese agriculture is diversely structured, with many people and organizations (farmers, irrigation scheme managements, government) responding to different signals (physical, technical, economic) of decisionmaking, leading to the production of a variety of crops (which may compete with, or complement, each other in input requirements) with different net returns.

Sudanese agriculture generally comprises three subsectors: irrigated, mechanized rainfed, and traditional rainfed (fig. 6). Each of these subsectors produces food and cash (export) crops, with the traditional rainfed sector also producing a majority of the nation's livestock.

3/ The Jonglei canal is supposed to increase water available by 4 billion M3 to be shared equally between Egypt and Sudan.

Figure 6

Sudan: Location of Subsectors and Length of Growing Season in Days



Sectoral Structure

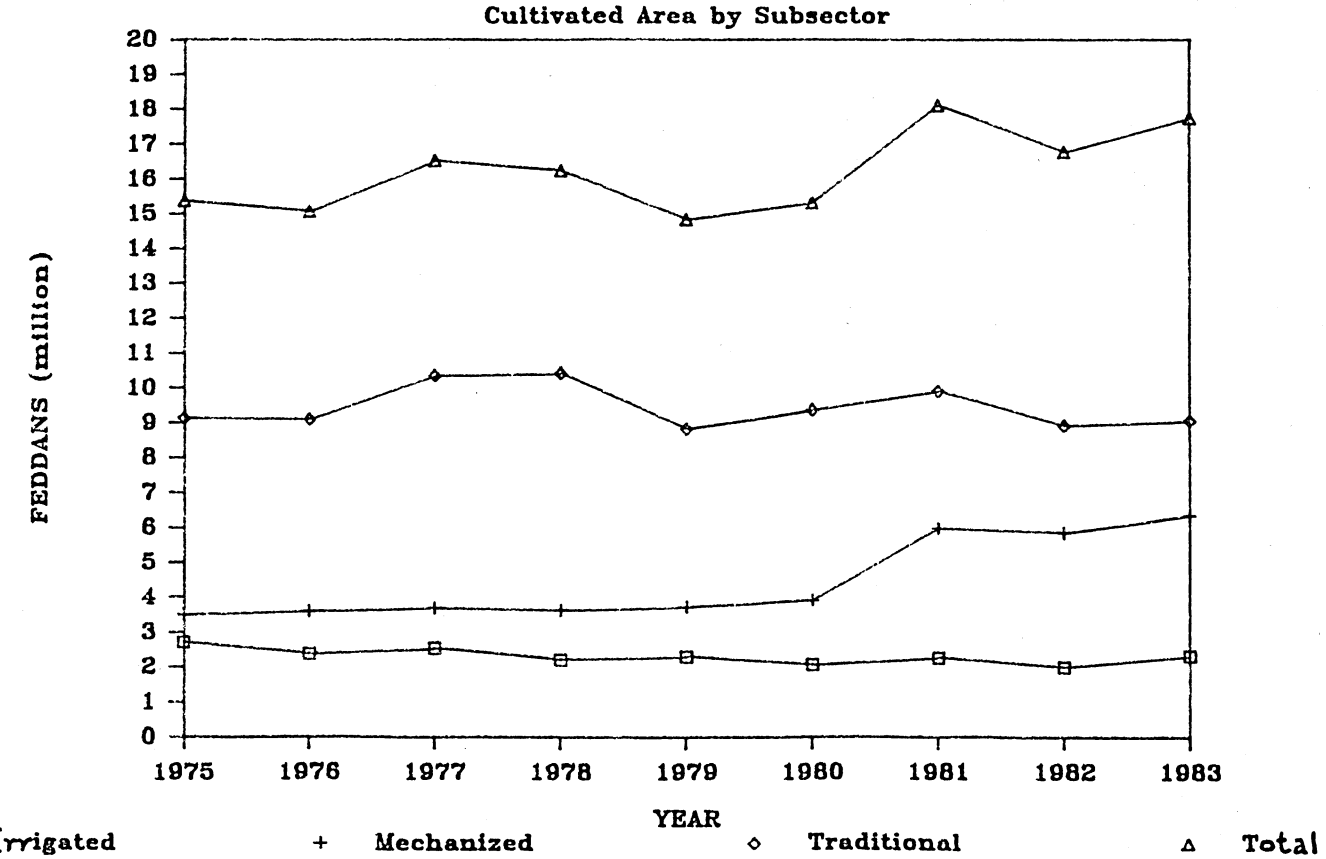
Figure 7 shows changes in areas under cultivation in each of the subsectors, with the traditional rainfed being the largest, averaging over 9 million feddan over the time period under consideration. The major crops grown in this subsector are millet, sorghum, sesame, groundnuts, and gum arabic. Except millet, all of the other crops are exported. Livestock is also an export income earner for the traditional subsector.

Mechanized rainfed subsector cropped area averaged about 4 million feddan until 1981, when favorable climatic and economic conditions allowed expansion to nearly 6 million feddan. The major crops grown in the mechanized subsector are sorghum and sesame, both of which have customarily been export crops.

The size of the irrigated subsector has remained fairly constant and is estimated at 3 million feddan of net cropped area in the major schemes. The actual area could come close to 4 million feddan, as the cropping intensity averages about 75 percent. Cotton, groundnuts, sorghum, sugarcane, and wheat are the major crops grown in the irrigated subsector, with cotton and groundnuts being the major export crops. Tenants who live on the irrigated schemes grow sorghum for on-farm consumption, while sugarcane and wheat are grown as import substitutes.

In each subsector, the agricultural production that is attained each year critically depends on a foreseeable, subsector-specific combination of physical, technical, economic, and institutional factors within a particular time frame (table 4).

Figure 7: SUDAN



Sudanese government policies and programs have been oriented to earning foreign exchange and have, therefore, emphasized development of cotton production in the irrigated subsector. In the past two decades, policies and programs have been oriented to generating domestic food surpluses and have, therefore, emphasized large mechanized farms in the rainfed sector. These orientations have implied a benign neglect of the traditional rainfed sector. Infrastructure and marketing problems are commonly associated with the traditional subsector, but the benign neglect of this subsector has led to a lack of research on its problems. While increasing production in the irrigated and mechanized subsectors can be achieved with additional capital investment, the traditional subsector does not lend itself to such capital investment and production increases will depend on other forms of incentive. The lack of adequate research results to design such incentives, however, is a serious problem. (This may be changing with the initiation of the Western Sudan Agricultural Research Project, co-funded by the U.S. Agency for International Development (USAID), the World Bank, and the Government under the public investment program.)

Structural characteristics of each subsector such as freedom of decision-making, input distribution, marketing, and input and output price determination are shown in table 5.

Table 5 also suggests that the response to a policy change, such as the producer incentives listed in table 2, will vary by subsector. Policy changes imposed across the board in the agricultural sector as a whole may be expected to produce different results even among the various subsectors, especially the varying distributional impact upon farmers, consumers, government revenues, and foreign exchange earnings. For example, devaluations may elicit different responses in each subsector. The intensity of traded inputs is the greatest

Table 4--Factors affecting agricultural production and critical time periods for forecasting production, Sudan

Subsector	Factors	Critical time period
Irrigated	Area allocation decisions	June-July
	Start of rains	July 1-July 15
	Level of Blue Nile	September-November
Mechanized rainfed	Fuel availability	June-July
	Seed availability	June-July
	Market prices	June-July
	Start and distribution of rains	June 15-October 15
Traditional rainfed	Seed availability	June
	Start and distribution of rains	June-September/October
	Market prices	

in the irrigated subsector, followed by the mechanized rainfed subsector, with negligible use in the traditional rainfed subsector. Devaluations will increase the costs to domestic producers for traded inputs and could also provide output price incentives. In the irrigated subsector, increased costs associated with imported inputs are transferred to producers. However, farmers have no choice in intensity of use in traded inputs (that is, level of fertilizer application to wheat) or in allocation of area for wheat and cotton to other crops, so they cannot adequately respond to price signals of increased costs of traded inputs by reducing either area planted or use of fertilizer on wheat and cotton. Therefore, an inefficient allocation of resources could be taking place within the irrigated subsector, and the effects of devaluations may be different than expected.

Table 5--Structural characteristics by subsector, Sudan

Subsector	Freedom of farmer decisionmaking	Input distribution	Marketing	Input and output price determination
Irrigated	Negligible in area allocation decisions and use of scheme-provided inputs. Farmers make decisions on timing and intensity of labor input.	Undertaken by schemes for imported inputs and water.	Cotton and sugarcane marketed through Government. Wheat crop is marketed under a quota system.	Prices for scheme-provided inputs; cotton, sugarcane, and wheat are Government-determined.
Mechanized rainfed	Farmers operate in competitive market environment. Access to land in specific areas is restricted by Government.	Farmers procure inputs commercially, although allocations for gasoil are made by Government.	Crops sold in commercial channels.	Market-determined except for gasoil and land rents.
Traditional rainfed	Farmers operate in competitive environment. No restrictions on land use or crop choice.	Farmers procure inputs through commercial channels, if available.	Crops sold in commercial channels.	Output prices market-determined except for gum arabic.

A different situation could exist in the traditional rainfed subsector when output price incentives caused by devaluations are not transmitted as increased price incentives for producers of gum arabic. Increased prices could lead instead to increased government revenues from gum arabic taxes, rather than increased production and increased foreign exchange earnings.

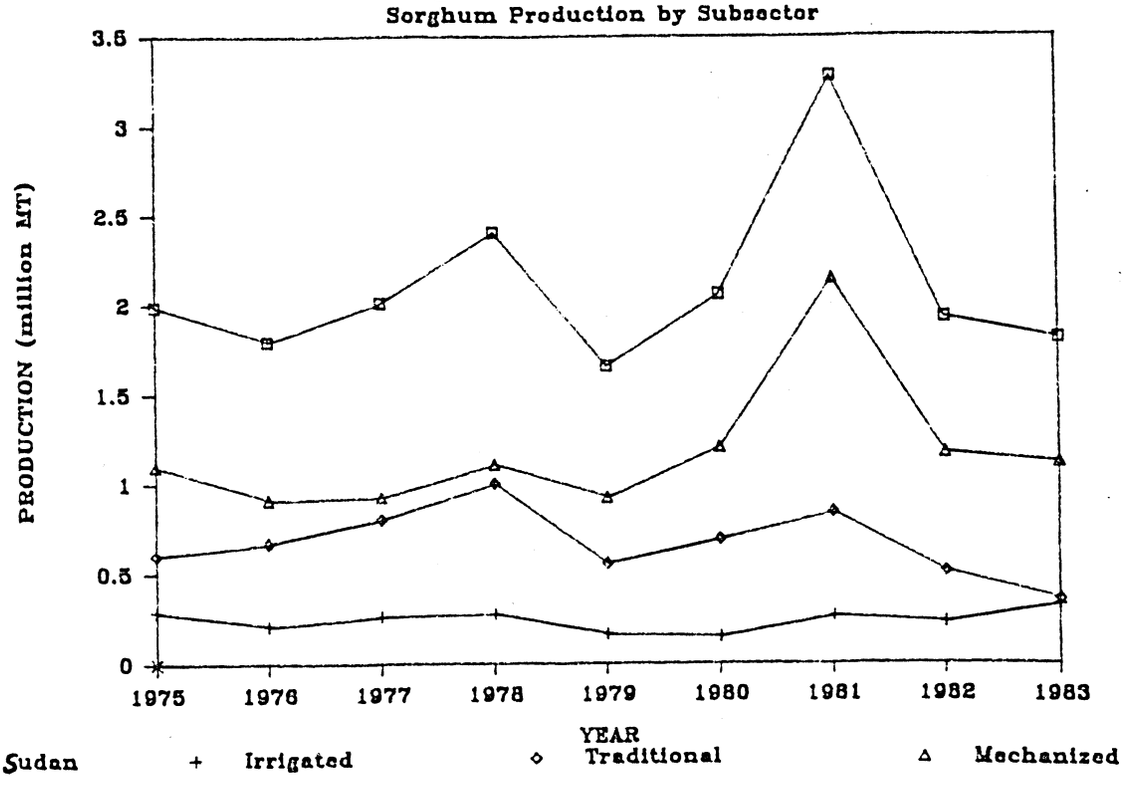
Changes in Structure and Performance, 1975-83

This section discusses recent structural changes and analyzes changes in production share by subsector of sorghum, groundnuts, sesame, gum arabic, and cotton (important cash, export, crops), and of wheat and sugarcane (import substitutes) in the light of the various combinations of cash (export) and food crops found in all three subsectors.

Sorghum

Figure 8 presents changes in the share of sorghum production by subsector during 1975-83. Most sorghum is produced in the rainfed area, specifically the mechanized rainfed subsector. In 1982, nearly 65 percent of total sorghum production was in the mechanized rainfed subsector, while nearly 24 percent was in the traditional rainfed subsector. Sudan produces sufficient sorghum for domestic consumption and has exported surpluses. In 1983, export earnings from sorghum ranked behind only cotton and livestock, while they nearly equalled those from cotton in 1982. However, this was unusual due to the fall in cotton production and sharp increases in sorghum production in 1981/82. Favorable weather, market prices, and area expansion in the mechanized areas contributed to the increased production of sorghum.

Figure 8: SUDAN



Sorghum has a very important role in meeting Sudan's domestic consumption and export needs and all three subsectors are involved in its production. Sudan's domestic market is segmented. For example, the large mechanized farms in eastern Sudan produced for the export and urban Khartoum markets, and increased Saudi investment in this subsector accounted for increased production in 1979-81. Mechanized production in the Blue Nile and Upper Nile regions satisfied domestic demand in the south and central regions. Demand for sorghum in the west is met from production in the western mechanized schemes and the traditional rainfed producing areas.

Tenants' needs for sorghum in the irrigated sector and needs of migrant laborers who engage in cotton picking are met by sorghum production in the irrigated subsector. Scheme management in the irrigated subsector has been reluctant to allow sorghum into the cropping pattern. However, due to tenant demands and preferences, schemes like Rahad and Gezira now allow sorghum in the cropping pattern. Although the traditional and irrigated subsectors met consumption needs in their own areas, the mechanized subsector has the potential of increasing production rapidly, because of the relatively greater area under sorghum cultivation and because of the existence of an improved hybrid sorghum variety (Hageen Dura 1), which currently is adaptable to both the mechanized rainfed and irrigated subsectors. Therefore, a realignment of production along comparative advantage lines would increase real income and export earnings from sorghum.

Sesame

Sesame is produced in rainfed areas, both in the mechanized and the traditional subsectors. Sesame is an important foreign exchange earner, with its share of foreign exchange earnings remaining unchanged between 1975 and 1983. Sesame production is affected by climatic and economic factors. With the exception of production increases in 1981, sesame production gradually declined until 1982 when it dropped by over 40 percent due to poor weather.

Sesame production from the traditional subsector accounts for nearly 67 percent of total production (fig. 9). Reform of sesame marketing, a major marketing policy change initiated after 1979, removed the oilseed marketing monopoly from the Sudan Oilseeds Company (table 1). The recent decline in production in 1982 led to increased farmgate prices in 1983, prices which nearly doubled the 1982 prices, resulting in increased production in the mechanized subsector in 1983 and a 20-percent increase in foreign exchange earnings for Sudan from sesame. By-products of oil and cake are also produced from sesame, and these are consumed locally or exported.

Groundnuts

Groundnuts are grown in the traditional rainfed and irrigated subsectors. The traditional rainfed subsector produces nearly twice the quantity of groundnuts that the irrigated subsector does. Annual groundnut production in both subsectors varied widely between 1975 and 1983 (fig. 10). Production in the irrigated subsector increased in 1977 as a result of increases in yields and area with the Rahad scheme being initiated. Changes in production from 1980 to 1983 in both subsectors reflect both price and weather effects.

Although, groundnut marketing was denationalized in 1979, a few large merchants and export companies in the irrigated sector dominate the present structure, while auction markets exist for sale and marketing of groundnuts in the traditional groundnut production subsector in western Sudan. Like sesame, groundnut is also a crop which produces high-value products like oil and cake, which are consumed locally and exported.

Figure 9: SUDAN

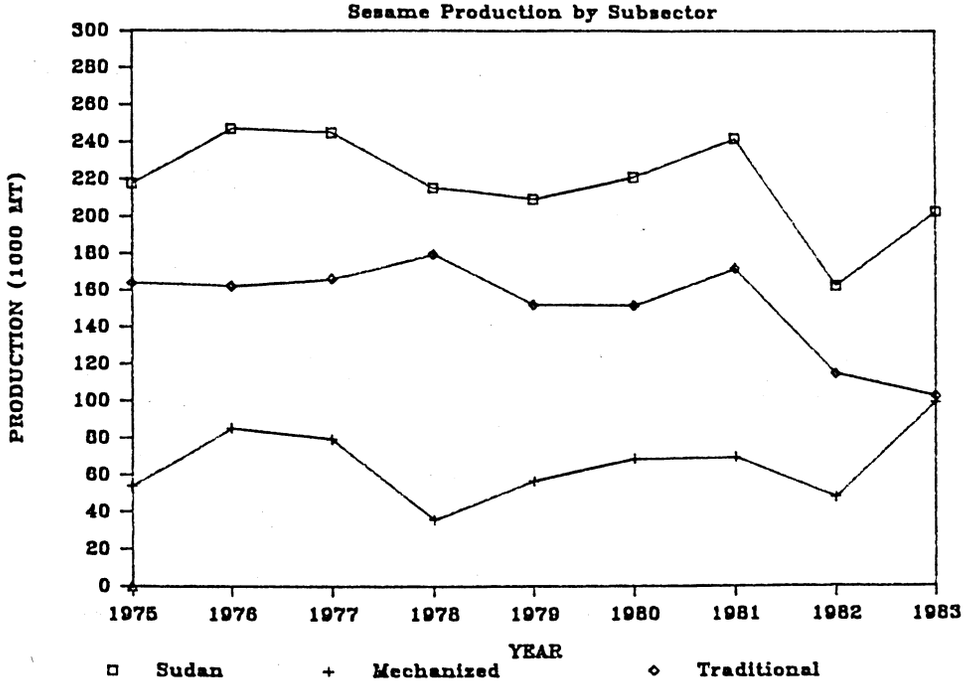
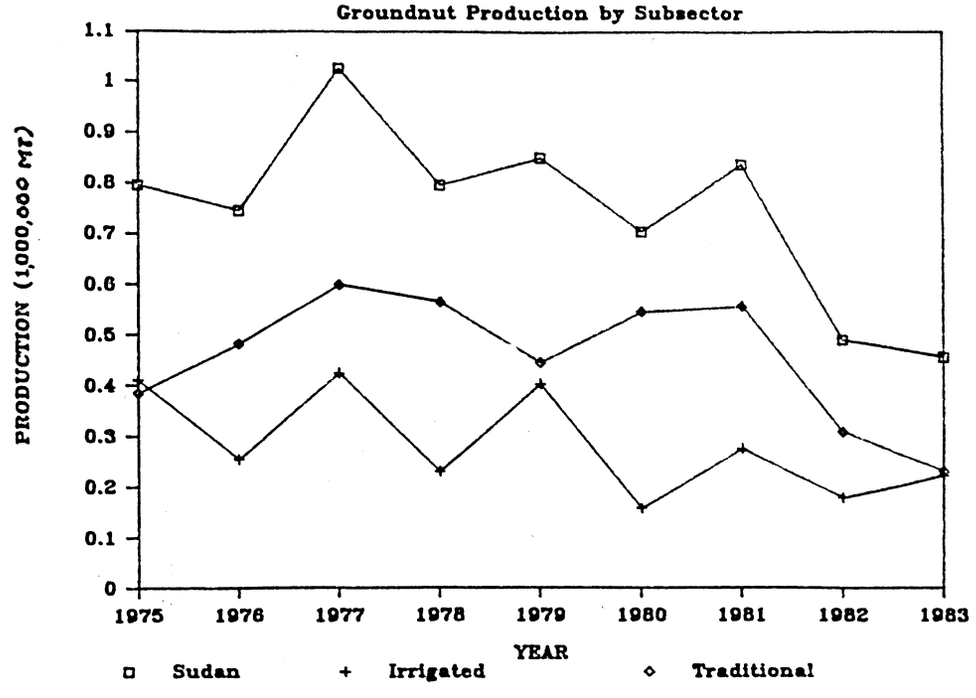


Figure 10: SUDAN

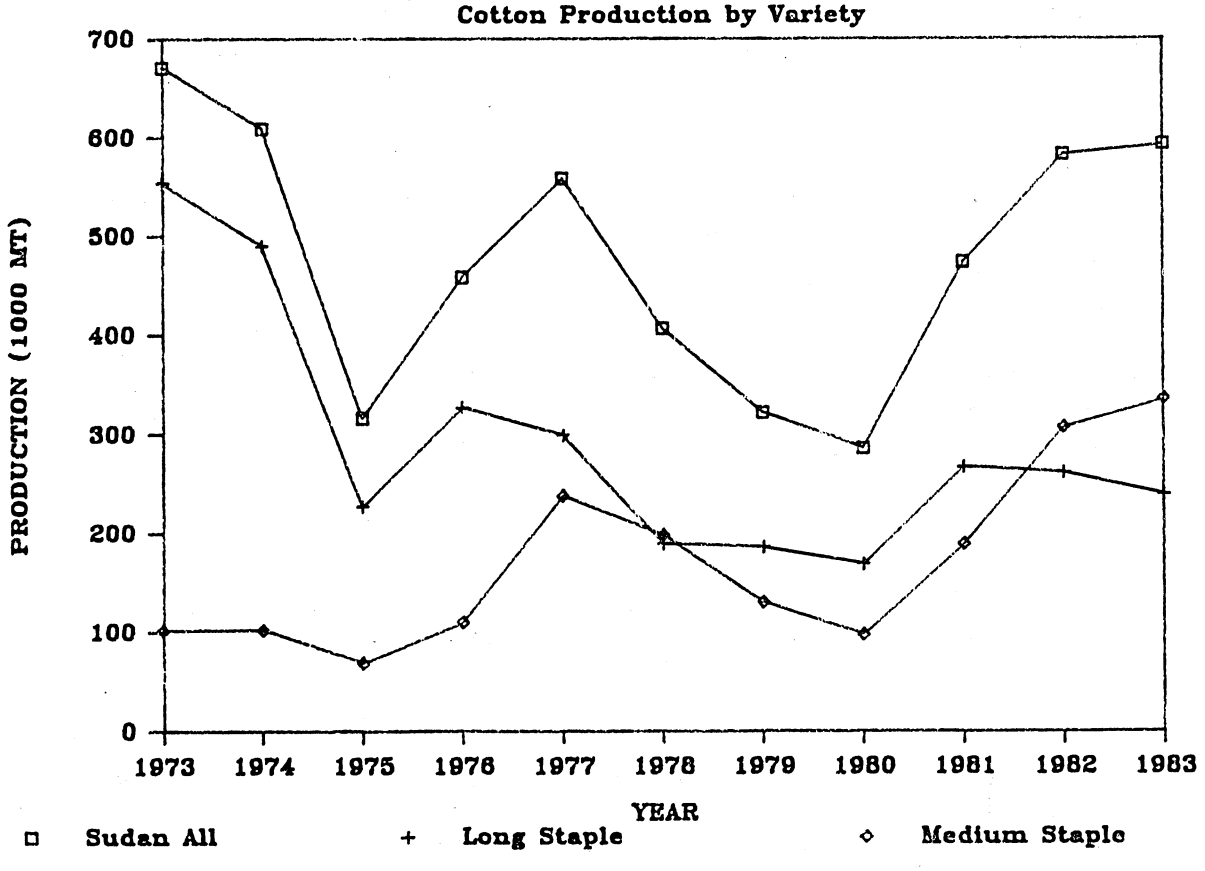


Cotton

Cotton dominated export earnings until the midseventies, when, due to a decline in cotton production, cotton's contribution to foreign exchange earnings declined from nearly 45 percent in 1975 to 23 percent in 1982 (fig. 2). Actual export earnings from cotton declined from a high of US$115 million in 1975/76 to a low of US$15 million in 1981/82.

Sudan produces extra long staple (ELS), medium staple (MS), and short staple (SS) varieties of cotton. The former two varieties, which are grown under irrigated conditions, constitute more than 95 percent of cotton production. The change in the relative shares of ELS and MS cotton production after 1977 was caused by the initiation of the Rahad scheme (where MS cotton is planted), and increased MS area instead of ELS in the Gezira scheme (fig. 11). Cropping areas changed because scheme managers perceived that the world market would be strong for MS cotton and there would be a shortage of labor for cotton harvesting. While the decline in aggregate production has been reversed, Sudan still must expedite its cotton export marketing. White fly infestation and delays in acquiring jute sacks for cotton harvesting (due to lack of foreign exchange) have caused problems in cotton marketing and have led to delayed sales and spoilage, forcing prices downward. (As of May 1985, nearly 1.5 million bales of Sudanese cotton remained in stock resulting from marketing bottlenecks.)

Figure 11: SUDAN



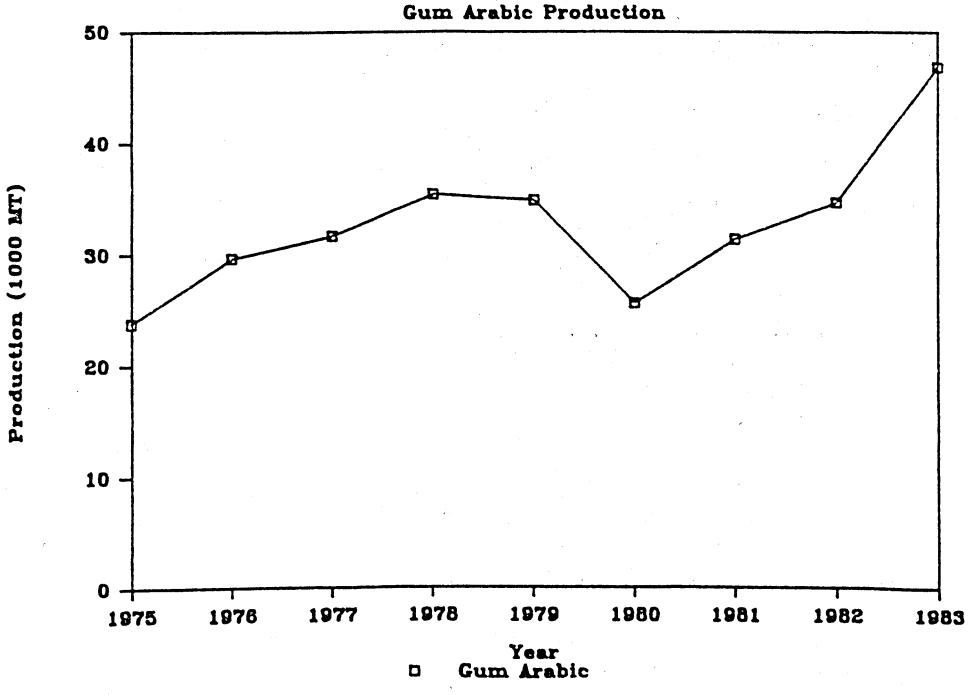
The increases in cotton production since 1981/82 resulted from rehabilitation of the irrigated subsector under the public investment program and pricing and institutional changes. Many changes under the public investment program led to greater incentives to cotton producers: the World Bank-financed agricultural rehabilitation project and scheme-specific rehabilitation projects, improvements in irrigation infrastructure and in the timing and quality of imported inputs like fertilizer, pesticides and machinery. 4/

Gum Arabic

Gum arabic is grown in the traditional rainfed subsector in the eastern and western parts of the country. Sudan produces over 90 percent of the world's gum arabic exports, and thus acts as a price setter in this market. The Government maintains a similar role domestically through the Gum Arabic Company, which acts as the sole purchaser of gum from farmers. Increased production of this crop is important for the economy because over 10 percent of Sudan's export earnings come from gum arabic.

As discussed earlier, no traded inputs are used in gum arabic production, but because it is a perennial tree crop which produces gum 5 years after planting, producer incentives have to be maintained to enable farmers to retain their gum-producing trees. The decline in production in the late seventies and early eighties (fig. 12) resulted from producer incentives not being maintained, which then led farmers to cut their gum trees and sell them for firewood.

Figure 12: SUDAN



4/ The impact of the most important institutional change, replacement of the joint account by the individual account, is analyzed in detail in a forthcoming report by Kamil I. Hassan and Brian C. D'Silva.

Wheat

Wheat is produced in Sudan under irrigated conditions. Production is influenced by a number of physical, institutional, and economic factors.

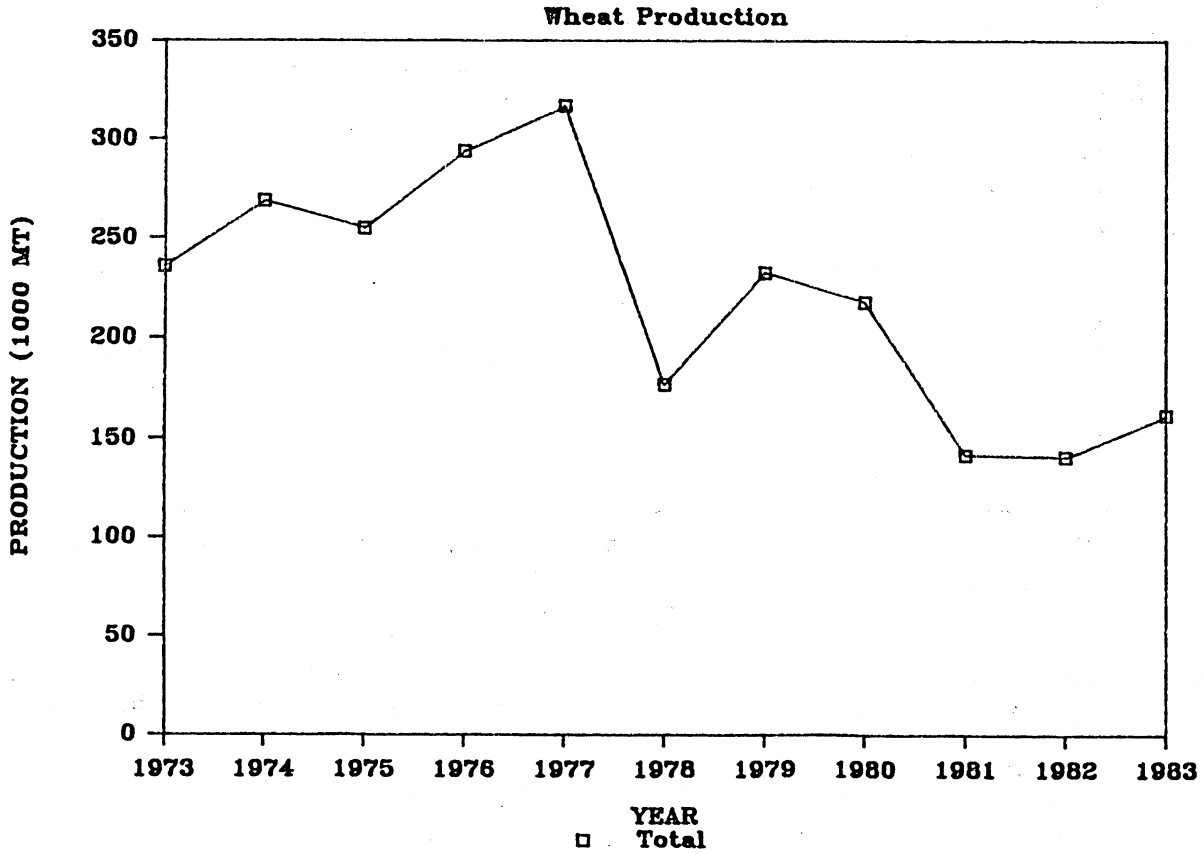
--As a majority of area planted to wheat lies in schemes where area allocations for crop production are administered, decisions concerning relative areas planted to cotton and other crops influence area planted to wheat.

--Water shortage can affect yield performance due to the competition for irrigation water in the October-February period.

--As the producer price for wheat is set by the Government, the Government becomes an important determinant of the incentive afforded to wheat producers.

Wheat production in Sudan has fluctuated (fig. 13) because all of these factors have been changing. In the midseventies, the Government embarked on attaining a goal of wheat self-sufficiency because over 50 percent of wheat consumption is imported. This led to increased area under production, but yields were held down by reason of competition for water from cotton, which had higher priority, especially in the Gezira scheme. In 1983, the producer price was increased to reflect the import parity price, but a warm winter adversely affected yields. In October 1984, when the Gezira management board realized the inadequacy of Blue Nile flow for both cotton and wheat production, the decision was made to plant no wheat in the scheme.

Figure 13: SUDAN

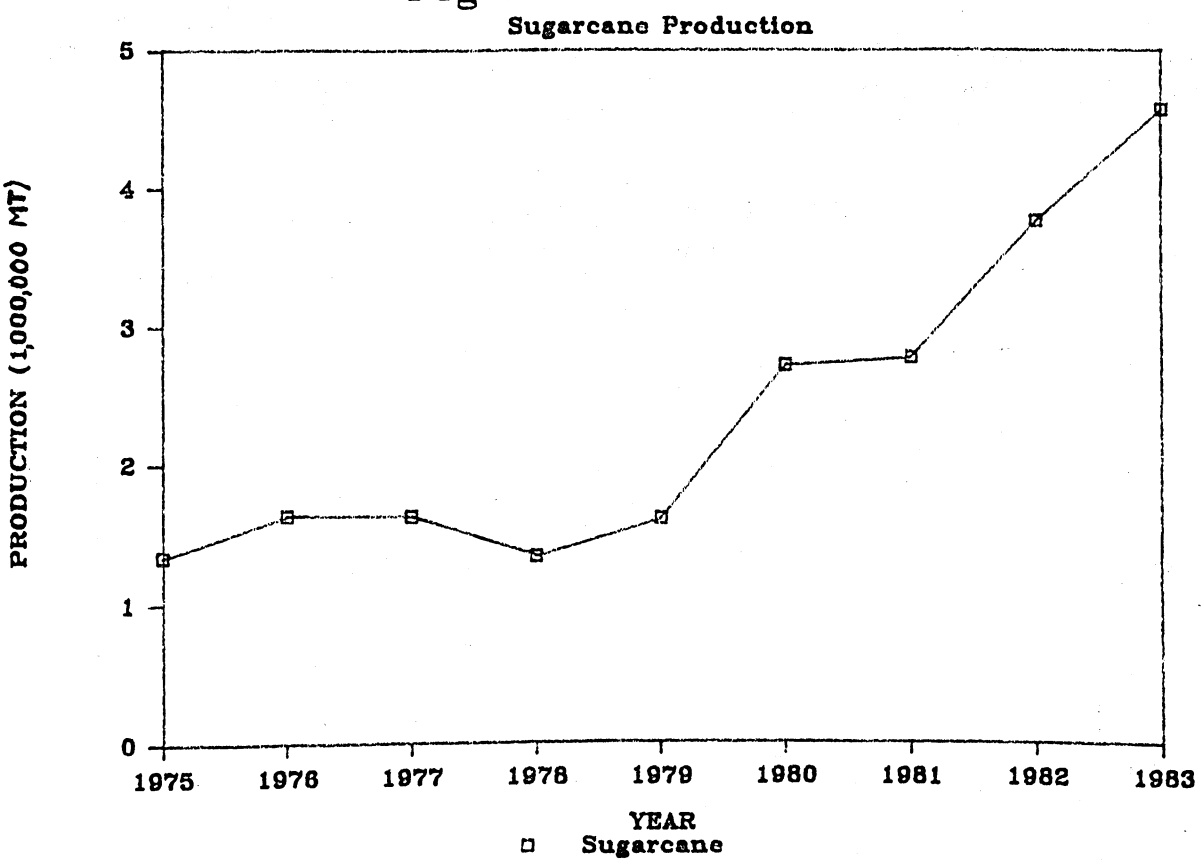


Future increases in wheat production could be limited not only by the constraint of irrigation water availability, but also by the lack of appropriate varieties and the requirements of foreign exchange in wheat production. 5/ 6/

Sugarcane

Sugarcane is produced in the irrigated subsector. Until 1981/82, sugar was second only to petroleum in value of imports. Due to forecasted increase in sugar consumption, the Kenana scheme was started in the midseventies with a project area of 150,000-square kilometers, of which 81,000 were to be planted in cane at time of completion. A sugar refinery has been constructed with a capacity of 330,000 tons of refined sugar per year. As Kenana is now completed, its results can be seen in both increased domestic production (fig. 14) and a reduction in sugar imports from US$158 million in 1981/82 to US$24 million in 1983/84. Domestic production of sugar, however, is at a higher cost than world prices.

Figure 14: SUDAN



5/ The present varieties, called Giza and Mexicali, yield only 0.5 ton per feddan under farm conditions, compared with nearly 2 tons per feddan under similar conditions in Egypt.

6/ Wheat required US$1 of foreign exchange in imported inputs for US$0.50 of production value at prices prevailing in 1985, and thus is a net user of foreign exchange.

Use of Petroleum Products in Agriculture

Petroleum accounts for the largest share of imports, and policy reform has focused on pricing and procedures governing imported petroleum products (benzene, gasoil, and aviation fuel). Sudan's import bill for petroleum products increased by over 325 percent from 1976/77 to 1980/81, from US$110 million to US$469 million (6).

As petroleum prices to consumers were subsidized, removal of the subsidy has been a major focus of donor-initiated policy reform. In March 1985, prices for both benzene (used for cars) and gasoil (used in agriculture and diesel engines) rose by over 70 percent to the point where petroleum became a source of tax revenues rather than a drain on the government budget. In June 1985, there was a rollback in gasoil prices which affected the government budget and also availability of gasoil. Linked to import parity pricing of petroleum products, reform has also focused on privatizing the importing and internal distribution of petroleum products. This reform, implemented in May 1985, was to lead to greater availability of benzene and gasoil.

Use of Gasoil in Agriculture

Agriculture is the second largest user of gasoil after transportation, consuming nearly 20 percent of the total. Gasoil is used primarily in the irrigated and mechanized rainfed subsectors. An anlysis of gasoil use in agriculture shows that over 63 percent is used in agricultural operations, 32 percent for irrigation, and the rest for canal maintenance. Fuel consumption by crop for the irrigated and mechanized subsectors is shown in table 6.

Table 6--Estimate of fuel consumption for all agricultural operations 1/

Crop	Subsector and type of production system			
	Irrigated (hand harvesting)	Irrigated (mechanical harvesting)	Mechanized rainfed (light soils)	Mechanized rainfed (heavy soils)
	Gallons per feddan			
Cotton	4.1	8.1	--	--
Groundnuts	.6	3.0	--	--
Sorghum	1.1	1.6	1.3	1.7
Wheat	1.4	1.9	--	--
Sesame	--	--	.9	1.3
Sugarcane	21.6	27.11	--	--

-- = Not applicable.
1/ Excluding fuel use for irrigation pumping.

Source: (6)

Estimating Gasoil Requirements for the Irrigated and Mechanized Subsectors

Estimates of gasoil used in 1983 for the irrigated and mechanized subsectors are shown in table 7. Production of mechanized rainfed sorghum absorbed nearly 48 percent of total gasoil requirements, while irrigated cotton was second, absorbing 20 percent of the total.

Table 7--Estimated total gasoil requirements by crop in the irrigated and mechanized subsectors, 1983

Crop	Subsector	Estimated area	Estimated gasoil consumption
		1,000 feddan	1,000 gallons
Cotton	Irrigated	868 (10.32)	3,558 (20.53)
Sorghum	Irrigated	632 (7.51)	695 (4.01)
Wheat	Irrigated	324 (3.85)	615 (3.54)
Groundnuts	Irrigated	241 (2.86)	241 (1.39)
Sorghum	Mechanized	5,502 (65.42)	8,253 (47.62)
Sesame	Mechanized	842 (10.01)	842 (4.85)
Sugarcane	Irrigated	125 (1.48)	3,125 (18.03)
Total		8,409 (100.00)	17,329 (100.00)

Note: Figures in parentheses represent percent of total.

The early seventies were favorable to agricultural production in Sudan. However, a sharp break with the rising trend in agricultural productivity appeared in 1975/76 (table 8), and led to policy changes, which affected productivity in the early eighties. A bumper crop year in 1981/82 showed the extent to which Sudan's agricultural production potential could be realized. The value of agricultural exports doubled between 1980/81 and 1982/83. Then followed two poor rainfall years in western Sudan in 1982/83 and 1983/84. The drought year 1984/85 showed the extent to which the vagaries of weather exert an impact on the performance of the agricultural sector. The 1984/85 crop season was by far the worst in recent history because it directly affected all three subsectors.

The Irrigated Subsector

Drought affects the irrigated as well as the rainfed subsectors. Over 75 percent of the irrigated area cultivated in Sudan depends on the level of the Blue Nile, which has its source in Ethiopia. Due to low rainfall in Ethiopia and Sudan, the level of the Blue Nile in 1984 was at its lowest since the all-time recorded low of 1913 (fig. 15). As primary operations such as planting sorghum and cotton are related to the onset of the rains, drought led to delayed plantings and thus reduced yields in a majority of areas under irrigation. The combination of lack of rainfall and low levels of the Blue Nile affected the area planted and cropping patterns in the major irrigated schemes, especially the 2.1 million feddan Gezira scheme.

Areas allocated to different crops in schemes such as Gezira while following a prescribed rotation are also allocated under the assumption of near normal flows of the Blue Nile. The peak of the Blue Nile flow does not occur until August and September, while decisions on area allocations and actual plantings

Table 8--Index of total agricultural production in Sudan, 1969-82

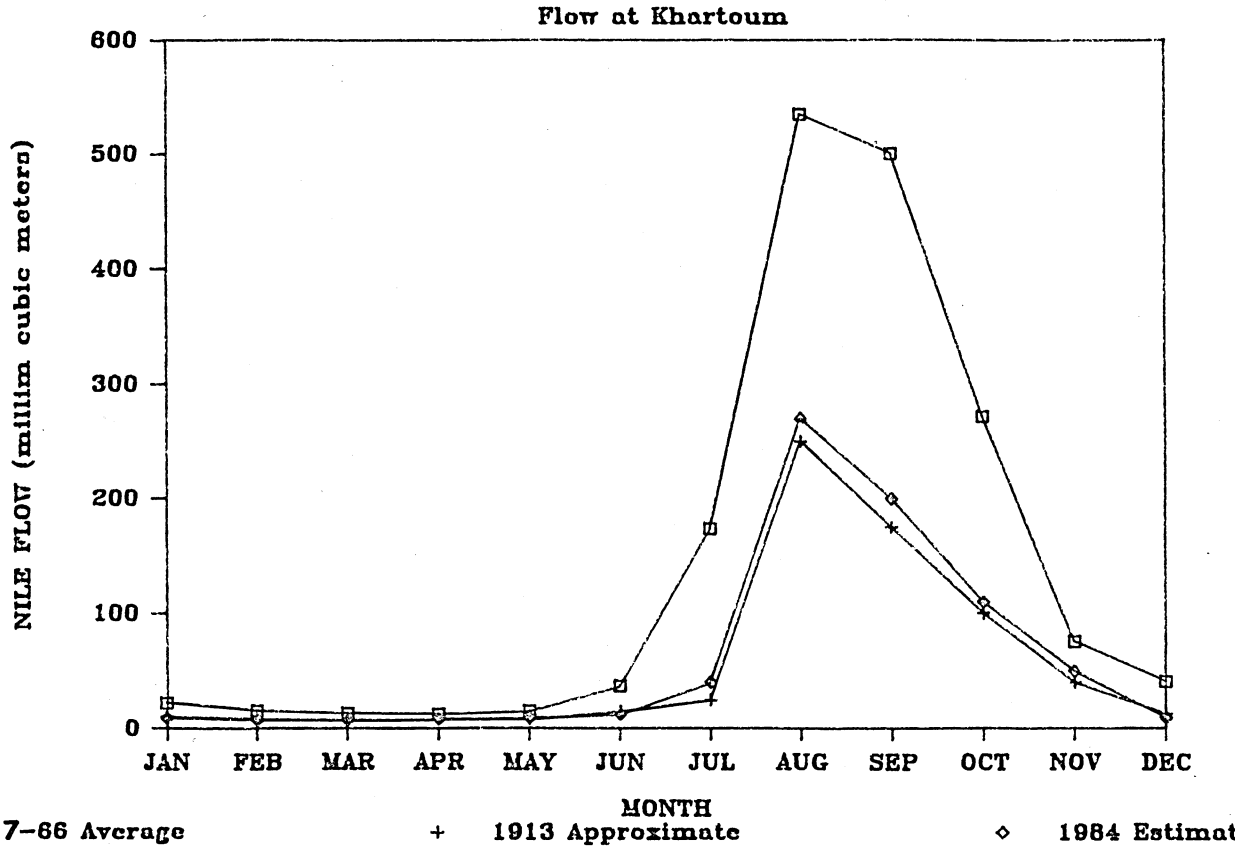
Year	Index (1969-71 average = 100)
1973	96
1974	111
1975	114
1976	98
1977	100
1978	116
1979	103
1980	95
1981	95
1982	118

Source: (8)

of all crops except wheat are made in July, making planning difficult. A reduced flow of the Nile in August and September affects the availability of irrigation water in October through February. The requirement for irrigation water is greatest in October when wheat is planted and all crops (sorghum, groundnuts, wheat, and cotton) require irrigation. 7/

In 1984, the low level of the Blue Nile prohibited 300,000 feddan from being planted to wheat in the Gezira scheme, leading to a production shortfall of nearly 150,000 metric tons of wheat. No fodder crops were planted in the scheme, affecting the availability of animal feed. The level of the Blue Nile also affected water availability for the Blue Nile pump schemes and the pump scheme along the Main Nile north of Khartoum. In addition, the lack of gasoil to run the irrigation pumps in these areas hindered access to irrigation water, thereby delaying crucial operations like planting and irrigation.

Figure 15: BLUE NILE



7/ A further analysis of the impact of alternative cropping patterns in the Gezira scheme on water use and cereal production can be found in Brian D'Silva and Nancy McKaig, "Changing Cropping Patterns in Sudan's Gezira Scheme: A Means of Raising Food Production During Drought," in USDA/ERS, Sub-Saharan Africa: Outlook and Situation Report (Washington, D.C.: July 1985), pp. 38-42.

Livestock are usually not allowed onto the irrigated schemes until all the cotton has been picked. In nondrought years, tenants and nomads bring livestock to graze on the schemes as soon as the cotton has been picked. However, in 1984, the drought caused minimal fodder availability outside the irrigated areas, and scheme management could not prevent livestock from grazing in the schemes. This led to increased pressure on the range resources of the irrigated areas as nomads from western Sudan with migrated sedentary farmers settled along the perimeters of the irrigated schemes. Lack of fodder also led to distress sales of cattle and sheep later in 1984 at prices at least 80 percent lower than those of a normal year.

There are strong linkages between the irrigated and traditional rainfed subsectors with labor migration for cotton picking. Labor contracts for picking cotton traditionally require laborers to be paid a cash wage as well as sorghum in kind. As the drought affected production of sorghum and millet in western Sudan, increased immigration lowered cash wages, but the value of the in-kind wages increased by over 400 percent because of higher sorghum prices.

While sorghum production in the irrigated subsector in 1984 exceeded that of 1983, primarily due to slightly increased areas under cultivation, minimal surpluses for urban consumption or other rural areas were available. This was due to the increased in-migration from western Sudan and no substitution of sorghum area for cotton, since cotton had been planted under the assumption of a normal Blue Nile flow.

The shortfall in wheat production not only affected domestic cereal availability, but also required increased imports of wheat both commercially and concessionally. Sudan's commercial import capacity is minimal because of its large external debt and debt servicing; reduction in wheat production was manifested in increased food aid requirements.

Although Sudan has over 4 million feddan under irrigation, the structural rigidities within the subsector and its emphasis on cotton resulted in lower food grain output from the subsector in 1984/85 when it was most needed.

The Mechanized Rainfed Subsector

Factors affecting production in the mechanized areas and the role of the mechanized subsector in providing sorghum to various markets need to be understood to determine the effect of the drought on this subsector. Fuel, rainfall, and labor are critical production inputs in these areas. The mechanized subsector covers an area of up to 6 million feddan, so availability of rainfall in at least some of the areas will be sufficient for production, as was the case in 1984. For example, in the Gedaref area (eastern Sudan), the northern part of the mechanized areas had minimal rainfall while the southern part had adequate rainfall resulting in a variation in yields from zero to three sacks per feddan. Similar disparities in rainfall affected production in the Damazine (Blue Nile) area, while lack of rainfall in the west led to decreases in production of up to 60 percent.

The geographical dispersion of sorghum producing areas and the physical size of Sudan have led to segmented markets, with surpluses being produced in the mechanized rainfed subsector.

The west is usually self-sufficient in sorghum because of the mechanized areas in South Kordofan. But in 1984, as the traditional and mechanized areas in western Sudan were affected, the west became a food-deficit area. The mechanized areas in eastern Sudan produce for the urban and export markets. Some of these areas have been under cultivation for nearly 40 years, and yields are declining due mainly to loss of soil fertility. Hence, mechanized cultivation is now expanding in the Blue Nile region primarily as a result of investment in clearing new farms. Surpluses from this area could also be used for urban consumption and the export market. However, only parts of the Blue Nile producing areas received sufficient rain for sorghum in 1984.

While urban demand for sorghum continued and even increased (with the inflow of refugees from the west), additional demand was generated by the inflow of refugees from the drought in Ethiopia. As formal exports of sorghum were banned in 1984, cross-border trade was illegal. Prices varied considerably within Sudan, reflecting not only geographical distances but also regional availability: prices were highest in the west, lowest in the east.

In the Gedaref market in eastern Sudan, the largest sorghum market in Sudan, prices of sorghum increased from LS 30 per sack in early June (at the beginning of the season) to LS 55 per sack at the end of August 1984. Although the harvest had not begun in August, the steep increase in prices of over 80 percent reflected expectations concerning the harvest and over-all sorghum availability. Prices in the east continued to increase through the rest of the year, and approached LS 80 per sack in November. Prices in the far west (El Fasher) approached LS 150 per sack, compared with LS 40 per sack the previous year.

Unlike 1982 and 1983 when shortfalls in sorghum production in the traditional rainfed areas were made up by production from the mechanized areas, the severity of the drought in 1984 affected even the mechanized areas--reducing production by over 50 percent. If Sudan had not had the large mechanized subsector, the food situation in 1984 would have been worse.

The Traditional Rainfed Subsector

Of all the subsectors, the traditional rainfed subsector was most severely affected because this subsector accounts for most of the population, these people produce their own food, and the subsector depends on rainfall. In western Sudan, 1984 was the culmination of a 3-year drought, which further compounded the gravity of the food scarcity. In 1984, compared with 1982 and 1983, there was no rain during the growing season in areas north of 13 degrees latitude.

As western Sudan was by far the worst-hit area of the country, the analysis will focus on this region. Three types of agricultural producers in western Sudan are: the sedentary, the transhumant, and the nomadic. 8/ All were affected as the major food crops of sorghum and millet failed in North

8/ Unlike nomads who do not have a permanent home and do not grow crops, transhumants grow sorghum, have a place of residence, and migrate after planting their sorghum in search of fodder for their livestock, returning to their homes just before harvest.

Kordofan and North Darfur. Transhumants depend on the rain in North and South Kordofan for sorghum and fodder for their livestock. Lack of rain affected sorghum and fodder availability. Lack of fodder in the west also affected the large livestock population that nomads and transhumants tend in western Sudan. Nomads and transhumants moved their herds towards the Nile, increasing pressure on the resources of the irrigated subsector. During a period of increasing food grain prices, livestock prices fell sharply due to distress sales by livestock owners. These reductions in herd size will require time to rebuild, so that livestock production can increase and exports resume.

Cash crops such as groundnuts, sesame, and gum arabic are also produced in western Sudan, and the drought affected their production and thus incomes for the traditional farmers.

The effects of the drought on this subsector could also be seen in the large-scale migrations both within and out of the west. These migrations began after the failure of the crop in North Darfur in 1983, which caused nearly 900,000 people to migrate from North to South Darfur. At the same time, the drought in Chad led Chadians to migrate into South Darfur in search of food. In 1984, as the failure of the season began to be noticed, individuals from North Kordofan migrated to areas along the Main Nile to Omdurman (outside Khartoum), to South Kordofan, and to Kosti along the White Nile. These population movements made it difficult to determine how many remained in their villages and to estimate emergency food aid requirements. However, some donors, especially the USAID mission in Khartoum, had monitored the food situation in Darfur as early as January 1984. Therefore, during the 1984 season, the USAID mission, through constant monitoring of the growing season (in all of the major producing areas), anticipated the magnitude of the drought before the Government of Sudan declared western Sudan a disaster area. This delay in acknowledgment of the magnitude of the problem by the Government of Sudan compounded problems in food aid requests, approval, and delivery due to migration of people within and out of western Sudan.

Food Aid: The Immediate Response

Sudan has historically exported sorghum and imported wheat. Over 75 percent of wheat imports come from the United States, with nearly 50 percent of these imports being on concessional terms through P.L. 480 and Commodity Import Program (CIP) funding.

As the effects of the drought unfolded, especially in western Sudan, the necessity for emergency food aid also increased. This emergency food aid was initially targeted for the drought-affected population in western Sudan. However, the influx of Ethiopian refugees into eastern Sudan caused food aid to be diverted to refugee camps in the east.

Determining food aid requirements during a drought is a major problem, especially when population shifts over a large country like Sudan. The cereal deficit in Sudan between November 1984 and October 1985 had been estimated at 2,102,000 metric tons. 9/ As 112,000 metric tons were imported commercially,

9/ This is assuming that consumption patterns remain unchanged. Grain price increases, population movements, increased slaughter and distress sales of livestock all affected the demand for food in the aftermath of the drought.

the remainder had to be imported as emergency food aid or on concessional terms. The United States approved 942,168 tons of food aid as of July 1985, of which 532,514 tons was emergency food aid and the rest was on concessional terms. Other donors approved 295,000 metric tons, still leaving an unmet deficit of over 864,000 tons.

As the United States is the largest donor of emergency food aid to Sudan, it is important to understand the strategy followed by USAID in the development of a relief program for western Sudan. The strategy as originally devised in 1984 centered on three premises: (1) attempts would be made to get food to the local (village) level; (2) local consumption patterns would be taken into account; and (3) stocks would be built up in western Sudan before the onset of the rains there in 1985.

Distributing food to the villages was viewed as assisting people to remain on their land so that if rain did materialize in 1985 they could be given seed and production could take place. This would also minimize food losses and prevent further population dislocation. As sorghum is the preferred grain in the west, and wheat bread is consumed in urban areas, food aid brought into the country should reflect this mix. Hence, the composition of already programmed concessional food aid had to be reconciled with emergency food aid imports. An effort to build stocks in the west prior to the onset of the rain was important, because rain could prevent access by washing out roads and rail tracks, an event which occurred with some frequency in July 1985.

While the above premises seem sound and logical, there was an increasing time lag between food arrivals in Port Sudan and their distribution in western Sudan. This lag was compounded by the April 6 political coup, railway strikes, lack of fuel, absence of spare parts, and inadequate numbers of trucks and freight cars. All these prevented a timely build-up of stocks in the west and put between 1 and 2 million people at risk of starvation. There is, however, no doubt that increased food shipments will be required beyond October 1985.

Determining Food Aid Needs for 1985-86

Ascertaining the likely production levels of sorghum and wheat in the coming season becomes critical in determining the food gap and hence food aid needs for 1985-86. Estimating these needs will require a constant monitoring process of rainfall levels in the Blue Nile watershed, crop conditions in Sudan's rainfed producing regions, and the Blue Nile level in July and August 1985. It is only through monitoring these factors that production levels can be forecast with accuracy.

The major factors affecting production in each of the three subsectors, and the critical time periods for each, are shown in table 4. The availability of hybrid sorghum seed for farmers in the irrigated subsector will lead to increased sorghum production in the irrigated areas. In the mechanized rainfed subsector, remunerative prices prevail and increased diesel fuel is being made available by the Government with donor assistance. As producers in the mechanized rainfed subsector are primarily commercial farmers, they should be capable of purchasing seed before the critical time period. Therefore, the distribution of rainfall becomes a crucial determining factor affecting

production by this group of producers. The wide geographical distribution of the mechanized rainfed areas and their existence in stable rainfall regions suggest that rainfall more plentiful than in the previous year should lead to greater production from this subsector. In the traditional rainfed subsector, there can be no overemphasizing the availability of seed. Even with adequate rainfall, sorghum production in this subsector will probably not exceed that in the irrigated subsector. But with adequate rainfall, there should be a definite increase in production of sorghum in the country over the previous year's level. To determine the level and to plan accordingly, it is important that the rainfall levels and the condition of crops be monitored continuously until November in the mechanized and traditional rainfed producing areas.

A major reason for increased wheat imports during 1984/85 was the nonplanting of wheat in the Gezira scheme. The area planted to wheat will depend on the amount of water available for wheat production because the cotton areas in the major irrigated schemes will not be reduced in extent in 1985/86. Water stored in the upstream reservoirs on the Blue Nile during August and September will be used to irrigate cotton and wheat. Since wheat must be planted in October, a decision must be made before then on allocating available water between cotton and wheat without sacrificing the ongoing cotton crop. Therefore, monitoring rainfall in the Ethiopian highlands during August and September and the level of the Blue Nile in Sudan will be necessary for forecasting wheat production.

POLICY OPTIONS FACING THE AGRICULTURAL SECTOR

Sudan's present economic and political crises are overshadowed by the prospects of 1 to 2 million people facing starvation in spite of receiving over 1 million tons in food aid since mid-1984. Such an event would have been unthinkable even a year ago due to the perception of Sudan being capable of achieving the status of "breadbasket of the Middle East." Hence, the most immediate policy issue facing Sudan concerns increasing domestic food availability and determining the commodity mix of food imports (wheat versus sorghum) as well as the source (commercial versus concessional).

It is quite possible for food production in Sudan to increase in 1985/86 to the level where food imports, especially that of sorghum, could be negligible. Achieving such a situation would require adequate rainfall at least in areas where mechanized sorghum production takes place, an increase in the flow of the Blue Nile, and changes in cropping patterns toward food crops and away from cotton within the irrigated subsector. If at least two of the above three situations exist, then sorghum production could increase at least by 50 percent. While the food shortage may be alleviated in the short term, it is the economic and political problems that need attention in the long run, especially from the perspective of policy reform. While policy options are not necessarily limited, problems such as those that Sudan currently faces not only accentuate the need for policy reform, but also sharply limit options. Resolution of important issues has larger implications, especially on the political side.

In light of the drought, increased debt service obligations, and reduced export earnings, the question remains: What are the objectives of policy-makers and what are their policy options? Achieving food self-sufficiency and

increasing agricultural export earnings could be viewed as being a necessary precondition for Sudan's economic recovery. Policy options related to these objectives could be viewed in relationship to each of the three subsectors in Sudan's agriculture.

The Irrigated Subsector

Policy reforms concerning the irrigated subsector could be related to changes in cropping pattern, changes in decisionmaking powers of tenants vis-a-vis scheme management, or increasing availability of modern inputs like fertilizer to crops other than cotton or wheat. 10/ While this subsector has been the focus of reform concerning institutional change and pricing of both inputs and outputs since 1981, the results to date have been mixed. While cotton production has increased, problems in marketing cotton have reduced its export earnings. Similarly, the existence of differential exchange rates, especially for cotton and irrigated subsector imported inputs vis-a-vis other export crops may not have provided the full impact of price incentives.

Scheme managers presently decide on cropping patterns and input use within large irrigated schemes like Gezira and Rahad, and tenants have minimal decisionmaking power and operate within a restricted economic environment. The only major decisions that tenants control are timing of weeding and harvesting and allocation of labor between hired and family for the various operations. Hence, while price incentives (as a result of macroeconomic policy reforms such as devaluations) may have been initiated, tenants do not have the freedom to allocate their resources in response to the changing structure of incentives. This suggests that effects of macroeconomic policy reforms may not be as expected and a further understanding of pricing changes on the efficiency of resource allocation is necessary. However, effects of major reforms within the large irrigated schemes depend on the extent to which scheme bureaucracies are willing to change. Some of the policy reforms are analyzed below, keeping in mind the perceived twin objectives of policymakers.

Changes in Cropping Patterns

An analysis of the implications of changing cropping patterns in the irrigated sector with reference to its impact of foreign exchange earnings, food self-sufficiency, Nile water use, and seasonal employment needs to be undertaken. This analysis should have implications for the optimal mix of commercial and concessional food imports (especially wheat and wheat flour) as well as generating an estimate of the subsector's foreign exchange earning capability.

The fall in the level of the Blue Nile in 1984 emphasized the importance of analyzing the present cropping pattern in the irrigated schemes, especially with reference to water use, meeting domestic food needs, and increasing foreign exchange earnings. If area planted to cotton remains unchanged, the irrigation water available for other crops, especially wheat, depends on Blue

10/ An analysis of these policy options is currently under way by the author through construction of an irrigated subsector model of Sudan. The initial focus of this research is decisionmaking at the farm and scheme levels in the Rahad and Gezira schemes.

Nile flows. Reducing cotton area by 200,000 feddan in the Gezira scheme and planting it to sorghum or wheat could lead to a reduction in water use during the crucial October-March period, as well as increased cereal production up to 270,000 tons. 11/

However, reduction in cotton area will reduce potential export earnings. But if food deficits continue, the value of domestically produced sorghum could exceed net foreign exchange earnings from 200,000 feddan of cotton, because the world cotton market is weak and Sudan has problems marketing its cotton.

The role of wheat in the irrigated subsector cropping pattern becomes important for technical and economic reasons. At present, Sudan will have difficulty increasing wheat yields and area planted to wheat. Furthermore, as most wheat operations are done mechanically, wheat is a net user of foreign exchange. Sudan also has been receiving over 200,000 tons of P.L. 480 concessional wheat from the United States for each of the past 3 years. This has saved precious foreign exchange for Sudan. Unless wheat yields are increased and changes take place in wheat production technology (that is, it shifts away from using foreign exchange), wheat will not be an economically viable crop to produce in Sudan.

Should cotton exports improve, cotton is preferable to wheat in that it generates foreign exchange and also affects employment. Cotton picking provides seasonal employment and food as wage goods for migrants from western Sudan.

Changes in Decisionmaking Powers

Effects of changes to the present structure of decisionmaking in the irrigated subsector need to be analyzed, especially in light of macroeconomic policy changes affecting the incentive structure to producers in the irrigated schemes.

Scheme management has a major decisionmaking role concerning crops to be planted, timing of operations, technology used, and the use of scheme-provided inputs. As tenants may have different objectives than scheme managers, introducing flexibility into the tenant decisionmaking process becomes necessary. For example, tenants in the Rahad scheme have gradually been able to increase the area planted to sorghum from zero to 5.5 feddan, so that 25 percent of the tenancy area is presently planted to sorghum. But tenants still are not able to adjust annually the relative areas planted to groundnuts and sorghum or groundnuts and cotton in response to changing economic signals. Part of the rationale in the rigidity of the cropping pattern is related to the organization of production units, agronomic considerations, and the ease of conducting specific scheme-provided operations such as the spraying of cotton.

11/ In 1984, the availability of a hybrid sorghum made possible an increase of sorghum yields of 200 percent in the Gezira scheme. (See section on changes in structure and performance, 1975-83, for sorghum.) The constraint on increasing area under hybrid sorghum is seed availability.

Introducing flexibility of decisionmaking for tenants could lead to an efficient allocation of irrigated subsector resources if price incentives are maintained. An illustration of introducing flexible decisionmaking could be seen in the use of modern inputs on crops other than wheat or cotton.

Increasing Availability of Modern Inputs

Introducing flexibility in tenant decisionmaking on use of modern inputs has implications for production, incomes, foreign exchange, and employment.

Fertilizer is presently restricted to use on cotton and wheat. This includes the level of use which is based on agronomic but not on economic conditions. Due to the availability of a hybrid sorghum variety, fertilizer will now need to be applied to sorghum. Price incentives transmitted through devaluations will increase costs of imported inputs, such as fertilizer, and should lead tenants to use fertilizer on crops which will generate increased net income and not necessarily increased physical output.

Tenants could have a choice of technology for weeding and harvesting, not only for crops such as cotton but also for groundnuts and sorghum. Introduction of herbicides for cotton has reduced labor requirements for weeding, but currency devaluations have changed the relative price ratio between herbicides and manual labor. Tenants in the Rahad scheme have shown a preference for mechanical harvesting of groundnuts and handpicking of cotton, both of which lead to increased yields. As herbicides and mechanical harvesters are imported, they require foreign exchange and also displace labor. Therefore, pricing of imported inputs to the farmer becomes an important issue not only as it affects the structure of incentives but also the use of scarce foreign exchange.

The above specified areas of policy changes in the irrigated sector should be analyzed not only individually, but also in relationship to each other, and in relationship to other agricultural subsectors and the macroeconomy. For example, allowing tenants freedom in fertilizer use could lead to increased sorghum and groundnut production and reduced cotton production. This may lead to increased food production within the subsector and reduced foreign exchange earnings from cotton. But if a demand for Sudanese sorghum materializes in the Middle East, then increased sorghum production through use of hybrids and fertilizer could become competitive in the Middle East, thereby increasing sorghum exports.

The Mechanized Rainfed Subsector

Over 50 percent of Sudan's sorghum production comes from the mechanized rainfed subsector. With adequate rainfall and gasoil availability, sorghum production in this subsector should increase to pre-drought levels. Major areas of concern for the mechanized subsector are: availability of hybrid sorghum seed in adequate quantities, maintenance of soil fertility, availability of machinery, pricing of inputs, and producer incentives, especially the ability to convert export earnings at the commercial exchange rate.

Availability of hybrid seed will increase productivity levels in the mechanized areas and hence the competitiveness of sorghum in the Saudi Arabian

market. No rotation pattern is presently practiced and fertilizer is not used due to vast areas under mechanized cultivation. Should these practices continue they could lead to severe environmental degradation as is presently seen in the Blue Nile Province. This could affect the long-run productivity of the subsector. Also, land charges being paid by individuals who farm in this subsector are minimal, usually LS 1/feddan per year. The land charges should be raised to reflect the cost of maintaining the productivity in the soil. Another aspect of the subsector which needs to be analyzed is the status of leases. Nearly 50 percent of area in eastern Sudan under mechanized cultivation is in the undemarcated sector (areas which have not legally been leased for mechanized cultivation) and so there are no land rents charged and expansion takes place with clearing. Therefore, the changing production trends in this subsector have important policy implications for land use policy and long-run productivity of the subsector.

Pricing of imported inputs, especially fuel and machinery at import parity, are important to reduce price-induced shortages and reflect the actual costs of production.

As sorghum could develop into an important source of export earnings from export sales, the practice of valuing the crop at the commercial rate should remain and the present movement toward a unified exchange rate should be maintained.

The Traditional Rainfed Subsector

While this subsector could have been the most flexible and dynamic in adjusting to changing economic conditions, the long-term effects of the drought, especially in North Darfur and North Kordofan, could be serious. There is no way of knowing how many outmigrants will return to their land. Hence, assuming that price incentives still exist as a result of the drought, increases in production could be constrained by the availability of seed and labor.

Sesame, groundnuts, gum arabic, and livestock are the major export earners from this subsector. In 1985, groundnut seed will be imported for these areas. The 1984/85 season resulted in a 60-percent drop in gum arabic production and an associated drop in foreign exchange earnings. Reform of gum arabic pricing is a major policy issue facing the Government. While Sudan has a world monopoly in gum arabic exports, the full incentives resulting from devaluations are not passed on to producers but are instead used to generate tax revenues.

As the drought also affected the livestock population in this subsector, rebuilding herds will be a major task facing livestock owners. The prospects of increased export earnings from livestock will depend upon the time required to expand and rebuild herds.

Intersectoral and Macropolicy Linkage Issues

Policy changes, especially at the macro level, affect all three subsectors. For example, exchange rate adjustments affect the structure of incentives and relative competiveness both intrasectorally and intersectorally. Furthermore,

both the production and supply response to changing prices, especially devaluations could be different due to differences in intensity of traded input use, level of technology, and institutional factors. Hence, an analysis of macropolicy changes should attempt to trace the effects of these changes both intrasectorally and intersectorally. 12/ This can be illustrated with the results of exchange rate adjustments on the international competitiveness of Sudan's export crops, which are produced in all three subsectors. While cotton is produced principally in the irrigated subsector, groundnuts are produced in the irrigated and traditional rainfed subsectors. Sesame is produced in the mechanized and traditional rainfed subsector, and sorghum is produced in all three subsectors.

Associated with this diversity in production of crops are locational differences in production such as soil type and rainfall variability (due to the vast land area of Sudan and the Nile water resources), differences in infrastructure, transportation, and levels of technology. These differences affect the cost of production, the relative intensity of traded and nontraded inputs, the production process, marketing channels, and relative profitability of the crops. As export sales of these crops are also used to generate government revenues through indirect and direct taxes, the financial profitability of a crop could vary from its economic profitability. Hence, the effects of exchange rate changes should be analyzed taking into account these various differences. Furthermore, relative commodity price changes (as a result of exchange rate changes) should be traced in a dynamic rather than static context. Devaluation should align domestic prices with international prices so as to increase the competitiveness of a commodity. These price changes could also affect the demand for inputs, lead to changes in subsectoral output and input mix, and affect intersectoral commodity and input flows.

For example, increasing costs of production for cotton in the irrigated subsector could lead to fertilizer being shifted away from cotton to sorghum or groundnuts in the irrigated subsector, thereby affecting the overall output levels of all three crops. Similarly, decreases in fertilizer use for cotton could lead to fertilizer being used in the mechanized rainfed sector, thereby leading to increased mechanized sorghum production. Fertilizer distribution is presently administered by the Government, and its application is limited to cotton and wheat in the irrigated sector. An intersectoral analysis of changes in the distribution mode and pricing of fertilizer is necessary especially as fertilizer is a traded input and is only available in limited quantities in the country. As fertilizer is priced administratively and not on economic criteria, a discrepency exists between the opportunity cost at the subsectoral level and the financial cost paid by the tenant in the irrigated subsector. Hence, decisions on fertilizer allocation should be made on the basis of an analysis of net foreign exchange earning response of each crop to fertilizer in addition to agronomic recommendations.

12/ The author is presently working on the development of a multi-commodity simulation model which will analyze the intrasectoral and intersectoral effect of pricing changes (as through devaluations) on production, government revenues, and foreign exchange earnings.

Meeting food and fodder needs within the irrigated area could be a major problem which could be met by changing crop area allocations in the irrigated schemes. In addition to drought-induced price increases for food crops and reduced production levels of cash crops such as groundnuts and sesame, migration within the traditional rainfed subsector and between the traditional rainfed and irrigated subsectors has also occurred. These migrations have increased human and livestock population concentrations along the White and Blue Nile as well as within the irrigated subsector in schemes like Gezira. A major reason for migration into the irrigated schemes was the availability of water and fodder for livestock and employment and food for the human population. As cotton in the irrigated schemes is picked manually, wages are paid both in cash and in kind. As increases in the price of sorghum increased value of in-kind wage payments, cash wages remained constant through the 1984/85 picking season rather than increasing between each picking, reflecting the availability of labor in the schemes.

The increased human and livestock populations have put additional pressures on the land and water resources of the irrigated subsector. If adequate rainfall does not materialize in western Sudan and if a reverse migration does not take place, these pressures will continue on the irrigated subsector. This will increase the demand for both sorghum and fodder in the schemes. Even without the migrants, tenants on irrigated schemes like Gezira have large livestock populations which are prohibited from entering the scheme until the end of the cotton season. With the migrants, both the human and livestock populations in the irrigated subsector are doubled.

PROSPECTS FOR AGRICULTURAL RECOVERY AFTER THE DROUGHT

Central to any discussion concerning agricultural recovery lie assumptions concerning the length of the present drought, the possibility of recurrence of drought, and the role to be played by irrigated agriculture in a country facing foreign exchange shortages. As noted earlier, there has been a change in rainfall patterns at least in western Sudan which has led to a reduction in length of growing season in parts of North Kordofan and North Darfur. Should the present rainfall patterns continue, then changes in production patterns of crops and by subsector could be anticipated.

In the short term (that is, up to 1990), increased emphasis on sorghum production will be in the mechanized producing areas. Area expansion will not likely take place at the rate of the late seventies and early eighties in the mechanized subsector. Therefore, increased emphasis will need to be placed on agronomic research, particularly cultural practices and use of fertilizer in these areas. It is possible that with adequate rainfall in 1985, production in these areas could reach pre-drought levels of 2.1 million tons of sorghum. Also, the availability of the new sorghum hybrid, which could double yields in the mechanized areas, could affect dramatically the production level. However, sufficient hybrid seed would need to be produced each year for use in both the mechanized and irrigated subsectors to improve the competitiveness of Sudanese sorghum.

Expansion of area under sesame production in the mechanized areas could result if newly available shatter-resistant varieties are adopted. Furthermore, should the Jonglei canal be completed, expansion of mechanized production

could occur in the Southern Clay Plains and infrastructure will be in place to link the area with the urban or export markets.

Planned expansion of infrastructure, especially the proposed USAID and African Development Bank cofinanced road from Kosti to El Obeid and to En Nahud will have a major effect on the producing areas in western Sudan, especially for groundnuts and sesame. Recovery of gum arabic in the west will depend on the extent to which pricing reforms, return migration, and normal rainfall patterns take place. Should adequate rains return in the 1985 season and should these continue, Sudan's rainfed sector could once again emerge both as a provider of food and as a source of foreign exchange earnings.

A major issue facing the traditional rainfed subsector is the return of migrants to their homes in western Sudan. As population dislocations and internal migrations have caused individuals to migrate toward the Nile system, the extent to which these individuals decide to stay in the irrigated areas and work as hired laborers or sharecroppers would have implications both for the traditional rainfed areas and the irrigated subsector. The migrants may opt for stability in income and food (as cotton pickers in the irrigated areas are paid part of their wages in sorghum) rather than returning to the uncertainties of weather in western Sudan. Increased labor availability in the irrigated areas could affect the perceived labor shortage for cotton picking and affect production levels in the irrigated subsector.

As the level of the Blue Nile is a determining factor in water availability and hence cropping patterns for the irrigated subsector, prospects for agricultural recovery in the irrigated subsector depend on flow of the Blue Nile. The low level in 1984 emphasized the need to reevaluate present cropping patterns in the irrigated schemes like Gezira. While there may not be any major changes in cropping patterns in the next few years, there may be adjustments in areas allocated to food crops such as sorghum and wheat as compared with groundnuts and cotton.

Recent macroeconomic changes affecting the exchange rate used for valuing cotton and irrigated subsector inputs, together with enhanced cost recovery through increased charges for land and water and restrictions on government-provided credit to the schemes, could lead to changes in cropping patterns in the irrigated subsector. These changes could also be influenced by the recovery of world cotton prices and Sudan's improvement of the marketing of its cotton.

Due to the importance of agricultural exports in Sudan's foreign exchange earnings, recovery of the agricultural sector is crucial to the country's economic recovery. However, improvement in agricultural exports will in itself not be sufficient to overcome debt repayments and import requirements. Sudan is known to have substantial oil reserves, but exploration has been halted as a result of continued armed conflict in the south. Resolution of this conflict would affect not only export earnings from oil, but also completion of the Jonglei canal and a reduction of the drain on the treasury caused by increased defense expenditures.

CONCLUSIONS

Sudan's policy reforms aimed at increasing agricultural and food production may have incomplete results because its agricultural economy has structurally and institutionally distinct subsectors, particularly when the assumptions about the operation of the agricultural sector underlying these policies are proven incorrect, as happened in Sudan during the great drought of 1984. The failure of the Blue Nile flow to sustain both cotton and wheat production in the irrigated schemes, and the sharp drop in rainfed sorghum production due to the drought, severely affected the Government's policy objectives of increasing food self-sufficiency and raising foreign exchange earnings in that bad year. The problems facing the Government were compounded by large-scale population dislocation, which further hindered the task of distributing food aid.

The above experience shows the need for detailed and timely analysis of each of the subsectors comprising the agricultural sector, and particularly the aspect of decisionmaking about cropping patterns, input use, and marketing of output in each of these subsectors, and the way in which they are interrelated through the forces of supply and demand, price determination, employment, and income generation. Such analysis will make planning for Sudan's recovery from its multiple economic and agricultural problems more meaningful.

The donor-initiated policy reforms like exchange rate adjustments, tailoring of price incentives, institutional changes in the irrigated subsector, and reduction of consumer subsidies on wheat bread, sugar, and petroleum products affect various groups differently, making pertinent analysis all the more necessary before major concerns can be addressed properly. Such concerns include movement towards a unified exchange rate, enhancement of incentives to producers of export crops, greater freedom for tenants in the irrigated subsector in use of modern inputs and choice of technology in production, and provision of seed and fuel to the rainfed subsectors.

The major lesson with respect to policy options in Sudan would appear to be that policy reforms have inadequately met the challenge of sustaining a viable economy (not to mention such ambitions as becoming the "breadbasket of the Middle East"). The overriding influence of weather can blunt such a challenge. However, good weather by itself will not result in bumper crops if policies exert a restraining negative effect.

However, if macroeconomic policy changes already enacted are maintained, a resumption of normal rainfall and river flows should lead to agricultural recovery. In these circumstances, Sudan could produce adequate sorghum for domestic consumption again as early as 1985. Prospects for longer term economic recovery are related to factors such as domestic political stability.

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