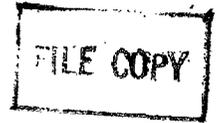


Report No. 4528a-SU

# Sudan

## Pricing Policies and Structural Balances



(In Three Volumes) Volume III: Agriculture In Sudan

November 10, 1983

Country Programs Department  
Eastern Africa Regional Office

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### CURRENCY EQUIVALENTS

Currency Unit - Sudanese Pound (LS)

LS 1.00 = 100 piasters (pt) = 1,000 milliems (mm)

LS 1.00 = US\$0.77  
US\$1.00 = LS 1.30 1/

### WEIGHTS AND MEASURES

1 mile (mi)	=	1.61 kilometers (km)	
1 feddan (fd)	=	0.42 hectare (ha)	= 1.04 acres (ac)
1 metric ton (mt)	=	1.1 short tons (t)	= 2204.5 pounds
1 kantar of seed cotton (K)	=	143 kilograms (kg)	= 315 lb
1 kantar of cotton lint (k)	=	50 kg	= 110 lb
1 bale of cotton	=	191 kg	= 420 lb
1 rottle	=	0.455 kg	= 1.0 lb
1 UK gallon	=	4.54 liters (l)	= 1.2 US gallons

All gallons are UK gallons (equal to 1.2 US gallons).

All tons are metric tons.

All dollars (\$) are United States dollars (US\$).

ths = thousands

mls = millions

### Fiscal Year

July 1 - June 30

The following conventions are used for years:

Fiscal - 1979/80

Calendar - 1980

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1/ For a history of recent exchange rate movements, see Annex 1, Table 6.8.

SUDAN

PRICING POLICIES AND STRUCTURAL BALANCES

AGRICULTURE IN SUDAN

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SUDAN  
PRICING POLICIES AND STRUCTURAL BALANCES

ANNEX 2: AGRICULTURE IN SUDAN

Introduction

This annex provides the details of the analysis that lies behind the conclusions presented in Chapter 3 on the agricultural sector in Sudan.

The first section examines the trends in yields in the agricultural sector over the past 20-25 years, giving details by crop and class of cultivation (irrigated, mechanized rainfed and traditional rainfed). On the basis of this analysis, the major sources of growth (and decline) during the period are identified.

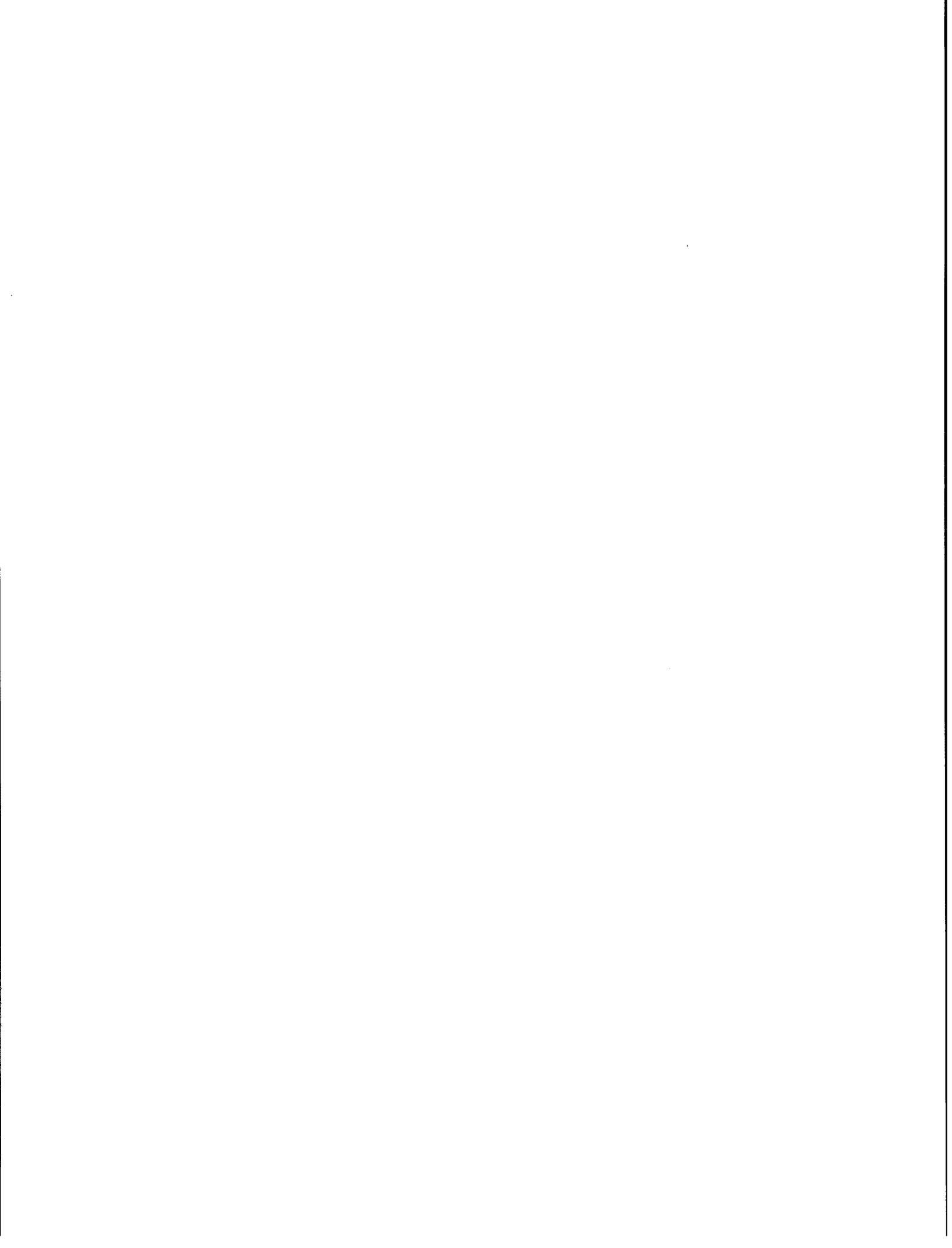
The second section seeks to identify the price incentives to agricultural production, in both nominal and real terms, and relative to other activities.

The third section examines the comparative advantage of various crops in the Sudan grown under different conditions.

The fourth section seeks to identify degree and sources of capital intensity in agricultural production in Sudan. This issue is particularly important because capital intensity seems to have been increasing at the same time that capital has become increasingly scarce. The annex also reviews the foreign exchange dependence of alternative crops.

In the past it has often been argued that there is a shortage of labor to carry out critical agricultural operations. The fifth section reviews the evidence and concludes that the scarcity is more apparent than real, reflecting not an absolute scarcity of labor, but inadequate wage rates.

The final section of this annex reviews the effect of transportation costs in this vast country on agricultural costs and the role of informal credit in supporting agricultural production.



YIELD TRENDS AND SOURCES OF GROWTH IN AGRICULTURE

1. Tables 1 and 2 give the average yields and least square growth rates for crop yields estimated for three distinct periods:<sup>1/</sup>

- (1) 1965/1973, a period before the oil shocks, the rising price of imported inputs and the focus of investment resources on area expansion;
- (2) 1974/1981, a period following the oil shocks of 73/74 and the end of the civil war; a period closely associated with expanded public investments, increasing imports, declining real export earnings from agriculture, increasing debt obligations and foreign exchange constraints;
- (3) 1981/1983, the years associated with urgent measures to rehabilitate the agricultural sector and changing policies designed to help the economy adjust to the oil shocks and rising external debt.

Average Yields

2. Average yields for long staple cotton declined after 1973 and have still not yet recovered to their pre-1974 levels. Average yields for medium staple cotton rose after 1973, while those for groundnuts fell by the end of the decade after showing considerable improvement in the mid 70's.

3. Average yields were lower between 1974/81 than in the earlier period for wheat and sorghum in the irrigated sector and all crops except sorghum and short staple cotton in the rainfed sector; they were significantly higher for irrigated groundnuts. Yields have yet to recover to their pre-1974 levels for irrigated wheat and sorghum, and for groundnuts, sesame and millet in the rainfed sector. In the Gezira cotton yields for all crops in 1981/83 remained below the 1971/81 averages (ref. Table 1).

Growth Rates in Crop Yields

4. The growth rates on yields since the mid sixties are distinctly different for the irrigated and rainfed sectors.<sup>2/</sup>

5. In the irrigated sector, where the main crops are cotton, sorghum, groundnuts and wheat:

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<sup>1/</sup> All tables are located at the end of each annex.

<sup>2/</sup> The conclusions on the growth rates may appear to conflict with those derived from average yields. The data are however consistent; the average yield figures focus attention on changes between periods, while the growth rates focus attention on changes during periods.

- (i) the period from 1965/73 saw generally increasing yields due to the use of higher levels of inputs, good management and intensification. During this period the flow of essential inputs--water, fertilizers, pesticides, seeds, machine services--was well managed and assured. Yields increased dramatically specially in the Gezira;
  - (ii) the period from 1974/81 saw a dramatic decline in yields with negative growth rates for all the crops. This pattern is most evident in the Gezira, but occurred throughout the irrigated sector. During this period the flow of essential inputs was interrupted, the financial viability and physical condition of the schemes deteriorated and the quality of management in the sector declined resulting in declining yields;
  - (iii) the period from 1981 to the present has seen a dramatic improvement in yields, particularly in the Gezira.
6. In the rainfed sector where sorghum, groundnuts, sesame, millet and gum arabic are as major crops:
- (i) the period from 1965/73 saw generally decreasing yields which were probably weather-related, but may in part also have been due to a relative neglect of the sector;
  - (ii) the period from 1974/81 saw generally increasing yields for rainfed groundnuts, millet and short staple cotton and slowly decreasing yields for sesame. These increases for groundnuts and millet were weather-related as generally better weather conditions prevailed in rainfed areas. The decreases in sorghum yields were related to the growing role of the mechanized rainfed sector which follows low intensity extensive cultivation practices.
  - (iii) the period 1981/83 has seen major decline in rainfed yields--groundnuts (-10% p.a.), sorghum (-16% p.a.), millet (-29%). These declines were partly weather-related and in part due to input scarcities and poor incentives.

#### Sources of Growth

7. Using production, yield and average data for various crops between 1971-83 we are able to decompose the changes in production experienced in this period into their yield and area components--that is estimate the proportion of the changes in output that can be attributed to changes in areas compared to those that can be attributed to changes in yields. These results are reported in Table 3. The first column shows the average annual percent change in total output and the next two their decomposition into area and yield effects. The last column gives the proportion of the change in total output that can be attributed to yield changes alone.

8. Several important findings emerge from this analysis:

- (i) most of the changes in output can be attributed to changes in areas planted to the various crops. This is true whether or not on the average output has decreased (e.g. long staple cottons and irrigated sorghum) or increased (e.g. groundnuts and rainfed sorghum). The exceptions are short staple cotton, sesame and wheat where yield effects have tended to be marginally more important;
- (ii) for the major rainfed crops--groundnuts, sorghum, area effects dominate;
- (iii) most of the crops have experienced declining yields with some important exceptions--medium and short staple cottons, irrigated groundnuts and wheat. But for a number of important crops declining yields have been offset by increased acreages so that output has continued to increase. This is particularly true of rainfed groundnuts and sorghum (both mechanized and traditional).
- (v) In the irrigated sector changes in output are dominated by yield effects for groundnuts and sorghum and by area effects for wheat. For cotton, although the area effects dominate, much of the change in areas can be accounted for by a switch from long staple to medium staple cottons;
- (vi) for both long staple cotton and irrigated sorghum, which have experienced a decline in output, declining yields have played an important role.

9. This analysis tends to support the two basic premises on which the short term strategies for the recovery of the agricultural sector have been based, namely: In the rainfed sectors, output changes can be readily made by expanding or contracting the areas planted, because land in general is not a constraining factor. It is the other resources--inputs, labor, transportation and above all viable technologies--that are major constraints. Strategies for increasing output in this sector will have to rely mainly on area expansion in the short run while in the longer term a major effort will have to be made in providing the research, transportation and institutional infrastructure needed to make this sector more productive and export oriented. All the same efforts will be needed to establish cultivation practices consistent with the long term productivity of the soil. In the irrigated sector (and mainly government managed schemes), output changes have to rely more heavily on changes in the yield components as the potential for area expansion is limited in the short run due to the high capital costs of developing new irrigation schemes and the limits on the availability of water under the Nile Water Agreement. Efficient management of resources and incentives will be needed to reverse the generally declining yield trends of recent years. Strategies in this sector must focus on

providing the necessary inputs, management and incentives needed to increase yields. In the longer term, more irrigated areas can be brought under cultivation once the Jonglei canal is completed and additional water is available.

10. Table 4 compares the recent yield performance of selected crops in Sudan with the performance in other countries. For the main irrigated crop cotton yields are far below comparable yields in Egypt and way below those in the US and Israel. This is also true for wheat compared to India, Egypt and Pakistan, and groundnuts and sorghum compared to China and the U.S. This suggests that, even taking account of differences in soil, climate and water availability, the scope for increasing yields is large in the Sudan.

11. However, there will be a price to pay for increasing yields beyond the historical levels achieved before 1974. There is some though not conclusive evidence (from controlled experiments over 50 years on cotton in Gezira) that after the introduction of intensification and the elimination of fallows from the cropping patterns, base yields (with zero fertilizer use) have been dropping due to reduced fertility of the soils.<sup>3/</sup> This can only be offset by, (i) reintroducing fallows (and reducing intensities), (ii) introducing new varieties of legumes in the cropping rotations, and (iii) increasing fertilizer inputs at a higher marginal cost per output.

12. But before further increases in nitrogen inputs are allowed in the irrigated sector, careful comparisons should be made to see whether at the margin it would be more desirable to increase nutrient use in the irrigated sector (going from, say, 2N to 3N per feddan on cotton)<sup>4/</sup> or to increase nutrient use in the rainfed sectors (going, say, from zero use to 1N per feddan on cotton), at least in areas where rainfall is relatively reliable. At present, little attention is being paid to evaluating the trade-offs between the use of critically short traded inputs (fuels, fertilizers and machinery) in the irrigated vs. the rainfed sectors, and the choice between increasing investments at the intensive vs. extensive margins. In the longer term, when additional irrigated areas can be brought under cultivation via water from the Jonglei canal, an evaluation will have to be made on whether, at the margin, it is more effective to increase intensification and fertilizer use on existing irrigated areas or exploit new irrigated areas.

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3/ This detailed experimental work has been done by Dr. H. Ishaq at A.R.C.

4/ 1N is equal to 40 lbs of nitrogen per feddan.

**Table 1**  
**SUDAN: AVERAGE CROP YIELDS**  
(Yield of Cotton in K/fd and Other Crops in kg/fd)

Crop	1965/73	1974/81	1981/83
<u>All Sectors</u>			
Cotton	3.3	2.9	3.3
Long Staple	4.4	3.2	3.1
Medium Staple	2.6	3.3	
Groundnuts	330.1 <sup>(a)</sup>	375.3	317.4
<u>Irrigated</u>			
Groundnuts	667.8 <sup>(a)</sup>	892.0	717.6
Wheat	514. <sup>(a)</sup>	434.6	450.0
<u>Gezira</u>			
Cotton (LS)	-	3.8 <sup>(c)</sup>	3.3
Cotton (MS)	-	4.8 <sup>(c)</sup>	4.6
Groundnuts	723.6 <sup>(b)</sup>	1057.4	667.3
Sorghum	647.4 <sup>(b)</sup>	506.0	378.1
Wheat	523.5 <sup>(b)</sup>	450.1	434.1
<u>Rainfed</u>			
Groundnuts-Rainfed	273.7 <sup>(a)</sup>	266.0	246.4
Sesame-Total	144.0 <sup>(b)</sup>	100.0	113.8
Cotton-Short Staple	0.88	0.91	1.38
Millet-Total	222.9 <sup>(a)</sup>	153.8	167.8
Sorghum-Rainfed	100.7 <sup>(b)</sup>	185.7	-

a) 1962/1973; b) 1971/73; c) 1971/81

Note: 1 Kantar (K) of seed cotton weighs 143 kg.

**Table 2**  
**SUDAN: GROWTH RATES IN CROP YIELDS**

Crop	1965/73	1974/81	1981/83	Long Term Growth
<u>All Sectors</u>				
(Percent per Annum)				
Cotton	6.4	-6.9	36.3	0.4(d)
(Long Staple)	3.0	-10.5	37.0	-0.6(d)
(Medium Staple)	2.9	-0.1	24.7	2.6(d)
Groundnuts	-0.9(a)	-1.6	-3.8	-
<u>Irrigated</u>				
Groundnuts	1.3(a)	-2.5	8.3	1.7(e)
Wheat	-1.9(a)	-5.1	41.1	-1.3(e)
<u>Gezira</u>				
Cotton (LS)	-	-8.3(c)	37.7	-4.7(f)
Cotton (MS)	-	-2.6(c)	37.1	-0.8(f)
Groundnuts	74.4(b)	-6.8	15.1	0.6(f)
Sorghum	40.5(b)	-11.2	32.9	-4.6(f)
Wheat	31.0(b)	-9.7	54.7	-2.3(f)
<u>Rainfed</u>				
Groundnuts	-2.8(a)	1.3	-10.5	-0.9(e)
Sesame	-13.2(b)	-0.6	4.2	-2.1(f)
Cotton(Short Staple)	-0.7	7.0	30.4	-0.2(d)
Millet	-3.6(a)	5.3	-28.9	-3.1(e)
Sorghum	-6.0(b)	-0.0	-15.5	-0.7(f)

(a) 1962/73; (b) 1971/73; (c) 1971/81; (d) 1954/83; (e) 1962/82; (f) 1971/83.

**Note:** All growth rates are based on least-squares log-linear regression estimates.

Table 3  
SUDAN: SOURCES OF CHANGE IN AGRICULTURAL OUTPUT (1971/83)

Crop	Average Annual Percent Change in Output:			Proportion of Change in Output Attributed to Yield
	Total	Area Effects	Yield Effects	
<u>All Sudan</u>		(Percentages)		
Cotton	-13.9	-12.1	-1.8	13.0
Long Staple	-30.9	-16.8	-14.1	45.8
Medium Staple	16.2	13.3	2.9	18.1
Short Staple	0.8	-2.3	3.1	57.9
Groundnuts	13.5	18.2	-4.7	20.2
Irrigated	5.1	3.3	1.8	36.2
Rainfed	8.5	12.5	-4.0	24.1
Sesame	-13.1	-6.1	-7.0	53.0
Wheat	1.4	0.7	0.7	51.0
Sorghum	43.2	77.3	-33.9	30.5
Irrigated	-3.1	-2.0	-1.1	36.7
Rainfed	46.3	74.4	-28.1	27.4
Mechanized (1974-83)	33.9	62.4	-21.3	31.3
Traditional (1974-83)	12.7	21.8	-9.1	29.5
Rice	0.5	0.5	-0.0	3.1
<u>Gezira Only</u>				
Cotton	-19.8	-10.0 <sup>*</sup>	-9.8	49.2
Cotton	6.7	6.6	0.1	1.1
Groundnut	4.8	0.0	4.8	100.0
Sorghum	-1.6	0.9	-2.5	73.4
Wheat	6.7	4.2	2.5	37.0

**Table 4**  
**RECENT YIELD PERFORMANCE OF SELECTED CROPS IN SUDAN**  
**AND OTHER COUNTRIES**  
**(Kg/ha)**

	1979	1980	1981	1982	Average
<b>Cotton Lint</b>					
Egypt (a)	878	963	1012	1045	976
USA (a)	-	1109	1252	1216	1192
Israel (b)	1335	1323	1352	1437	1362
Sudan (a)	820	684	618	1058	795
<b>Groundnuts (b)</b>					
China	1366	1503	1431	-	1433
India	797	727	800	-	775
USA	2927	1849	2974	-	2583
Sudan	862	894	828	-	861
<b>Sorghum (b)</b>					
USA	3423	3935	2903	4025	3572
India	708	699	673	719	700
China	2328	2412	2387	2500	2407
Sudan	274	363	746	897	570
<b>Wheat (b)</b>					
Pakistan	1316	1488	1563	1640	1502
Egypt	3323	3177	3225	3162	3222
India	1480	1568	1436	1650	1534
Sudan	731	1257	736	1137	965

**Source:** Commodities Division, EPD, World Bank.

- (a) Irrigated  
(b) Irrigated and Unirrigated

Annex 2.2

PRICE INCENTIVES IN AGRICULTURE

1. Price incentives (along with the timely availability of inputs) are critical to motivating producers to achieve higher yields and output. Both the schemes and the producers are likely to gain if producers prices are gradually but continually adjusted towards their border price equivalents and the exchange rate is adjusted to reflect the proper opportunity cost of inputs and outputs.

2. To see how price incentives effect production we need to evaluate them in real and relative terms--that is adjusted for inflation and relative to border prices, relative to other input and output prices and relative to other goods farmers have to purchase as reflected in the consumer price index.

Border and Domestic Prices.

3. First, consider domestic producer prices in relation to their producer price equivalents. Table 1 gives the relevant data. Several points can be made:

- (a) both the nominal f.o.b. and domestic producer prices have been rising rapidly for the period for practically all crops; domestic prices have risen dramatically for cotton and sorghum;
- (b) domestic producer prices have been higher than their border price equivalents for sorghum and wheat, suggesting a positive protection for these crops and hence an incentive to increase production;1/
- (c) domestic producer prices have been lower than their border price equivalents for groundnuts, sesame and for cotton (specially after 1974). This suggests that there has been a "negative protection" to domestic producers (prices received are lower than under free trade) and a positive benefit to domestic consumers.2/

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1/ These ratios actually underestimate the nominal protection. Strictly speaking border price equivalents would have to adjust for processing, marketing and transportation costs. The ratio of the domestic price to the adjusted border price is the nominal protection coefficient (NPC) and its value greater than unity indicates a positive protection to producers (and a tax on consumers) compared to the "free trade" case.

2/ In this case the ratios overstate the negative protection as adjustment for other costs would have reduced the border price equivalents and hence the value of the ratios.

### Domestic Terms of Trade

4. No time series data are available for input and output costs and net farm incomes for Sudan so that effective protection rates cannot be determined. It is possible, however, to calculate the barter and income terms of trade for the major crops. This analysis is presented in Tables 2 and 3.

5. Deflating the index of producer prices by the consumer price index for low income groups in urban areas, (as a proxy for the rural consumer price index)<sup>3/</sup> we calculate the net barter terms of trade (ref. Table 2). The results show that although nominal producer prices increased dramatically in Sudan between 1972 and 1981, the real producer prices (the barter terms of trade) declined for wheat and sesame. For cotton, while the ex-store prices paid to the SGB increased over four folds between 1972/81, the barter terms of trade suggest a decline in real terms of around 20 percent by 1980/81.<sup>4/</sup>

6. By estimating the total value of domestic production at producer prices we can calculate the index of gross producer incomes. Deflating this by the urban-CPI proxy gives the real income terms of trade. (These refer to gross income because costs of inputs have yet to be deducted to get net incomes). Again, the results show that whereas gross nominal incomes have risen dramatically for all crops, real crop incomes have declined for cotton, wheat and sesame but have risen for sorghum and groundnuts. These trends help explain the tendency for farmers to shift out of cotton, wheat and sesame production and into sorghum and groundnuts where these crops compete for land. As expected in the traditional rainfed areas, sorghum and groundnut production have gained at the cost of short-staple cotton. In the irrigated subsector, wheat, sorghum and groundnuts have gained at the cost of cotton production. In the rainfed mechanized areas sorghum production has increased dramatically. Real gross producer returns--induced by relative price incentives--have been a major factor in explaining the production shifts in the past decade in Sudan--shifts that have seen the production of cotton and its exports decline dramatically.<sup>5/</sup>

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<sup>3/</sup> There are no data available to allow the construction of a rural consumer price index as no rural expenditure surveys have been undertaken. This is a major gap in the data. As sorghum is the main food staple in rural areas and between 60-80% of the rural consumer expenditures usually go to food items, the price of sorghum could serve as a useful proxy for the rural CPI. But domestic sorghum prices have been extremely volatile and distorted due to Saudi incentives for export. We, however, have data on sorghum prices prevailing in the Gezira which are likely to be less volatile, and can be used as a deflator. The CPI (urban-low) may be an underestimate of the rural CPI were one available. Further when we are looking at relative incentives among crops, the choice of the deflator does not matter.

<sup>4/</sup> We do not have later data as these prices are calculated from SGB accounts for which data are available only from 1972 to 1980.

<sup>5/</sup> The decline in the barter and income terms of trade for cotton seem even greater when sorghum prices are used as a deflator. See Table 3.

### Returns in the Gezira

7. For the irrigated sector we can go even further as we have data on both gross and net returns (net of input costs and other expenses) to crop production in the Gezira for the period 1972-80. These values shown in Table 4/ in both nominal and real terms, make the point even more dramatically. Real net returns to all crops have declined sharply in the Gezira between 1973 and 1980. They declined relatively more for cotton than for other crops. Net returns to cotton declined by 80%, groundnuts by 73%, wheat by 52% and sorghum by 50% over the period.<sup>6/</sup> In this period the Gezira experienced a decline in cotton production from an average of 449,000 mt in 1970/71 to a low of 181,000 MT in 1980/81--a decline of over 40%.

8. In 1981 and 1982 however, producer prices, especially for cotton, appear to have improved considerably, and the cotton prices that are to be paid to producers are announced ahead of time. Accounts on costs of production are kept for each individual crop and each tenant separately. Each tenant can now calculate for himself what his net returns from each crop will be--both for the cotton he has to sell to the SGB and the other outputs which he is free to sell on his own.

9. As producers finally begin to respond to the real returns to their individual effort, there is a need to evaluate this new system of production relations in the irrigated schemes to assure that producers continue to feel better off. There is some evidence that in the Gezira Scheme a change from the joint to the individual accounts system in the 1979/80 season, though increasing the overall net returns to cotton, led to a decline in average incomes and an increase in income inequalities a natural development consistent with the drive to provide better incentives to efficient producers.<sup>7/</sup> The effect of the new system of individual accounts, though beneficial at the outset, needs to be carefully studied and monitored.

10. Finally, there is also the question of whether these irrigated schemes should continue to be run as large top-down state farms with as little initiative as possible allowed to tenants. Since tenants had little leeway to plan their area allocation to different crops, were provided all services by the schemes and after deduction of individual costs, were given the residual as income, there was little incentive for them to allocate additional resources to the controlled cotton crop. Instead, effort in the past has been directed towards uncontrolled activities--wheat, sorghum, vegetable production, livestock activities and specially a variety of non-farm enterprises--from which the tenants stood to reap higher benefits for their effort. The change towards the individual accounts is a step in the right direction because it gives the tenants better information on the real returns to their resources and hence allows more efficient allocation of their efforts. But tenants are still not free to choose what crops to grow, what inputs and services to use and from what source and where to sell the output. Consideration needs to be given to

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<sup>6/</sup> The declines are even more pronounced if Gezira sorghum prices are used as a deflator. These results are shown in Table 5.

<sup>7/</sup> Ali Abdel Gadir Ali and Huda Abdel Sattar, "On Production Relations in Sudanese Irrigated Agriculture," University of Gezira, June 1981.

measures to further place choice and consequences more in the hands of the tenants, and less in the hands of the schemes and their managers. The constant refrain heard in Sudan that "if left to themselves the tenants would not grow cotton" does not bear weight, for millions of farmers around the world grow cotton without being forced to do so; and Sudan has the natural resources required to become an efficiently competitive producer of cotton for world markets. It is a matter of providing incentives at the farm level so that cotton becomes the most profitable crop to the peasants, as it is deemed to be the most profitable crop for the nation.

11. In an excellent study of water allocations in the Gezira, Hamid Faki has shown how scheme level and tenant objectives are often in conflict.<sup>8/</sup> Tenants have adopted a method of unattended night watering and other measures to rationalize the allocation of water to various crops by reducing labor input for irrigation--thus essentially bypassing scheme regulations. He states that:

"Within the limits of freedom attained under the existing situation, the tenant shifts resources, especially irrigation water, from cotton growing to the production of other crops which yield more returns to scarce resources than cotton does at current prices. If, however, the tenant were completely free to decide, he would grow no cotton and would increase the production of wheat and sorghum instead. This is in opposition to national efficiency criteria where cotton yields the highest returns to scarce resources at economic prices. If the contradiction between the micro and macro economic levels are to be minimized within the existing situation, other price relationships should prevail at the farm level.<sup>9/</sup>

12. As with water so with other inputs, services and crops. Tenants will always seek to meet their objectives which include--in addition to maximizing returns--the needs of subsistence (hence the production of sorghum) and a desire to incorporate livestock into their farm plans. Currently over a million livestock animals exist "unofficially" in the scheme and no allowances have been made for fodder area. Yet the scheme managers continue to believe "that tenants must do what they are told to do", and if they don't, they are somehow behaving perversely. The paternalistic system of relationships by which the schemes have been run may have outlived its usefulness.

13. Some steps have already been taken to study these issues. A number of studies are being planned as part of the Gezira Rehabilitation project to look into these and other related issues in the irrigated schemes. These studies will explicitly examine such issues as the optimal size of the tenancies, the relationship between tenant and scheme level goals, the role of informal shiel credit systems, the possibility of introducing private machinery services, the role of livestock and the crop and input marketing systems in the schemes.

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<sup>8/</sup> Hamid Faki, Economics and Management of Irrigation in the Sudan Gezira Scheme, Doctoral Dissertation, University of Hohenheim, April 1982.

<sup>9/</sup> Op.cit. p.159.

**Table 1**  
**SUDAN: FOB AND PRODUCER PRICES FOR MAIN AGRICULTURAL CROPS**

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
<b>1. FOB Prices (LS/MT)<sup>a)</sup></b>										
Cotton-LS	278.2	337.8	553.8	454.0	842.9	633.9	1080.0	1137.9	1179.4	1346.5
Sorghum	31.3	28.5	34.1	51.4	45.8	41.5	51.3	74.3	101.9	134.1
Groundnuts	86.7	85.0	95.3	195.5	144.2	160.7	206.6	300.3	341.4	565.2
Wheat	38.8	31.9	54.8	71.6	68.5	61.9	49.3	65.9	111.7	132.7
Sesame	100.9	110.4	106.2	207.2	189.8	198.8	206.8	348.3	513.1	689.1
<b>2. Producer Prices <sup>b)</sup></b>										
Cotton-LS (Scheme) <sup>c)</sup>	276.2	335.5	550.0	388.2	714.3	544.0	713.8	821.0	900.0	1200.0
Sorghum	20.0	29.5	43.2	71.0	51.3	48.5	80.4	84.3	180.0	175.3
Groundnuts	28.0	52.0	55.0	59.0	63.0	60.0	70.0	131.0	78.0	263.0
Wheat	37.0	40.0	64.0	65.0	65.0	75.0	75.0	85.0	118.0	160.0
Sesame	-	-	86.0	89.0	110.0	86.0	120.0	198.0	260.0	300.0
<b>3. Producer Prices as a % of Border Prices</b>										
Cotton-LS (Scheme)	99.3	99.3	99.3	85.6	84.7	85.8	66.1	72.2	76.3	89.2
Sorghum	63.9	103.6	126.6	138.0	112.1	116.9	156.6	113.4	176.8	130.6
Groundnuts	32.3	61.1	57.7	30.1	43.7	37.3	33.9	43.6	22.8	46.5
Wheat	95.4	125.3	116.9	90.8	94.9	121.1	151.9	128.9	105.6	120.5
Sesame	-	-	81.0	43.0	58.0	43.3	58.0	56.8	50.7	43.5
<b>4. Index: Ratio of Producer to FOB Prices</b>										
Cotton-LS (Scheme)	100.0	100.0	100.0	86.2.0	85.3	86.4	66.6	72.7	76.7	89.8
Sorghum	100.0	162.1	198.1	216.0	175.4	183.0	245.0	177.5	276.3	204.4
Groundnuts	100.0	189.3	178.5	93.4	135.4	115.6	104.9	135.0	70.7	144.0
Wheat	100.0	131.4	122.5	95.2	99.5	126.9	159.3	135.2	110.7	126.3
Sesame	-	-	100.0	53.0	71.6	53.4	71.6	70.2	62.6	53.8

- a) Converted at the Effective Normal Exchange Rate.  
b) Sources: Sudan Gezira Board, and Internal Trade Statistics, Ministry of National Planning.  
c) This is the price for long staple cotton lint paid to the scheme authorities.

**Table 2**  
**SUDAN: AGRICULTURAL SECTOR: DOMESTIC TERMS OF TRADE**  
(CPI used as deflator) a/

	Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1.	<b>Consumer Price Index</b> (Urban-Low)	100.0	117.1	147.8	182.9	186.2	217.4	260.5	340.9	427.3	532.2		
2.	<b>Producer Prices</b> (LS/MT)												
	Cotton LS (Scheme)	276.2	335.5	550.0	388.2	714.3	544.0	713.8	821.0	900.0	1200.0	1580.0	1920.0
	Sorghum	20.0	29.5	43.2	71.0	51.3	48.5	80.4	84.3	180.0	210.0	262.0	
	Groundnut	28.0	52.0	55.0	59.0	63.0	60.0	70.0	131.0	78.0	263.0	-	801.2
	Wheat	37.0	40.0	64.0	65.0	65.0	75.0	75.0	85.0	118.0	160.0	230.0	280.0
	Sesame	-	-	86.0	89.0	110.0	86.0	120.0	198.0	260.0	300.0	-	640.9
3.	<b>Index of Producer Prices</b> (1972=100)												
	Cotton-LS (Scheme)	100.0	121.5	199.1	140.6	258.6	197.0	258.2	297.3	325.9	434.5	572.1	675.2
	Sorghum	100.0	147.5	216.0	355.0	257.7	242.7	401.90	421.4	900.0	1050.0	1310.0	-
	Groundnut	100.0	185.7	196.4	210.7	225.0	214.3	250.0	467.9	178.6	939.3	-	2861.6
	Wheat	100.0	108.1	172.9	175.7	175.6	202.7	202.7	229.7	318.9	432.4	621.6	756.7
	Sesame (1972=100)	-	-	100.0	103.5	127.9	100.0	139.5	230.2	302.3	348.8	-	745.3
4.	<b>Barter Terms of Trade</b> (3 ÷ 1)												
	Cotton-LS (Scheme)	100.0	103.8	134.7	76.8	138.9	90.6	99.1	87.2	76.3	81.6		
	Sorghum	100.0	125.9	146.1	194.1	137.7	111.5	154.3	123.6	210.6	164.7		
	Groundnut	100.0	158.6	132.9	115.2	120.8	98.5	95.9	137.2	65.1	176.5		
	Wheat	100.0	92.3	117.0	96.0	94.3	93.2	77.8	67.4	74.6	81.2		
	Sesame	-	-	100.0	83.6	101.5	67.9	79.1	99.8	104.6	96.8		

**Table 2(cont.)**  
**SUDAN: AGRICULTURAL SECTOR: DOMESTIC TERMS OF TRADE**  
 (CPI used as deflator) a/

	Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
<b>5. Production</b>		<b>( '000 MT)</b>											
Cotton		684	555	671	647	316	459	559	396	329	304	458	563
Sorghum		1591	1301	1691	1681	1991	1800	2017	2380	1669	2103	3345	2044
Groundnut		387	568	554	928	796	738	1027	813	852	741	720	502
Wheat		124	152	235	269	255	294	317	168	233	130	163	180
Sesame		296	340	240	234	218	247	245	214	209	211	242	140
<b>6. Value of Production at Producer Prices</b>		<b>(Mill. LS)</b>											
Cotton-LS (Scheme)		188.9	185.9	369.1	251.2	225.7	249.7	399.0	325.1	296.1	364.8	723.6	1080.9
Sorghum		31.8	38.4	73.0	119.3	102.1	87.3	162.1	201.1	300.4	441.6	876.4	-
Groundnuts		10.8	29.5	30.5	54.7	50.1	44.3	71.9	106.5	66.5	194.9	-	402.2
Wheat		4.6	6.0	15.0	17.5	16.6	22.0	23.8	14.3	27.5	20.8	-	50.4
Sesame		-	-	20.6	20.8	23.9	21.2	29.4	42.4	54.3	63.3	-	39.7
<b>7. Index of Gross Producer Incomes</b>		<b>(1972=100)</b>											
Cotton-LS (Scheme)		100.0	98.4	195.6	133.0	119.5	132.2	211.2	172.1	156.8	193.1	383.0	572.2
Sorghum		100.0	120.6	229.6	375.1	320.9	274.4	509.6	632.1	944.1	1158.6	-	-
Groundnuts		100.0	272.6	281.2	505.3	462.8	408.6	663.4	982.9	613.3	1799.3	-	-
Wheat		100.0	132.5	327.8	381.1	361.3	480.6	518.2	311.2	599.3	453.3	-	-
Sesame		-	-	100.0	100.9	116.2	102.9	142.4	205.3	263.3	306.7	-	-
<b>8. Income Terms of Trade</b>		<b>(7 ÷ 1)</b>											
Cotton-LS (Scheme)		100.0	84.0	132.3	72.7	64.2	60.8	81.1	505.6	36.7	36.3	-	-
Sorghum		100.0	102.9	155.3	205.1	172.4	126.2	195.7	185.4	220.9	217.7	-	-
Groundnuts		100.0	232.7	190.2	276.3	248.6	187.9	254.7	288.3	143.5	338.1	-	-
Wheat		100.0	113.5	221.8	208.4	194.0	221.0	198.9	91.3	140.2	85.2	-	-
Sesame		-	-	100.0	81.5	92.2	69.9	80.8	89.0	91.1	65.2	-	-

a/ Khartoum Lower Salaried Employees Index

b/ This is the price for long staple cotton lint paid to the scheme authorities.

Sources: Sudan Gezira Board and Internal Trade Statistics.

**Table 3**  
**SUDAN: AGRICULTURAL SECTOR DOMESTIC TERMS OF TRADE**

Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
<b>5. Production</b> ('000 MT)												
Cotton	684	555	671	647	316	459	559	396	329	304	458	563
Sorghum	1591	1301	1691	1681	1991	1800	2017	2380	1669	2103	3345	2044
Groundnut	387	568	554	928	796	738	1027	813	852	741	720	502
Wheat	124	152	235	269	255	294	317	168	233	130	163	180
Sesame	296	340	240	234	218	247	245	214	209	211	242	140
<b>6. Value of Production at Producer Prices</b> (Mill. LS)												
Cotton-LS ((Scheme)	188.9	185.9	369.1	251.2	225.7	249.7	399.0	325.1	296.1	364.8	723.6	1080.9
Sorghum	31.8	38.4	73.0	119.4	102.1	87.3	162.2	201.1	300.4	441.6	876.4	-
Groundnuts	10.8	29.5	30.5	54.8	50.1	44.3	71.9	106.5	66.5	195.0	-	402.2
Wheat	4.6	6.1	15.0	17.5	16.6	22.0	23.8	14.3	27.5	20.8	-	50.4
Sesame	-	-	20.6	20.8	24.0	21.2	29.4	42.4	54.3	63.3	-	89.7
<b>7. Index of Gross Producer Incomes</b> (1972=100)												
Cotton-LS (Scheme)	100.0	98.4	195.6	133.0	119.5	132.2	211.2	172.1	156.8	193.1	383.0	572.2
Sorghum	100.0	120.6	229.6	375.1	321.0	274.4	509.6	632.1	944.1	1158.6	-	1095.6
Groundnuts	100.0	272.6	281.2	505.3	462.8	408.6	663.4	982.9	613.3	1799.3	1200.0	-
Wheat	100.0	132.5	327.8	381.1	361.3	480.6	518.2	311.2	599.3	453.4	-	372.4
Sesame (1974=100)	-	-	100.0	100.9	116.2	102.9	142.4	205.3	263.3	300.7	-	435.4
<b>8. Income Terms of Trade</b> (8÷1)												
Cotton-LS (Scheme)	100.0	66.7	90.5	37.5	46.4	54.4	52.6	40.8	17.4	18.4	29.2	-
Sorghum	100.0	81.7	106.2	105.7	124.6	113.0	126.8	150.0	104.9	110.3	-	-
Groundnuts	100.0	184.8	130.1	142.4	179.6	168.4	165.1	233.2	68.1	171.4	-	-
Wheat	100.0	89.8	151.6	107.4	140.2	198.0	128.9	73.9	66.6	43.2	-	-
Sesame (1974=100)	-	-	100.0	61.5	97.5	91.8	76.6	105.3	63.2	63.1	-	-

Source: Sudan Gezira Board and Internal Trade Statistics.

**Table 4**  
**SUDAN: NOMINAL AND REAL RETURNS TO CROPS IN THE GEZIRA 1972-80**  
(CPI used as deflator)

Unit	1972	1973	1974	1975	1976	1977	1978	1979	1980
<b>Nominal Gross Returns (a) LS/PD</b>									
Cotton	32.2	44.6	39.6	39.0	83.9	45.0	80.7	85.3	31.6
Wheat	19.0	20.0	37.0	25.0	25.0	44.0	49.0	21.0	65.0
Groundnuts	14.0	66.0	69.0	88.0	48.0	52.0	87.0	52.0	90.0
Sorghum	9.0	29.0	43.0	71.0	31.0	32.0	30.0	29.0	52.0
<b>Nominal Net Returns (b) LS/PD</b>									
Cotton	15.1	20.9	18.6	17.6	39.4	21.4	37.9	40.1	14.9
Wheat	7.0	8.0	23.0	7.0	10.0	17.0	20.0	-1.0	14.0
Groundnuts	-1.0	53.0	55.0	70.0	28.0	30.0	63.0	26.0	52.0
Sorghum	-3.0	18.0	58.0	13.0	19.0	20.0	17.0	14.0	33.0
C.P.I. a/ (1970=100)	108.2	120.9	141.6	221.1	225.1	262.9	314.9	412.1	516.0
<b>Real Gross Returns (1973=100)</b>									
Cotton	84.5	100.0	70.4	53.8	118.4	54.3	81.4	65.7	19.4
Wheat	111.3	100.0	146.6	80.0	78.6	118.5	110.7	36.1	89.1
Groundnuts	24.8	100.0	82.8	85.4	45.7	42.4	59.3	27.1	37.4
Sorghum	36.3	100.0	117.5	156.8	67.2	59.4	46.5	34.4	49.1
<b>Real Net Returns (1973=100)</b>									
Cotton	84.5	100.0	70.4	53.8	118.4	54.3	81.4	65.7	19.4
Wheat	102.5	100.0	227.8	56.0	78.6	114.4	112.4	-4.3	48.0
Groundnuts	-2.2	100.0	82.2	84.5	33.2	30.5	53.4	16.8	26.9
Sorghum	-19.5	100.0	255.3	46.2	66.4	59.8	42.5	26.7	50.2

Source: (a) Khartoum Lower Salaried Workers Index. (b) Sudan Gezira Board.

COMPARATIVE ADVANTAGE IN AGRICULTURE: THE EVIDENCE FROM RECENT STUDIES

1. A number of studies of competitive advantage have been carried out recently by donor agencies<sup>1/</sup> and GOS in Sudan. The most comprehensive are also the most recent ones carried out by the Ministry of Finance and Planning.<sup>2/</sup> Some of the results on estimated domestic resources costs (DRC) are shown in Tables 1 and 2. These measure the domestic costs per unit of foreign exchange earned or saved in the domestic production of a commodity and hence the relative efficiency of producing any given commodity domestically as compared to the foreign exchange that could be saved by not importing or earned by exporting.
2. The four basic findings (subject to caveats discussed later) that emerge from these studies can be briefly summarized:
  - (a) Sudan has a clear comparative advantage in the production of nearly all crops for export--with the exception of rice--under the recent conditions of technology, prices and yields prevailing in the country.<sup>3/</sup>
  - (b) Given current yield levels many crops grown under traditional or rainfed mechanized conditions--definitely sorghum and sesame and in some studies wheat and groundnuts--show a higher comparative advantage than their counterparts grown under irrigated conditions.<sup>4/</sup>

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<sup>1/</sup> These are: (a) K. Nashashibi: "A Supply Framework for Exchange Reform in Developing countries: The Case of Sudan." IMF, 1979. (b) C. E. Youngblood, O. I. Franklin and A. Valdez: "The Structure of Incentives in Sudan's Rainfed Agricultural Sector," Sigma One Corporation, Raleigh, Feb. 1982. (c) Ministry of Finance and Economic Planning: "Comparative Study of Cost of Growing Wheat in Sudan and Importing it from Abroad," prepared by the Sudanese Consultation Bureau, Khartoum, Dec. 1982. (d) T. Moe, "Sudan: Export Development Study," Report No.4263-Su, East Africa Regional Office, World Bank, Dec. 1982.

<sup>2/</sup> These are: (a) A. Sattar, "Study of the Cost of Production and Comparative Advantage of Crops under Different Farming Systems in Sudan, UNDP/IBRD, Planning Assistance and Training Project, Ministry of Finance and Planning, Khartoum, May 1982 (draft) and (b) Democratic Republic of Sudan: "Comparative Advantage of Agricultural Products," UNDP/IBRD Planning Assistance and Training Project, Ministry of Finance and Planning, Khartoum, April 1983.

<sup>3/</sup> This is seen by comparing the value of the DRC with the shadow exchange rate (SER). If the DRC per unit of foreign exchange earned/saved is less than the SER, it implies a comparative advantage in producing a product domestically. A SER of LS 1.8/\$ is taken as the basis for comparisons as it is the prevailing parallel market rate.

<sup>4/</sup> This is seen by comparing the DRC's. The lower the absolute value of the DRC the higher its comparative advantage and hence its ranking. The crops in Table 1 are listed in accordance with their ranking in the Moe study using 1982 data.

- (c) Sudan also has a high comparative advantage in producing and exporting livestock--both cattle and sheep.
- (d) Sudan also has a comparative advantage in the domestic production of wheat as an import substitute under certain conditions in irrigated areas.

3. This suggests that Sudan's basic strategy of relying on its agricultural sector for both recovery and export growth is well grounded in economic efficiency and comparative advantage.

4. These findings are, however, conditional on the price, yield and exchange rate assumptions used in the studies, and simple static measures of DRC based on single year data can be misleading. This is specially true for data from 1980/81 because in that year yields had reached an all time low, especially in irrigated areas after a continual six year decline starting in the early 1970s. Cognizant of this fact and recognizing that DRC measures are often sensitive to changes in yields, input levels, prices and the treatment of traded vs non-traded inputs, the latest studies carried out by the GOS attempt to arrive at more robust results by doing extensive sensitivity analysis.<sup>5/</sup> Their findings do not change the major conclusions, but they do show that a recovery to higher yields and hence productivity levels is critical to Sudan's comparative advantage. How critical is evident from Table 2, which shows that at low productivity levels which Sudan has experienced in recent years, even its main export-cotton loses its comparative advantage.<sup>6/</sup> Other crops have a definitely lower comparative advantage. Moe's study also makes the same point by projecting DRCs for 1985-90 on the basis of higher yields (see Table 2) which restore the ranking of irrigated cotton. Due to very low yields experienced in the Gezira in 1980/81, cotton had been placed at the bottom of the rankings.

5. Thus yield increases and the recovery of yields to or above pre-1973 levels are a basic pre-condition for sustaining the comparative advantage specially in the irrigated sector. This only reinforces the importance of maintaining the yield recovery of recent years, especially in the irrigated sector, as an essential ingredient to a recovery program.

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<sup>5/</sup> Democratic Republic of Sudan (1983) op.cit.

<sup>6/</sup> That is, the DRCs exceed the comparable shadow exchange rate of LS 1.8/\$ at the low productivity level. Although the GOS studies assume 'low,' 'medium' and 'high' productivity levels in their sensitivity analysis, they do not identify what these assumptions imply in terms of input use and how they compare to current levels of input use and yields.

6. Continuing devaluations further encourage efficient exploitation of Sudan's comparative advantage for all crops by making traded outputs more competitive and the use of imported inputs--specially in the heavily import dependent irrigated sector--more costly.<sup>7/</sup> But devaluations are only one element; they are not a substitute for increasing productivity in the agricultural sector.

7. All DRC calculations need to be used with caution because they are very sensitive to (a) specification of yield and price levels, and a given year's yield and cost structures need not reflect long term averages; (b) assumptions about transportation costs and hence regional differences in border price equivalents; (c) the costs of non-traded inputs and hence distortions introduced by improper pricing of these inputs<sup>8/</sup> in domestic markets; (d) the selection of appropriate border price equivalents and (e) the choice of the 'shadow exchange rate' at which to evaluate border prices. Nonetheless they provide a useful first approximation of the true comparative advantage, especially if sensitivity analysis has been carried out. This has been done in the case of the GOS studies, making their conclusions more robust and acceptable.

8. The second and perhaps more controversial conclusion is that the rainfed sector has higher comparative advantage than the irrigated sector in the production of some crops and livestock. This sector is at present being given lower priority in formulating both the recovery programs and in recent investment outlays. The arguments against placing a high reliance on the rainfed--and especially the traditional--subsectors were that (a) their yields, based on currently available technology packages, did not offer much hope for rapid expansion of outputs and exportable surpluses, and (b) the high costs of transportation from the traditional areas--specially North and South Kordofan, and South Darfur--made it uneconomic to transport surpluses out of these regions. These studies suggest, however, that in spite of the low yields and high transport costs, the traditional and rainfed sectors continue to have a comparative advantage in many crops and have an important role to play in a strategy for recovery and export growth. This sector also has the considerable advantage of using a far lower share of traded and imported inputs that further make exports from it desirable. With continuing devaluation and increases in the cost of imported inputs, the comparative advantage of traded outputs from this sector increases even with increasing transportation costs.

9. The potential of the rainfed sector remains untapped only partly due to the relative neglect in investment allocations. Government policies of fixing prices of cotton, sesame, groundnuts and gum arabic have also been a

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<sup>7/</sup> This of course assumes that the elasticity of demand for imported input use and output are relatively high and all prices are passed on to producers. If both elasticities are low then, under certain conditions, devaluation could increase the use of imported inputs by less than it would increase the value of output, thus reducing international value added and comparative advantage. A 10% increase in the price of imported inputs (given a foreign exchange dependence of 60%) could reduce import costs by 3.6 percent if the import demand has an elasticity of .6; this could reduce international value added if the elasticity of export demand is less than .36 for a given crop.

<sup>8/</sup> Thus where transportation and labor costs are high but are themselves distorted this leads to distortion in the calculations of DRCs. Whereas the GOS studies do not correct for these distortions, the Moe Study does.

disincentive. Commodities like sorghum, millet and livestock, whose prices are relatively free of government interference, move readily from surplus to deficit areas at home and abroad, reflecting the price and transport differentials as producers and traders seek to maximize their incomes. Removal of government interventions in market prices would narrow the gap between producer prices and border price equivalents in traditional areas, would improve producer incomes, and would encourage better realization of the potential from the rainfed sector for exports.

10. How much of a potential is there? Unfortunately, DRC calculations do not tell us at what costs additional production can be realized in the rainfed and traditional sectors. This depends on constraints on the land, labor and livestock resources in the region, and the transportation and institutional capacities in the markets serving these sectors. The allocation of resources to alternative crops given relative incentives, marketing costs and resources in the traditional sector needs to be compared with alternatives in other sectors in an integrated framework to look at the implications for production, exportable surpluses and balance of payments. Data collected for the DRC studies are a first and necessary step towards developing a sector wide strategy. A study to incorporate this data into a wider sector planning framework should be given a high priority in the sector work program by the GOS.

**Table 1**  
**SUDAN: DOMESTIC RESOURCE COST ESTIMATES**  
(LS/U.S.\$)

Rank in 1982 <u>4/</u>	Crops	DRC 1976/77 NASHASHIBI <sup>3/</sup>	DRC 1980/81 SATTAR <sup>2/</sup>	DRC 1982 MOE <sup>1/</sup>	DRC (1985/90) MOE <sup>1/</sup>
1	Groundnuts-Gezira	.41 (a)	.74	.37	.31
2	Groundnuts-Traditional	.31	.45	.39	.33
3	Sorghum-Mechanized-Rainfed	-	.68	.42	.66
4	Sesame-Traditional	.37	1.05	.42	.46
5	Sorghum-Traditional	.53	.54	.43	.64
6	Sesame-Mechanized-Rainfed	-	1.70	.46	.46
7	Sorghum-Gezira	.75	.83	.53	.73
8	Cotton (MS)-Rahad	-	-	.55	.43
9	Wheat-Gezira	-	-2.70	.68	.42
10	Millet-Traditional	-	.96	.69	.69
11	Cotton (MS)-Gezira	.45	.79	.71	.38
12	Cotton (ELS)-Gezira	.37	.84	.89	.29
	Sugar	.39	-	-	-
	Rice	6.70	-	-	-

**Sources:** 1/ T. Moe: Sudan: Export Development Study, Report No.4263-Su, IBRD, December 1982, p.30,31. Irrigated crops are assumed to be comparable in Moe's classification to crops grown in the Gezira and unirrigated crops are assumed to be grown under traditional technologies.

2/ A. Sattar: Study of the Costs of Production and Comparative Advantage of Crops Under Different Farming Systems in Sudan, UNDP/IBRD, May 1982, p.5. The calculations are for average productivity.

3/ K. Nashashibi: "A Supply Framework for Exchange Reform in Developing Countries: The Case of Sudan," IMF, 1979.

4/ Ranked in accordance with T. Moe's study using 1982 data.

**Table 2**  
**SUDAN: DOMESTIC RESOURCE COSTS AT DIFFERENT**  
**PRODUCTIVITY LEVELS (1980/81 data)**  
**(LS/U.S.\$)**

Crop/Farm Areas and Type	Productivity Levels			AVERAGE
	Low	Medium	High	
<b>A. Gezira (Canal Irrigation)</b>				
Cotton-(LS)	3.70	0.92	0.55	.84
Cotton-(MS)	-20.00	0.96	0.62	.79
Groundnuts	1.60	.74	.44	.74
Wheat	-.73	-2.17	1.03	-2.17
Sorghum	2.50	.72	.46	.83
<b>B. Sudd (Pump Irrigation)</b>				
Cotton (MS)	-2.20	1.30	.45	.83
Groundnuts	3.20	.77	.47	0.60
<b>C. Gedaref (Rainfed-Mechanized)</b>				
Sorghum	1.25	.73	.48	.68
Sesame	2.50	2.10	1.10	1.70
<b>D. N. Kordofan-S. Darfur (Rainfed Traditional)</b>				
Sorghum	1.20	.60	.45	.54
Millets	1.56	.92	.72	.96
Groundnuts	.82	.48	.33	.45
Sesame	2.80	.90	.60	1.10
<b>E. Livestock</b>				
Cattle-Irrigated Areas	.18	.30	.27	-
Cattle-Rainfed Areas	.31	.59	.50	-
Sheep-Irrigated Areas	.63	.91	1.00	-
Sheep-Rainfed Areas	.45	.50	.71	-

**Sources:** A. Sattar "Study of Cost of Production and Comparative Advantage of Crops Under Different Farming Systems in Sudan," UNDP/IBRD, Planning and Assistance Project, Khartoum, May 1982 (Draft), Table 1.02, p.5.

Democratic Republic of Sudan: "Comparative Advantage of Agricultural Products," UNDP/IBRD, Planning Assistance and Training Project, Ministry of Finance and Planning, April, 1983.

CAPITAL INTENSITY IN AGRICULTURE

1. The ability of the irrigated and mechanized rainfed sectors to respond to price incentives is partly constrained by (1) the heavy dependence of the sectors on imported inputs and (2) their heavy reliance on capital intensive technologies into which they seem to be increasingly locked. This raises three inter-related issues: (i) the capital intensity of these subsectors in an economy where capital is, and will continue to be, increasingly scarce, (ii) the heavy dependence on imported inputs at a time when foreign exchange is in extremely short supply and when the supply is subject to increasing uncertainty and disruptions, and (iii) the extent to which these sectors are net contributors to foreign exchange.

2. Data on the overall capital intensity of the agricultural sector and how it has changed over time are scarce. Data available from the Sudan Gezira Board on its operations, shown in Table 1 indicate that:

- (a) while total joint crop expenses per feddan of cotton area sown decreased in real terms by 35%, the expenses on inputs and those operations which use imported inputs <sup>1/</sup> increased by about 10%, and expenses on wages for cotton picking and pulling decreased by 57% in real terms;
- (b) while total crop expenses per kantar of cotton produced increased by 36% (reflecting declining cotton yields) those on operations using imported inputs increased by 130% and those on labor intensive tasks decreased by 12%;
- (c) administrative expenses--on supervisory, administrative, and managerial labor--increased in real terms by 30% and 175% when measured in terms of the cotton area sown and cotton production respectively;

3. This indicates that even though imported and capital intensive inputs have been becoming relatively more costly, the capital intensity of the major irrigation scheme has been increasing. This is a perverse response to changing relative factor prices. This

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1/ As the Sudan Gezira Board did not separate its expense accounts by crops before 1981 it is difficult to assign expenses to different crops. Cotton production is used here as a benchmark because in the past, most production expenses of the scheme were collected out of the cotton crop. For the purposes of this section we have assumed that expenses on fertilizers, seeds, spraying and land preparation definitely involve imported inputs. These are an underestimate because much to the transportation and handling and some of the ginning and baling also involve imported inputs of fuel and machinery. All expenses were deflated by the CPI (urban-low) to get expenses in real terms.

evidence is supported by the fact that, over the years, an increasing number of operations have been mechanized in the Gezira and the rainfed mechanized sectors. Furthermore, the rehabilitation of these and like schemes is predicated on even higher capital intensity and use of capital and import intensive inputs.

4. The first argument that is offered in defense of increasing capital intensity is that this is a step taken through necessity due to the shortages of labor in Sudan in general, and in the irrigated schemes in particular, specially during the critical peak seasons. Mechanization becomes essential to assure the tasks gets done in a timely manner. Thus implicitly the argument is that the "real shadow wage" of labor (if season and timeliness are properly accounted for) is so high that capital inputs have become "relatively cheaper" and it makes sense to move in the direction of higher capital intensity. (We treat this issue of the demand for timeliness of operations and the relative shortage of labor later in Annex 2.5 in detail.)

5. A second argument that is often offered is that mechanization leads to better cultural practices, higher intensities and hence higher yields. Higher yields may well result, but extensive work on this issue in other countries has shown that there is a very complex interaction involved between timeliness, intensity, other inputs, and mechanization, and that claims on behalf of yield and intensity effects of mechanization need to be supported by evidence from carefully controlled experimental and field data.<sup>2/</sup> No such evidence is presently available for the Sudan nor has this issue been studied in its complexity. What is certain is that during the same period during which capital intensity and mechanization were increasing in the Gezira, yields continued to decline.<sup>3/</sup> Furthermore, while increased mechanization may lead to higher yields, the costs may exceed the benefits in economic (and even financial) terms (ref. para 14).

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<sup>2/</sup> This is a continued claim made regularly by proponents of mechanization. Often yield differences between mechanized and non-mechanized farms arise from the confounding effects on yields and intensity introduced by other factors--irrigation, fertilizers and better management which are highly correlated with mechanization. A detailed analysis of the evidence from South Asia (some from areas like the Punjab which are not too different from the Gezira) showed that mechanization was neither an important factor leading to increased intensity, nor was there much evidence for the yield-increasing effects of mechanization. See H. Binswanger "The Economics of Tractors in South Asia: An Analytical Review", Agricultural Development Council, New York, 1979. But the land-labor ratios in the Sudan are dramatically different, so bottlenecks maybe more severe. At any rate this is an area full of methodological pitfalls. Only carefully controlled experimental data can help to confirm or deny this hypothesis.

<sup>3/</sup> Again one cannot infer causality because casual empiricism is misleading in this case.

6. What are the implications of increasing capital intensity for the short term balance of payments? For this we need to examine not only the dependency on foreign exchange for imported inputs, but also the net foreign exchange earnings that result from exporting the output. Data from the GOS and the Moe studies summarized in Table 2 provide extensive information. This table shows (i) the coefficients of foreign exchange dependence (CFED), which measure the amount of foreign exchange needed for traded inputs to generate one dollar of gross foreign exchange earnings, and (ii) the international value added (IVA) per feddan which measures the net foreign exchange earnings generated by the production and marketing of one feddan of output.<sup>4/</sup>

7. These cross-section studies indicate:

- (i) the relatively high dependency of the irrigated and rainfed mechanized crops on foreign exchange compared to the same crops grown in traditional areas (after transportation costs are allowed for); between 35-67% of the value of output is required to pay for imported inputs in the irrigated Gezira, pump irrigated and rainfed mechanized subsectors according to the GOS study compared to only between 18-36% for the rainfed traditional crops (see CFED data under GOS study);
- (ii) the high contribution of the agricultural sector as a whole to foreign exchange earnings as the IVA is positive for all crops;
- (iii) the high net foreign exchange earnings capacity specially for irrigated cotton and groundnuts in spite of their high demand for imported inputs;
- (iv) the substantial net foreign exchange earning capacity of sesame, short staple cotton and groundnuts from the traditional rainfed areas.

8. This coupled with the fact that the sector as a whole consumes a relatively limited proportion of total imports confirms the short term strategy being followed by the GOS to help alleviate the foreign exchange crisis--namely a (i) heavy reliance on export of cotton and groundnuts from irrigated areas with (ii) an assurance of foreign exchange for inputs necessary for this sub-sector. What is

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<sup>4/</sup> The CFED and IVA are both dependent on the assumptions on yields, border prices and exchange rates assumed for the calculations and often differ widely. The higher the yields, the higher the exchange rate (in LS/\$), and the higher the border prices, the lower the CFED (if less than unity) and the higher the IVA (if positive). The GOS study is more comprehensive and is presumed to be based on field survey data. The Moe study is methodologically more sound, although the data was not collected on a sample basis.

required is a heightened attention to the dormant but large potential of the traditional rainfed area as an earner of net foreign exchange--a point already made in reference to the comparative advantage of traditional areas in producing many crops.

9. But just because the irrigated and other sectors have a positive IVA does not preclude the possibility of reducing the use of imported inputs. Consideration needs to be given to measures and policies designed to do this. Any reduction in the use of imported inputs (without a commensurate loss in output) will further reduce the foreign exchange dependence and increase net foreign exchange earnings from all sectors.

10. Taking the heavy dependence on imported inputs, the major concern should be to:

- (a) price all traded inputs at their border price equivalents to assure their efficient use; and
- (b) make certain that these inputs are increasingly used in activities where the net value added in foreign exchange via exports is positive.

11. While the latter is generally true as we have seen, the domestic input price structures commonly fail to reflect the true opportunity cost of these inputs, because they are made available at the official exchange rate. The real price of petrol (benzine) and tractors declined by 20% and 60% respectively between 1971 and 1980.<sup>5/</sup> Inputs must be priced at a realistic exchange rate and their prices continually adjusted upwards to reflect their true scarcity to the economy. Readjusted and higher prices for capital inputs will reduce their use in the sector though by how much in the irrigated sub sectors remains uncertain. Some elasticity does exist. But this will remain insufficient if product prices also do not reflect their true opportunity--border price value to tenant and scheme producers. Only when both product and input prices are aligned to reflect opportunity costs and returns can the "positive net value added in foreign exchange" criteria be correctly reflected in the economy and efficiency assured. At present input prices remain distorted and well below their border price equivalents.

12. Beyond getting the "prices right" for traded inputs and outputs there is the need to take measures to assure a continued supply of essential imported inputs to the "productive sectors." We stress this once again. For example, a large share of the fuel imports are used by the service, government and household sectors, but agriculture accounted directly for only 18% of all diesel consumption in 1980. Even if half of all the total energy used in transport was

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<sup>5/</sup> Deflated by the CPI (urban-low).

allocated to transport for agriculture, it would still have accounted for only 45% of diesel use and no more than 5% of total energy use in Sudan. Pricing of foreign exchange alone will not be an answer to its proper allocation because of the large demand on part of the trade and household sectors—the former supported by high profits in a protected environment and the latter fueled by large remittances. Retention in dollars of a share of agricultural export earnings by agricultural producers to allow the sector an uninterrupted access to essential imported inputs may be essential to allow adequate allocations of foreign exchange to the agricultural sector. Alternatively, and preferably, exporters should be able to sell the foreign exchange earned at the free market rate. This would assure the domestic resources needed to purchase the required foreign exchange at roughly the same price.

13. Further savings in the use of imported inputs can be achieved by a careful review of the cultural practices being followed in the major irrigated schemes and the rainfed mechanized sectors, to see if traded input intensities can be effectively reduced without major losses in output. For example, a reduction in the number of sprayings on acala cotton, from 11-12 per season to perhaps 6-8 per season should be considered. Initial research results have shown that the excessive use of broad-spectrum (and more costly) pesticides may have killed off not only the white fly but also its natural enemies, thus exacerbating white fly infestations in the years following excessive spraying.<sup>6/</sup> Use of narrow spectrum insecticides, changed planting and spraying dates and reduced use of pesticides in an integrated pest control program could lead to substantial savings in the use of this imported input. A reduction of spraying from an average of 12 to an average of 8 per season in Gezira for example could have saved a third of the LS 15 mls in 1980 used for pesticide imports. The same maybe the case for fertilizer use, which could be reduced at the margin without significant loss of net value of output once prices are adjusted.<sup>7/</sup>

14. To be effective, such cultural practices should be evaluated not only on the basis of agronomic or entomological considerations, as in currently being done, but should also include an economic evaluation. The marginal benefits (in terms of increased expected yields) should be weighed against the marginal costs (in terms of the increased cost of the inputs). But seldom are agronomic, engineering or pest control "optimal recommendations" subjected to economic

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<sup>6/</sup> "It makes little sense to control a pest in such a way that simultaneously its reproduction possibilities are increased by liquidating its natural enemies." R. V. van Gent, "Investigations of Parasites as a Component of Integrated Pest Control of White Fly in Cotton," Working Paper No.8, FAO/UNDP, IPC Program, Gezira Research Station, A.R.C. Wad-Medani, 1981.

<sup>7/</sup> Once imported inputs are priced at their border equivalents, it is certain that the fertilizer use per feddan will have to be adjusted downwards to assure economic optimality.

analysis. Recommended practices that lead to yield improvements should be evaluated from a multi-disciplinary point of view, including economic analysis, and should not be based solely on the recommendations of a single discipline, be it agronomy, engineering or economics.

15. Furthermore, even if mechanization is the most economic choice of technology (once labor bottlenecks and their shadow prices are properly accounted for) it is not essential that (a) all operations be mechanized or that (b) even one operation be fully mechanized. To give an example, labor bottlenecks during cotton planting do not mean that cotton picking operations have to be mechanized. To some extent this task specific mechanization has been the norm because cotton picking and pulling are still done by labor. But the tendency has often been to mechanize fully at the start of a scheme. Land preparation and airplane spraying are examples of this. If labor bottlenecks during cotton planting are such that the labor available at existing wage rates<sup>8/</sup> can only cope with 60% or even 30% of the planting, it is not necessary to do all planting operations by machines--only 40-70% of the planting could be mechanized. This of course assumes that tasks, labor and machines are divisible. The first two definitely are, while machines are also "divisible" considering the large size of the schemes involved. If 1000 tractors are needed to plant all the area by machines, 700 will suffice if 30% of the area is left to hand planting. Both task-specific mechanization and the partial mechanization of specific tasks are an important way of reducing the level of capital intensity.

16. Finally, capital inputs are underpriced because financial capital is. The nominal interest rates on agricultural credit given by the Agricultural Bank of Sudan (ABS) (for machinery purchases for example) varied from 9% for short term loans to 7% for medium and long term loans up to 1981. With the official annual rate of inflation varying between 16-33% between 1975 and 1981, this meant a negative real rate of interest for private borrowing even if one accepts the official inflation indices. This was a strong implicit subsidy and incentive to use capital inputs and no doubt helped induce mechanization in the rainfed sectors where private entrepreneurs operate large farm tracts. The relative factor costs (capital/labor price ratios) were highly favourable to mechanization. Between 1971-1980 some LS 12 mls. were authorized by the ABS for tractor loans.<sup>9/</sup>

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<sup>8/</sup> Labor supply should be distinguished from labor available as the latter is a quantity measure only while the former relates quantity available to wage rates. The same distinction needs to be made between labor demand and labor requirements. The point is simple but by no means trivial as many of the arguments on these issues have been couched in terms of physical quantity without any reference to the wage rate.

<sup>9/</sup> Based on tables provided to mission by A.B.S.

17. In 1981 ABS raised its lending rate to 14%. This was a highly commendable policy change that brought nominal rates closer to the inflation rates. But inflation rates are still higher than interest rates. Nonetheless, increasing nominal rates on credit will help to assure reduced capital (imported input) use and lead to increased efficiency in capital use.

18. To summarize, capital intensity can be reduced by (a) carefully reviewing current cultural practices to see if the use of traded inputs is optimal, (b) evaluating technology choices on agronomic, engineering and economic grounds, (c) considering the alternatives of task specific and partial mechanization, (d) further increasing nominal interest rates on agricultural credit, (e) pricing inputs at their border price equivalents and (f) increasing labor use.

19. The longer term dependence on capital inputs is troubling because:

- (a) It implies a heavy dependence on a steady flow of foreign exchange which in Sudan is highly uncertain;
- (b) it does not reflect the true relative scarcity of labor and capital in the Sudanese economy;
- (c) it leads to an enforced dualism and enclave development of the agrarian economy with a relatively small "modern" sector that is highly capital and import intensive and often commands most of the investments alongside a large, often stagnant labor intensive and low income "traditional" sector that is neglected;

20. Such dualistic development:

- (a) distorts income distributions and as a consequence;
- (b) distorts the pattern of consumption in favor of imported consumer goods;
- (c) drains the traditional sectors of manpower via rising urban-rural wage differentials, denuding the sector of its future farmers (note how even in the Gezira widows and young children dominate the tenant population); and
- (d) discourages the development of indigenous adaptive technologies suitable to the relative factor scarcities in the economy.

**Table 1**  
**SUDAN GEZIRA BOARD: INDICES OF SELECTED EXPENSES IN REAL TERMS**  
 (1971 = 100 and Deflated by CPI-Low)

	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
<u>Total Joint Expenses<sup>(a)</sup></u>	100.00	93.4	85.4	74.2	79.5	70.6
-Per Total Area	100.0	96.6	82.9	64.0	64.8	48.1
-Per Cotton Area	100.0	93.2	85.2	74.2	79.5	107.5
-Per Cotton Production	100.0	100.7	112.4	79.9	92.9	216.2
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>		
<u>Total Joint Expenses<sup>(a)</sup></u>	78.5	74.6	56.9	62.3		
-Per Total Area	57.5	54.9	43.1	50.3		
-Per Cotton Area	94.8	86.7	68.9	69.4		
-Per Cotton Production	141.9	109.0	112.5	145.0		
	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
<u>Total Crop Expenses<sup>(b)</sup></u>	100.0	89.9	72.2	71.0	68.7	51.4
-Per Total Area	100.0	93.1	70.1	61.2	56.0	35.0
-Per Cotton Area	100.0	89.8	72.1	71.0	68.7	78.2
-Per Cotton Production	100.0	97.1	95.1	76.4	80.4	157.4
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>		
<u>Total Crop Expenses<sup>(b)</sup></u>	66.9	68.0	47.9	58.5		
-Per Total Area	49.0	50.0	36.3	47.3		
-Per Cotton Area	80.9	79.0	58.0	65.2		
-Per Cotton Production	121.0	99.2	94.7	136.2		
	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
<u>Expenses on Imported Inputs<sup>(c)</sup></u>	100.0	89.0	79.0	85.0	97.4	91.5
-Per Total Area	100.0	92.1	76.7	74.0	79.4	62.4
-Per Cotton Area	100.0	88.8	78.9	85.0	97.4	139.4
-Per Cotton Production	100.0	96.0	104.1	92.3	113.9	280.3
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>		
<u>Expenses on Imported Inputs<sup>(c)</sup></u>	103.9	110.9	85.8	98.7		
-Per Total Area	76.0	81.6	65.0	79.0		
-Per Cotton Area	125.0	128.9	104.0	110.0		
-Per Cotton Production	187.0	161.9	169.8	230.0		

- (a) Including crop, transportation, ginning, baling and other expenses of the SGB.  
 (b) Expenses for all crop operations carried out by the SGB and charged to tenants.  
 (c) Expenses on fertilizers, seeds, spraying and land preparation.

**Table 1 (cont.)**  
**SUDAN GEZIRA BOARD: INDICES OF SELECTED EXPENSES IN REAL TERMS**  
**(1971 = 100 and Deflated by CPI-Low)**

	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
<u>Total Wage Expenses<sup>(d)</sup></u>	100.0	85.7	62.8	60.8	49.7	21.8
-Per Total Area	100.0	88.7	61.0	52.5	40.5	14.8
-Per Cotton Area	100.0	85.6	62.7	60.8	49.7	33.1
-Per Cotton Production	100.0	92.5	82.7	65.5	58.2	66.6
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>		
<u>Total Wage Expenses<sup>(d)</sup></u>	40.3	37.6	38.5	38.0		
-Per Total Area	29.5	27.7	29.2	30.9		
-Per Cotton Area	48.7	43.7	46.6	42.6		
-Per Cotton Production	72.9	54.9	76.2	88.0		
	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
<u>Administrative Expenses<sup>(e)</sup></u>	100.0	108.9	110.4	71.6	138.8	205.7
-Per Total Area	100.0	112.7	107.2	61.8	113.2	140.3
-Per Cotton Area	100.0	108.7	110.2	71.6	138.8	313.3
-Per Cotton Production	100.0	117.5	145.4	77.1	162.3	630.1
	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>		
<u>Administrative Expenses (e)</u>	181.4	149.1	128.8	118.4		
-Per Total Area	132.0	109.7	97.6	95.7		
-Per Cotton Area	219.2	173.2	156.0	132.0		
-Per Cotton Production	328.0	217.6	254.7	275.8		

(d) Expenses on cotton picking and pulling.

(e) Expenses on overseer wages, administrative expenses, other cooperative and miscellaneous expenses.

**Table 2**  
**SUDAN: COEFFICIENTS OF FOREIGN EXCHANGE DEPENDENCE**  
**AND INTERNATIONAL VALUE ADDED PER FEDDAN FOR DIFFERENT CROPS**

Rank <sup>c)</sup>	Crop/Farming System	GOS Study (1980-81)		Moe Study (1982)	
		CFED <sup>a)</sup>	IVAA <sup>a)</sup> (US\$/FD)	CFED <sup>a)</sup>	IVA <sup>b)</sup> (US\$/FD)
1	Sesame Rainfed-Traditional	0.18	31	0.03	77
2	Sesame-Rainfed-Mechanized	0.20	38	0.13	85
3	Cotton-Rainfed (Nuba)	0.29	44	-	92
4	Groundnuts-Rainfed-Traditional	0.33	30	0.06	135
5	Millet-Rainfed-Traditional	0.34	10	0.16	36
6	Groundnuts-Irrigated-Gezira	0.35	117	0.09	464
6	Cotton (MS)-Gezira -(Rahad)	0.35 -	196 -	0.11 (0.22)	200 (395)
8	Sorghum-Rainfed-Traditional	0.36	8	0.107	67
8	Cotton (ELS)-Gezira	0.36	212	0.34	180
10	Wheat-Irrigated-Gezira	0.37	42	0.39	71
11	Cotton (ELS)-Pump Irrigated	0.39	170	-	-
11	Cotton (MS)-Pump Irrigated	0.39	135	-	-
13	Sorghum-Irrigated-Gezira	0.42	28	0.14	111
14	Sorghum-Rainfed Mechanized	0.51	11	0.26	78
15	Sorghum-Pump Irrigated	0.67	12	-	-

**Sources:** 1) Democratic Republic of Sudan "Comparative Advantage of Agricultural Products," UNDP/IBRD. Planning Assistance and Training Project, Ministry of Finance and Planning, Khartoum, April, 1983, Annex A.  
2) T. Moe "Sudan: Export Development Study, East Africa Regional Office, Report No.4263-SU, IBRD, December 1982, Annex 12.

**Notes:** (a) Coefficient of Foreign Exchange Dependence (CFED) is defined as the ratio of value of traded inputs used to produce, market and transport, a commodity to the value of the output evaluated at border prices and the official exchange rate of LS 1.3/\$.  
(b) International Value Added (IVA) per feddan is the value of the output minus the value of the traded inputs used to produce, market and transport a commodity evaluated at the border prices and the official exchange rate of LS 1.3/\$.  
(c) Ranked by CFED in GOS study.

LABOR SHORTAGES IN AGRICULTURE

1. Is labor really in short supply in agriculture? There seem to be two prevailing views. The first and most prevalent among project managers and policy makers is that "labor cannot be obtained (at any price) to meet the needs for peak period operations."<sup>1/</sup> The literature on the Sudanese economy abounds with references to the severe shortages of labor in peak periods of the agricultural cycle. The second and less prevalent view is the one stated in the 1976 I.L.O. study which took some effort at examining this issue. This study which found that although organized agriculture in certain crucial areas faces 'shortage of labor' specially at harvest times, there was an overall abundance of labor in the country.<sup>2/</sup>

2. The fact is that both these views are likely to be misleading because they are based on physical "labor requirements" and "labor availability" without any reference to real wage rates. Nor are there any studies of the demand and supply (quantity-wage relationships) for labor in Sudanese agriculture. The conventional manpower forecasting of monthly labor "requirements" and "availabilities" does not get at the issue of labor demand vs labor supply--that is how much labor would be forthcoming in given seasons at different wage rates and how much labor would be hired at different wage rates given different technologies, cropping patterns and areas sown and harvested in different regions. Such an analysis would require an analysis of labor use, wage data and the underlying production relationships. Important as these issues are, no such critical analysis has been undertaken. Furthermore, there are no reliable rural wage and employment data available on which such an analysis can be based. The lack of rural wage data are particularly disturbing because it is not possible to make a meaningful statement about "labor shortages" without reference to a rural wage. There is virtually no published evidence on the earnings of seasonal workers in agriculture.

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1/ Personal notes of interview with SGB manager.

2/ See I.L.O. Growth Employment and Equity: A Comprehensive Strategy for the Sudan, Geneva, 1976, specially Chapter 7 and S. B. L. Nigam "The Labor Requirements and Supply Situation in Agriculture in the Sudan," Chapter 7 in Ali Mohamed el Hassan ((Ed.) Growth Employment and Equity: A Selection of Papers Presented to the I.L.O. Comprehensive Employment Strategy Mission to Sudan, 1974-1975, Economic and Social Research Council, Khartoum University Press, 1977.

Evidence from the Seventies

3. Since the I.L.O. studies, based on evidence in the first half of the seventies, provide the last comprehensive findings on the rural labor situation it is useful to summarize their findings. The evidence they compiled showed that:

- (a) the country had abundant supply of unskilled labor, the rural population was highly mobile and given adequate facilities and incentives the notion of "shortages of agricultural labor" could not be supported by the evidence;
- (b) "rural labor markets functioned fairly effectively to redistribute labor geographically and in accordance with location specific changes in the demand for labor;"
- (c) although there were regional imbalances between "availability" and "requirements" and though shortages of seasonal labor did exist in certain areas, "the popular view that large scale irrigated farming schemes in the eastern and central provinces of the country suffer from irremedial seasonal shortages of labor implying that the supply of labor is highly inelastic, is at best a gross exaggeration. At times labor is indeed in short supply at peak months of the agricultural cycle in such provinces as Kassala and the former Blue Nile provinces, but on the evidence available these shortages are not absolute physical constraints on the expansion of output; more labor would be forthcoming at somewhat higher wages and somewhat higher recruitment costs;"<sup>3/</sup>

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<sup>3/</sup> See I.L.O. (1976), pp. 89-90 and specially Nigam (1977) for detailed supporting evidence.

- (d) migration of labor was of a staggering magnitude and migrant labor was the main source of labor supply for agriculture, specially in the schemes, "with temporary migrants comprising as much as 14% of all workers or 6.5% of the total population;4/
- (e) typically migrant laborers (both male and female) were a heterogeneous group, had high mobility and short duration of stay at point of employment, were "pulled" by higher remunerations (compared to alternatives in traditional rainfed areas), but due to little open unemployment were sure of their seasonal earnings;5/
- (f) in irrigated areas like the Gezira scheme (where only about a fifth of the total labor came from tenant families), tenants supplied only about half of the labor that was available in their families to farming, while many tenants and their sons preferred to work in better paying off-farm occupations;
- (g) the size of the tenancy was an important factor in determining the supply of local and tenant labor in the schemes;6/

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4/ In 1973/74 the Gezira Board employed 542,000 people in harvesting cotton, 62% of whom came from outside on a seasonal basis. Some surveys reported up to 30,000 in migrants in a single village. Schemes in Kassala province attracted 100,000 migrants in the peak season. The study estimated that, of a labor force of around 7 million persons in the country, "about one million men and women move around the Sudan during any year in response to geographic disparities in employment opportunities." This included rural-urban and rural-rural migrants.

5/ A typical male migrant changed residences several times, moved seasonally from one scheme to another and often came from such distant places as Darfur and the Kardofan. Some agricultural laborers (the so called "fellatas" or foreigners) came from as far away as Chad, central west Africa and northern Nigeria. Differentials in rates of pay, distances to employment and push factors like low rainfall in regions from which migration occurred were and remain the main factors determining the rate of migration. The bulk of the recruitment is done by sheikhs or local village leaders.

6/ The shortage of labor during cotton picking was felt to be more acute in the original Gezira area where tenancy size is large, where tenants with higher incomes prefer non-agricultural occupations and act more like landlords than in the Managil extension where tenancies are about half as large, tenants often also work as farm workers and have fewer non-farm alternatives.

- (h) the working conditions for migrant labor were onerous, with long hours worked at low piece rates, on a seasonal basis and with only primitive living facilities provided by the tenants.
- (i) although no reliable data on trends in total real wage rates were available, the wages for cotton picking were low compared to alternative occupations in nearby urban areas and had increased by only 3 percent per annum in the preceeding 20 years in nominal terms--that is, the real wage rates for cotton picking were declining;7/
- (j) although the schemes paid the transportation costs to tenants for migrant workers in advance, the workers themselves paid for the return journey, so that the real net remunerations taken home by migrants were even lower;8/
- (k) although demand for labor would increase considerably by 1985 as a result of increases in the area under cultivation, except for seasonal shortfalls of labor for 2-3 peak months in Kassala and Blue Nile provinces, labor shortages would remain a short-lived phenomenon in very limited areas caused by locally restricted and lumpy investments in area under cultivation and lack of proper wage and non-wage incentives.

4. The I.L.O. studies concluded by cautioning that, given the high mobility of rural migrant labor and well functioning labor markets, the abundant overall supplies of unskilled labor in the country did not justify the high rates of mechanization because "the

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7/ The wage rates offered in the irrigated sector were considerably lower than in the organized sectors in nearby urban centers. Daily wage rates for cotton picking (including payments in cash and kind) were estimated at 35-50 piasters compared to 63 piasters in the organized sector. Wages in the cotton ginneries were estimated at 50 piasters to LS 1 for various jobs.

8/ They estimated that migrants from Kassala province took home between LS12-18, those from Southern Darfur LS 10-15 per person for a ten week picking season. By contrast workers in cotton ginneries and organized urban sectors took home LS 14 per month or LS 42 for a 10 week period.

notion about the shortage of agricultural labor propounded by some on the basis of which mechanization of agriculture is largely advocated is not based on facts and figures<sup>9/</sup> and that "we see no evidence that current wage rates justify increased mechanization" because in general mechanization should follow, not precede, the rise in the wages of seasonal workers.<sup>10/</sup>

5. They recommended that:
- (a) government increase the total number of seasonal workers by subsidizing travel by rail to the schemes;
  - (b) welcome the immigration of foreign workers (they noted the political objections);
  - (c) increase efforts to provide information about seasonal labor demands through the labor office of the Department of Labor;
  - (d) carry out studies to see whether capital intensive methods of producing crops in the schemes yield higher rates of return than labor intensive methods, particularly when account is taken of the foreign exchange costs of fuel and spare parts.
  - (e) change the joint system of accounts to provide incentives to save on outside labor for cotton picking and increase the use of tenants own labor.

#### Current Situation

6. What has happened in the intervening decade? Unfortunately, critical as the issue is, little additional evidence is available. But what is available tends to reinforce the conclusions and recommendations of these studies.

7. First, there is still no evidence that labor is in short supply in the economy as a whole because, if this were so, it would be reflected in rising real wage rates in all sectors for unskilled labor, specially in rural areas. Although nominal wages have risen, there is no evidence that real wages have increased significantly in rural areas.

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<sup>9/</sup> They estimated that the "demand for seasonal labor had been increasing at the rate of 30,000 additional workers per year in modern agriculture, largely due to increases in areas under mechanized rainfed agriculture. I.L.O. 1976, p.103.

<sup>10/</sup> Nigam op.cit. 0.153.

8. Second, labor markets continue to work effectively redistributing labor from one region to another. Sudanese labor remains extremely mobile over long distances and seems to respond to differential opportunities without major problems. Migrant labor remains critical to the irrigated sector and there is little doubt that without seasonal migrant labor the schemes would fail. In 1980 the SGB listed some 437,000 laborers used on the scheme of which 50% were "imported" mainly by the tenants themselves. (See Table 2).

9. In Rahad it is estimated that after the labor from some 1500 tenant families is accounted for, at least 60,000 non-family laborers are needed to harvest the cotton. Since local labor is practically non-existent, migrants must be the main source for harvest labor. Any interruption in the smooth flow of migrants to the scheme or the inability to recruit "enough" migrant labor to meet "requirements" are viewed as a crisis, because it is assumed that this will lead to a failure to harvest cotton. The "labor shortage" problem is, at the core a problem of the shortage of labor for cotton harvesting. There is, however, no evidence that in any year in the past decade or more, any cotton was left unharvested due to the inability to obtain an adequate labor supply.

10. With the enormous expansion of areas under various irrigated schemes, often in close proximity to each other in the Gezira and surrounding areas, the "labor shortage" issue has become even more acute and continues to be given as the main reason for further mechanization. Most operation have been mechanized already. Mechanized cotton pickers are now being tried out at Rahad and some are in use.

11. With rapidly expanding areas anticipated under cotton cultivation it is easy to see why this is such a crucial issue, and why everyone is concerned with the enormous labor "requirements" specially for cotton harvesting. For example in 1983 with total cotton areas of 502,000 feddans in the Gezira, 71,200 fd. in the White and Blue Nile Schemes, 33,000 fd. in Suki, 113,000 fd. in Rahad and 80,000 fd. in New Halfa--and using a commonly accepted rule or thumb of 1 cotton picker required per feddan of cotton, the total cotton

harvest labor "requirement" would total a staggering 804,200 laborers to pick the cotton in these schemes.<sup>11/</sup> And if projections for area under cotton for all the schemes at Full production materialize, a total of some 1.7mls. laborers will be needed for cotton harvesting by 1985. With a total of only 196ths. tenant families in the schemes (each say providing 2 full time laborers for the harvest season),<sup>12/</sup> the remainder of these "requirements" planners say, will have to be met by migrant labor. A growing "gap" between "requirements" and "availability" is the inevitable forecast.

12. There are several responses to this type of "manpower planning" forecast. First, the planned forecasts depend upon two critical factors (a) the picking rate assumed in the calculations and (b) the number of days available for cotton harvest. The average picking rate of 2 guffa per person per day depends on the cotton yields in the fields. With low yields of between 2-2.5 K/feddan (those experienced in 1980 when yields were very low when the Aricanli Survey was undertaken), a low picking rate is to be anticipated because of the sparse population of the cotton bolls. If yields were to double to say 4 K/fd. as they have in 1983 a higher picking rate of closer to 3 guffas per person per day is more likely. Nor are picking rates independent of the wages offered as incentive. Furthermore these calculations assume that only 12 days of harvesting time are available. Granted that the cotton picking period is short, it is not anywhere near that short. A period of between 20-30 days is often cited as being available for harvesting cotton in most areas. It is extremely rare that only 12 days are available for cotton picking as is often assumed.

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<sup>11/</sup> A detailed field survey carried out in 1980 in Gezira showed that 35% of the cotton pickers picked 1 guffa and 93% 2 guffas (70 lbs) or less per day. The picking rate depends on the yield and low yields lead to low picking rates. But assuming a 2 guffa/day rate, in a field with density 22.5 guffas/fd. (that is 2.5 K/fd or close to the average yields in 1980) one worker per feddan would be required during the cotton picking period which can be as short as 12 days--the time between start of picking and the next watering. This is a rule of thumb often used to calculate "requirements." See M. Cain and Ali Tosun Aricanli, "A Preliminary Report on the Results of a Survey of Cotton Harvest Laborers, The Gezira Scheme," Sudan 1980, Faculty of Economics and Rural Development, University of Gezira, Wad Medani, June 1980, p.15-16 and Ali Tosun Aricanli, "Agricultural Labor: A Dynamic Approach," University of Gezira, Wad Medani, February 1982 (draft).

<sup>12/</sup> There are an estimated 102,000 tenant families in Gezira, 14,300 in Rahad, 8,000 in Suki, 28,000 in the White Nile, 22,000 in the Blue Nile and 22,000 in the New Halfa.

13. How critical such simple assumptions can be to this type of manpower planning are shown in Tables 1 and 2. In Table 1 we calculate the "labor requirements" in the Gezira scheme for varying assumptions of picking rates (2 or 3 guffas) and different number of days available for harvesting (12, 15 or 20 days) on the basis of the actual cotton production between 1970-1980. We can compare these with the actual figures given by the SGB of the "labor available" (family local and migrant). They show that if the picking rate of 3 guffas is used and 15 or 20 day were available for harvest there were no labor shortages in physical terms even by the SGB's own figures. At 2 guffas and only 15 days or less of harvest time, labor "available" was far less than labor "required" between 1971-1979. Only where production fell below 1.8 million kantars--as it did in 1976--was there "adequate" labor. With production estimated at 3.26 million kantars in 1983 and assuming a picking rate of 2 guffas and only 15 days for harvesting some 723,000 workers would be required. But with 3 guffas and 20 picking days only some 667,000 cotton pickers would be required. These were not forthcoming according to scheme managers, at least at the remunerations being offered by the schemes. A severe physical labor shortage was felt; yet paradoxically all the cotton was picked!<sup>13/</sup>

14. Table 2 does similar calculations for labor "requirements" based on estimates of total cotton production in the Sudan<sup>14/</sup> from 1980-1990. If the lowest picking rate and the shortest harvesting period is assumed (2 guffas, 12 days) then by 1985 1.7 million and by 1990 some 2.1 million cotton pickers will be required to harvest all the crop manually. But at higher rates and more harvesting days (3 guffa, 30 days); these figures drop to as low as 0.45 million and 0.55 million respectively. These numbers are close to those already available in the Gezira alone. Nevertheless it is easy to see how the "labor shortage" issue remains at the forefront of scheme and national policy concern.

15. Second, let us take for granted that "labor shortages" (using physical manpower planning) will continue to plague the irrigated schemes, does this mean that the irrigated schemes will not be able to get the required labor? This is far from an acceptable conclusion because the amount of labor forthcoming is not independent of the wage and non-wage incentives offered to laborers and tenants. The evidence suggests that these have been declining in real terms.

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<sup>13/</sup> Cotton picking is still done manually in the Gezira. The "labor available" data from the SGB are at any rate not very reliable because they are more impressionistic than factual. They could grossly underestimate the labor actually being used at harvesting time in the schemes. See Aricanli, op.cit.

<sup>14/</sup> Apart from some 6% of the total production (of short staple cotton in traditional areas), the rest comes from the irrigated schemes--Gezira, Blue and White Nile, Suki, Rahad, and New Halfa.

16. There are three components of labor supply in the schemes--tenant labor, local labor and migrant labor. Figures from the Gezira Board show (Table 3) that, contrary to the accepted view the proportion of tenant labor available has remained fairly constant while the role of local labor has increased and that of migrant (or imported labor declined). But the SGB data are impressionistic and not very reliable. Recent and more reliable surveys of the harvesting labor situation show that the proportion of tenant family labor is far lower, the role of local migrant labor is increasing and that of migrant labor from distant Western provinces has declined considerably. Furthermore cotton harvesting has become predominantly a female task.<sup>15/</sup>

17. Consider first the tenant family labor. This has been declining and at the going wages rates and those available for cotton picking. The working age males--tenants and their sons--are leaving the schemes and seeking alternative and preferred occupations readily available outside the villages, in non-farm jobs and in urban jobs in Wad Medani and Khartoum.<sup>16/</sup> This out-migration explains the low labor force participation of tenant households in agricultural activities. This is due to both (a) declining real returns to family labor in the Gezira, specially to cotton production (see Annex 2.3) and (b) rising real returns to labor in non-farm and urban occupations. Being more educated, having better resources and connections, members of tenant households are the first candidates for this type of out-migration given the increase in the supply of attractive urban employment nearby. Urban and non-farm wages remain two to three times those in rural areas. Part of the withdrawal is also due to cultural factors as low status and low income agricultural work is not appealing to a population that is increasingly

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<sup>15/</sup> The 1980 Cotton Harvest Labor Survey showed that of the total harvest labor only 15% was supplied by tenant families (compared to 32% cited in the SGB data), 29% came from local labor (17% in SGB data), some 29% came from Gezira province, and only 27% came as migrants from outside the Gezira (compared to 50% of total according to SGB data). That means that the majority of seasonal laborers designated as "migrants" actually have their permanent residence within the boundaries of the Gezira, and can practically be regarded as local labor. The role of the "fellata" remains important but the proportion of long distant migrants is decreasing. Those who came earlier seem to have settled down in the region. A majority of the local labor (88%), Gezira province labor (80%) and migrant labor (67%) for cotton harvesting are women. See Aricanli (1980), op.cit. p.13-15.

<sup>16/</sup> Nearly 22% of all males (other than household heads) living in the villages and 10% of the females have left the villages. Aricanli (1982), p.38.

wealthy.<sup>17/</sup> The increasing participation of women in cotton picking is also evidence of higher paying alternatives for male members, as women with a lower reservation price often get assigned to lower paying jobs as men seek better opportunities elsewhere.

18. Local labor participation though increasing proportionately also has to contend with returns to alternative occupations. In the Gezira this is not only better non-farm employment opportunities but increasingly the opportunities for sharecropping. Keeping in mind that many "local labor families" have their earlier origins as in-migrants from the West, the dynamics of the transition from migrant labor to sharecropper consists of a process wherein migrant families come again and again to work for the same tenants and eventually settle down in "tenant villages" either acquiring a tenancy (rather rare) or a sharecropping interest in the land as members of the tenant family for whom they worked out-migrate to towns.<sup>18/</sup> For sharecroppers who are also partly laborers on others' fields, the labor offered to their own cotton would have declined with a decline in the real returns to cotton relative to other crops--a condition prevalent over the entire decade. Furthermore, most of the sharecropping is confined to groundnuts and sorghum.<sup>19/</sup> It is remarkable, though logical, that there is practically no sharecropping in cotton in the Gezira, an arrangement that is widespread in cotton growing areas in other parts of the world. This is because the low returns to cotton and the Boards monopoly over cotton marketing have kept prospective laboring cum sharecropping households away from cotton cultivation.<sup>20/</sup>

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17/ Among Arab out-migrants urban jobs have meant a severing of ties with agricultural activities. For earlier Western migrants whose ultimate goal is to become established as tenants or as sharecroppers, the break with agricultural activities is not complete. Aricanli, op.cit, p.91.

18/ In 1980 over 70% of the migrants to the Gezira were those who had come in the previous year and over 90% had been to work in the scheme some time before. Nearly 67% of the non-Gezira migrants and 75% of the Gezira province migrants had worked for the same cultivator in the previous 1-5 years; 20% and 37% respectively had worked for the same tenant for 6 years or more. Sharecropping is also more prevalent among people coming from West Sudan. While only 29% of the entire area cultivated is sharecropped, nearly a third of the area cultivated by Westerners in the scheme is sharecropped. Aricanli (1982), p.34-47 and p.66.

19/ Some 86% the sharecropped area is in these crops.

20/ Sharecropping is a rational way of allowing tenant households to get labor for their holdings as their own labor is given to non-farm work. It is also a way of sharing risk and returns.

19. The labor supplied for cotton picking to other fields by sharecroppers and by migrants of course depends on the wage rates offered. For migrants who come from further and further West, the transportation costs are a critical element in the labor offer. Although no time series data on real wages to cotton picking are available, there is evidence that real wage rates have been declining and are low compared to other available jobs.

20. In the Gezira in 1983 minimum wages for cotton picking were fixed by the SGB at 50 piasters/guffa; average payments by tenants were around 60-80 piasters per guffa<sup>21/</sup> plus food (with an average picking rate of 2 guffas/day that amounts to LS 1.2-1.6 per man day). Some tenants have been paying as much as LS 1.2 per guffa. These payments compare poorly with the LS 2.76 per day that is being offered by labor contractors and being paid at the cotton ginneries.<sup>22/</sup> Off farm wages of as high as LS 3-5 per man day were being reported for unskilled work in urban areas and by private farmers in some areas--for example the private pump schemes along the White Nile. Wages being offered by private contractos in Sennar were LS 2.35/days and in rainfed mechanized farming areas around Gedaref ranged from LS 5-10 per day. There is no doubt that wages offered to get labor for the irrigated schemes are too low relative to other sectors specially given the back breaking nature of the work. The fact that women (who have a lower reservation price) are the main entrants in this labor force suggests that piece rate wages (specially if picking rates are closer to 3 guffa) may just be competitive enough to keep attracting the female cotton pickers, but not the male labor.

21. Only recently have wages risen. Data on wage trends are not directly available but the SGB records the wage expenses, some of them paid out by the schemes to the tenants (as an advance) for cotton picking and cotton pulling.<sup>23/</sup> These are shown in Table 4. They show that between 1971-80 although wage outlays had increased in nominal terms--whether measured in terms of the total area sown, total cotton area sown or total cotton production--real wage rates had either stagnated or declined substantially in that decade. In

21/ In 1980 the wage ranged from 20-60 piaster/guffa but the average was 36 piaster/guffa. The mode was around 25 piaster/guffa. See Cain and Aricanli (1980), p.31.

22/ Political considerations also may intervene. In 1982 when labor contractors for the ginneries offered LS 1.76 per day they experienced a "labor shortage". By 1983 a wage of LS2.76--16% increase in one year--helped to get as much labor as was needed.

23/ Again these are expenses paid to tenants and may or may not cover tenant's labor costs. In fact tenants have been paying higher wage rates to attract the labor they need. That maybe one reason why all the cotton has been picked every year.

addition, working conditions for migrants remain difficult. Although most tenants now provide free food and shelter and a majority pay the costs to travel to schemes, these payments are low and not all migrants are provided transportation costs for the return journeys.<sup>24/</sup>

22. Nor are there any planned settlements for migrant labor in the schemes. In fact after over 20 years of confirmed evidence of the importance of migrants to the schemes the newer schemes were planned as if migrant labor was not an important component of the demographic reality in the scheme areas. In the more recently settled schemes like Rahad, no settlements were planned for migrant labor in the outlay of the villages, indicating that now as in the past the basic needs for migrant laborers and their families—for year round employment, housing, education—were never integrated into scheme plans despite the clear indications that migrants are critical to the success of the schemes!

23. For smaller and poorer tenants the real constraint is the low advances paid to attract labor. While the SGB pays an advance of LS 0.5 per guffa, tenants have been paying LS 1.2 per guffa to attract labor. Small tenants lacking the working capital cannot contract as much labor as they would wish to, nor are credit markets developed to which they can turn for working capital.

24. This evidence confirms the view that what plagues the schemes are not real labor shortages but rather excess demands at (past and current) low wage rates—that is at the real wage and non-wage incentives being offered, not enough labor is forthcoming in relation to demand. As these real wages decline, less and less labor will be forthcoming in relation to demand. The labor shortages for cotton should then be seen as a consequence of declining real wage and non-wage incentives being offered in the schemes in relation to the rising reservation price for tenant family labor because the returns to cotton and hence to labor in cotton have gone down, while returns to other crops and to labor in off-farm opportunities in the urban and service sectors have gone up; for local labor because the returns to labor in sharecropping in other crops and to labor in off-farm employment opportunities have gone up and for migrant labor because it has to come from further afar at higher transportation costs and can get better opportunities in the private sector. All these have reduced the supply of labor to the irrigated schemes while the demand has been increasing.

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<sup>24/</sup> In 1980 nearly 22% of the migrants were provided free food and another 72% both free food and shelter. Average transport costs paid ranged between LS .5-4 per migrant worker—the mode was around LS 2, suggesting that costs for migrants from the far West may have been only partly covered. Only 76% of tenants provided return transportation.

25. Added to these is the normal preference for mechanization because it is deemed "modern" by scheme managers and project planners and a widespread feeling that labor is difficult to manage and needs to be avoided.<sup>25/</sup> As a result, mechanization has appealed to both the scheme managers and tenants. To the managers its appeal lies in appeal lies in the reduced reliance on tenants for the recruitment and management of cotton harvest laborers and to the tenants and sharecroppers in the reduced family labor they have to devote to the unwanted and low return cotton they are required to grow!

26. Much more labor will be supplied to the irrigated schemes if:

- (a) competitive and rising real wage rates per unit of effort are offered in the schemes (relative to other sectors and occupations);<sup>26/</sup>
- (b) a premium wage is paid for hard physical labor involved in many agricultural operations (cotton picking and cane cutting are prime examples);
- (c) the rising costs of transportation to and from the schemes are fully allowed for in estimating the wages to be paid to seasonal migrant workers;
- (d) transportation is provided during the harvesting season to take workers from one scheme to the next;
- (e) larger advances are made, specially to smaller tenants--or greater working capital made available to them via formal credit institutions--to help them finance their contractual requirement for labor;
- (f) greater attention is given to non-wage incentives in the schemes by changing settlement policies to include the provision of basic services for tenants and migrant laborers--including housing, health, education--so as to attract greater supplies from other sectors and regions;

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<sup>25/</sup> In the sugarcane areas it was rumored that labor from the South could not be trusted with machetes and hence was not hired.

<sup>26/</sup> The returns to labor effort are particularly relevant for cotton picking labor where real wages per unit of effort tend to fall when yields are low and tend to rise when yields are high even for the same piece work rate.

- (g) greater attention is given to providing off-season employment opportunities for migrant labor.<sup>27/</sup> But none of these will be effective unless and most critically
- (h) cotton cultivation is made more productive and profitable, so that producers have both the incentive and ability to pay more for labor.

27. Higher real returns to cotton will (a) attract more labor though higher piece rates for migrants which cultivators will be inclined to offer, (b) will attract more of the sharecropping labor back into cotton cultivation and (c) will increase significantly the tenant family labor participation rates. In addition it will make the schemes viable and better able to advance higher amounts to cultivators for labor recruitment and expenses. A change from the joint to the private account system and increased producer prices are both steps in the right direction.

28. Further, the demand for seasonal labor could be reduced by: (1) reducing labor peak demand by staggering sowing and harvesting dates (2) developing cotton varieties that allow longer harvesting periods, or shorter growing periods and (3) by considering partial mechanization.

29. But how high a wage rate can the tenants and the schemes afford to pay before it pays to mechanize any given task including cotton picking? This is an issue that needs urgent enquiry. One needs to evaluate whether capital intensive methods yield higher economic rates of return than labor intensive methods. The "optimal choice of technology" will depend not only on assigning the proper economic (border price) value to imported and capital inputs and accounting for the economies of scale available in the schemes, but also on assigning the proper "reservation price" to the different types of labor available to the schemes in terms of other alternatives in sharecropping, off-farm employment and farming. In addition, the scheme level goals (of viability and maximizing cotton output) have to be reconciled on one hand with the farm-level tenant-sharecropper goals (maximizing returns to land and family labor while meeting subsistence needs) and on the other with national goals of assuring

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<sup>27/</sup> Again, no plans have been made to retain migrants in the off-season, the assumption being that they seasonally migrate in and then migrate out. This is no longer the case as earlier migrants have a tendency to become permanent. If year around services and employment were available, seasonal migrants could become permanent although they would continue to remit learnings to their villages.

efficiency and comparative advantage while at the same time providing enhanced net export earnings. Simple financial calculations on the basis of which decisions to mechanize have been taken in the past will inevitably be misleading.

30. Given the importance of the "labor shortage" issue and the role of internal migrant labor in Sudanese agriculture, it is essential that increased information be available for planning on the basis of demand and supply (quantity-wage) relations. For this, data need to be collected on a regular basis on rural wage rates (by region and by different task and seasons), labor use and labor migration in the schemes and the country as a whole. This is a task that should be urgently considered and could be assigned as a matter of priority to the scheme level statistical units and the Department of Agricultural Statistics in the Ministry of Agriculture.

**Table 1: COTTON PRODUCTION, LABOR "AVAILABLE" AND LABOR "REQUIREMENTS" FOR  
COTTON HARVESTING IN THE GEZIRA (1970-1980)  
(At Varying Picking Rates and Harvesting Days Available)**

Name	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
<b>Cotton Production (000 KT)</b>	3257.4	3018.5	2473.9	3026.0	2786.0	1063.6	1801.2	2231.3	1647.3	1398.6
<b>Total Labor (000's)</b>	552.1	557.8	556.5	586.2	493.4	325.2	469.0	503.2	462.6	435.7
<b>Family and Local Labor (000's)</b>	249.4	231.9	218.3	221.5	225.5	166.1	187.6	193.4	201.8	214.2
<b>Migrant and Floating Labor (000's)</b>	303.8	325.9	338.3	337.7	267.9	159.2	281.3	309.8	260.8	222.6
<b><u>Labor Requirements Under Different Assumptions</u></b>										
2 Guffa-12 days <sup>a/</sup>	1233.9	1143.4	937.1	1146.3	1055.4	402.9	682.3	845.2	624.0	529.8
3 Guffa-12 days	822.6	762.3	624.8	764.2	703.6	268.6	454.9	563.5	416.0	353.2
2 Guffa-15 days	982.9	910.8	746.5	913.0	840.6	320.9	543.5	673.2	497.0	422.0
3 Guffa-15 days	657.7	609.5	499.5	611.0	562.5	214.8	363.7	450.5	332.6	282.4
2 Guffa-20 days	493.3	457.1	374.6	458.2	421.9	161.1	272.8	337.9	249.5	211.8
3 Guffa-20 days	329.0	304.9	249.8	305.6	281.4	107.4	182.0	225.4	166.4	141.3

**Source: Production and Labor: Sudan Gezira Board.**

**a/ That is 2 Guffa (70 lbs) per man day and 12 harvesting days available; etc.**

**Table 2**  
**ESTIMATED COTTON PRODUCTION, AREA AND LABOR "REQUIREMENTS" FOR COTTON HARVESTING IN SUDAN, 1980-1990**

(At Varying Picking Rates and Harvesting Days Available)

Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
<b>Total Cotton Area (000 FD)</b>	1066.0	967.0	862.4	962.4	1000.0	1040.0	1075.0	1095.0	115.0	1135.0
<b>Total Production (000 KT)</b>	2302.1	2129.7	3207.0	3939.9	4151.7	4452.4	4891.8	5033.2	5074.8	5405.1
<u>Labor Requirements Under Different Assumptions</u>										
2 Guffa-12 days <sup>a/</sup>	872.1	806.7	1214.8	1492.4	1572.7	1686.6	1853.0	1906.6	1922.4	2047.5
3 Guffa-12 days	581.4	537.8	809.9	995.0	1048.5	1124.4	1235.4	1271.1	1281.6	1365.0
2 Guffa-15 days	694.6	642.6	967.6	1188.8	1252.7	1343.4	1476.0	1518.7	1531.2	1630.9
3 Guffa-15 days	464.8	430.0	647.5	795.5	838.3	899.0	987.7	1016.3	1024.7	1091.4
2 Guffa-30 days	348.6	322.5	485.7	596.6	628.7	674.3	740.8	762.2	768.5	818.5
3 Guffa-30 days	232.4	215.0	323.8	397.8	419.2	449.5	493.9	508.1	512.3	545.7
<u>1990</u>										
<b>Total Cotton Area (000 FD)</b>	1145.0									
<b>Total Production (000 KT)</b>	5425.6									
2 Guffa-12 days	2055.3									
3 Guffa-12days	1370.2									
2 Guffa-15 days	1637.1									
3 Guffa-15 days	1095.5									
2 Guffa-30 days	821.6									
3 Guffa-30 days	547.8									

Source: Production Data: Sudan Files.

1/ That is 2 guffas (70 lbs) per man day and 12 days of harvesting time available; etc.

Table 3  
SUDAN GEZIRA BOARD: LABOR "AVAILABLE", 1970-1980  
 (in '000 Persons)

	1970	1971	1972	1973	1974	1975
<u>Total Labor ('000s)</u>	<u>524.2</u>	<u>552.1</u>	<u>557.8</u>	<u>556.5</u>	<u>586.2</u>	<u>493.4</u>
(%)	100.0	100.0	100.0	100.0	100.0	100.0
Family Labor	30.4	32.6	29.6	28.3	26.6	31.5
Local Labor	12.2	12.6	12.0	10.9	11.1	14.2
Imported Labor (By Board)	7.6	8.6	13.8	15.5	19.0	13.1
Imported Labor (By Tenants)	45.5	43.6	41.7	42.7	36.6	39.2
Floating Labor	4.3	2.6	2.9	2.6	1.9	2.0

	1976	1977	1978	1979	1980
<u>Total Labor ('000s)</u>	<u>325.2</u>	<u>469.0</u>	<u>503.2</u>	<u>462.7</u>	<u>436.7</u>
(%)	100.0	100.0	100.0	100.0	100.0
Family Labor	34.8	27.3	25.7	28.7	31.7
Local Labor	16.2	12.7	12.8	14.9	17.4
Imported Labor (By Board)	8.9	10.4	13.5	0.0	0.0
Imported Labor (By Tenants)	38.4	48.6	46.1	54.7	49.7
Floating Labor	1.6	1.0	2.0	1.7	1.3

Source: Sudan Gezira Board, Wad Medani.

**Table 4**  
**SUDAN GEZIRA BOARD: LABOR COSTS, 1971-1980**

Name	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Cotton Picking ('000 LS)	5675.8	5325.5	4302.4	5648.6	6122.6	2495.7	5435.5	6238.6	8965.4	11726.9
Cotton Pulling ('000 LS)	2072.8	2094.2	2064.8	2132.4	1753.9	1010.8	2149.9	2236.1	2400.0	2400.0
Total Wage Expenses ('000 LS)*	7748.6	7419.7	6367.2	7781.0	7876.5	3506.5	7585.4	8474.7	11365.4	14126.9
<b>(a) Total Wage Expenses*</b>										
-Per Total Area Sown (LS/FD)	6.5	6.5	5.2	5.6	5.4	2.0	4.7	5.3	7.2	9.6
-Per Cotton Area Sown (LS/FD)	12.8	12.3	10.5	12.9	13.1	8.8	15.2	16.3	22.8	26.1
-Per Cotton Production (LS/KT)	2.4	2.5	2.6	2.6	2.8	3.3	4.2	3.8	6.9	10.1
<b>(b) Cotton Picking Expenses</b>										
-Per Total Area (LS/FD)	4.7	4.4	3.7	4.6	5.0	2.5	5.4	5.6	8.7	11.0
-Per Cotton Area (LS/FD)	9.4	8.8	7.1	9.4	10.1	6.3	10.9	12.0	18.00	21.7
-Per Cotton Production (LS/KT)	1.7	1.7	1.7	1.8	2.2	2.3	3.0	2.8	5.4	8.9
<b>Indices of Real Labor Costs (Deflated by CPI (Urban-Low); 1971 = 100)</b>										
-Cotton Picking	100.0	84.0	58.0	60.3	53.0	21.1	39.4	37.8	41.5	43.3
-Cotton Pulling	100.0	90.4	76.1	62.3	41.4	23.4	41.7	37.1	30.4	24.2
-Per Cotton Production (LS/KT)	100.0	85.7	62.8	60.8	49.7	21.7	40.3	37.6	38.5	38.1
<b>(a) Total Wage Expenses</b>										
-Per Total Area	100.0	88.7	61.0	52.4	40.5	14.8	29.5	27.6	29.2	30.8
-Per Cotton Area	100.0	85.5	62.7	60.8	49.7	33.1	48.7	43.6	46.6	42.6
-Per Cotton Kantar	100.0	92.5	82.7	65.4	58.2	66.6	72.9	54.9	76.1	89.0
<b>(b) Cotton Picking Expenses</b>										
-Per Total Area	100.0	83.3	59.6	60.0	52.4	26.0	47.4	40.8	48.7	49.1
-Per Cotton Area	100.0	83.9	57.8	60.1	52.8	32.2	47.6	44.0	50.2	48.3
-Per Cotton Production (LS/KT)	100.0	90.6	76.3	64.9	61.7	64.7	71.3	55.1	82.0	100.8

Source: Sudan Gezira Board. \* Cotton picking and pulling combined.

TRANSPORTATION COSTS AND INFORMAL CREDIT

(a) Transportation Costs

1. With Sudan's vast geographic area and sparse population density, transportation plays a crucial role in the development of the Sudan and its agriculture. The huge distances involved between regions make transportation costs an important element in determining the comparative advantage of different crops in different regions.<sup>1/</sup> Transportation costs by road and rail are high and carrying capacities limited. The lack of transportation is often cited as an important factor in explaining the low export potential of the traditional sector.<sup>2/</sup>

2. Both road and rail are heavy users of imported inputs and costs, though similar, are continually increasing. There is a heavy demand for transport of imported goods (coming in from Port Sudan) and a light demand for exporting goods, leading to differential import/export rates. After adjusting imported inputs to the border prices, the average round-trip transport costs per ton per km between major commercial centers are calculated by T. Moe are shown in Table 1.

3. Two facts emerge: (a) transportation costs are a high proportion of total ex-Port Sudan costs for most commodities which offers a high degree of protection to indigenous producers in local markets and an obstacle to export producers, specially those in the interior of the country; and (b) there is a substantial degree of subsidy implicit in the official rates being charged by Sudan Railways.

4. How important transport costs are compared to the total value of agricultural commodities is shown in Table 2. The data clearly show that for the traditional sector---in North Kordofan and South Darfur---the proportion of transportation costs to total value of output are nearly twice those from the closer rainfed mechanized and irrigated subsectors. This is the measure of protection available to local producers and the barrier presented to exporters.

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<sup>1/</sup> The distances from North to South and East to West are both around 2400-2500 km. The distance from El Obeid for example in the center-West to Port Sudan is nearly 1500 km by road. From El Fasher further West it is over 2100 km; from Malakal in the South it is over 1500 km and from Khartoum nearly 800 km.

<sup>2/</sup> In 1982, for example, much of a bumper crop of groundnuts was left in the West because transportation facilities were inadequate and costs too high.

5. We have already shown that, in spite of these high transportation costs; most of the crops grown in the rainfed traditional sectors have a higher comparative advantage compared to irrigated crops (ref. annex 2.3). Whether this will remain so depends on how rapidly transportation costs rise compared to how rapidly yields increase in the respective sectors.

6. But beyond comparative transportation costs there are severe bottlenecks due to a limited carrying capacity in the transport network serving the traditional areas in western Sudan. A study of the physical "availabilities" and "requirements" commissioned by the Government highlights this problem.<sup>3/</sup> Although it has yet to be completed, it concludes that agricultural production in the region "is being limited by the difficulties in marketing due to transportation problems." At present only about a quarter of the transport requirements are being met by rail transport--the rest have to be met by private road transport, at a higher cost.<sup>4/</sup> The emerging conclusion seems to be that additional road and more efficient rail facilities in the west would be required before increased marketed surpluses can be tapped for exports from the traditional sector. Whether or not these would be economically justified remains to be determined. But until the rail carrying capacity is increased, additional exportable surpluses can only be moved out by higher cost road transport--which itself is constrained by shortages of vehicles and fuel.

(b) Informal Credit System

7. Although other institutions serving agriculture--research extension marketing, parastatals--have received considerable attention, credit institutions have received relatively little attention until recently. Very little credit is available through formal institutions, and of that, even less is available to finance production.<sup>5/</sup> What little credit there is, is available at far higher effective rates for smaller, inexperienced borrowers than for

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<sup>3/</sup> Democratic Republic of Sudan: "Western Sudan Transport Study Project: Inception Report," Transport and Communications Sector, Ministry of Finance and Economic Planning, Khartoum, November 1982 (draft). This is a first step; to get estimates of transportation demand, costs will have to be incorporated in this study.

<sup>4/</sup> Some 1.3 million tons of goods and 22 million head of livestock were estimated as being moved in and out by the transportation system from western Sudan in 1980/81.

<sup>5/</sup> See Ahmed Homeida Ahmed "Lender Behavior and the Recent Performance of Rural Financial Markets in the Sudan," Ph.D. Dissertation, Ohio State University, 1980, p.50.

medium and large borrowers.<sup>6/</sup> In the irrigated sector there are, in addition, the advances made by the schemes for cotton cultivation. These, however, are inadequate to meet the working capital requirements of most tenants and sharecroppers, nor are they always paid in the timely manner required to be useful.<sup>7/</sup> No formal credit exists for other crops, and tenants have to rely on their own resources or turn elsewhere. There were some credit cooperatives in the 1960s, but because they were unable to repay their loans to the Agricultural Bank of Sudan (ABS) it stopped lending to them. Similarly in the Gezira scheme the loans to the Tenants Union for the purchases of agricultural machinery were also stopped due to the extremely poor record of debt repayment.

8. By default, borrowers in the traditional sector and small borrowers in the irrigated and rainfed sectors have to rely on informal credit systems and private money lenders.

9. The informal credit system and private money lending is dominated by the sheil system. Under this system a local merchant or money lender advances credit to the farmer in kind or cash to cover part of the costs of operations and/or living expenses during the season. The farmer verbally pledges his unharvested crops at prices considerably below their harvest value. At harvest the crop output is then taken by the lender. The sheil price is expressed in terms of the discounted price the lender agrees to purchase the crop at harvest time and varies with the period for which a loan is made. Thus sheil prices increase as one nears the harvest. The real interest on a sheil loan is the difference between the agreed sheil price and the harvest price amortized over the period of the loan. Inevitably these

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<sup>6/</sup> A. H. Ahmed has done a very careful analysis of all costs associated with borrowing by different size borrowers. Although the interest rates on loans were as low as 9%, by the time fees, transaction costs, travel and other expenses to obtain loans (all fixed costs per loan) were included the real effective borrowing costs for small borrowers varied between 17-30%, for medium size borrowers between 12-16% and for large borrowers between 9-13%, op.cit. p.164.

<sup>7/</sup> This was particularly true in earlier years. Recently the situation has improved. In 1981 in the Gezira scheme these included an advance of LS 8/KT for picking and LS 14/fd for labor recruitment. These were raised in 1982 to LS 10/KT and LS 18/fd respectively. With wage rates nearing LS 1.2 per guffa (LS 8.4/KT) in 1981 these advances seem adequate for picking. But in addition weeding expenses were reported as high as LS 200/fd in 1983 for which no advances were made.

interest rates are very high, and the 'shell' system can be properly described as exploitive.<sup>8/</sup>

10. The main link in the shell system are those between credit and the marketing of crops<sup>9/</sup> and most of the private money lenders are themselves traders or merchants.<sup>10/</sup> Given the terms described the rates of return to money lending are very high. For those who are forced to borrow, these high rates mean that the real returns to labor in crop production (whether or not the loan is for crop production or to meet consumption needs) are reduced considerably. Although the money lender bears the risk of a lower harvest price than he anticipated, he also profits from higher prices than expected. In case of crop failure or low productivity the loan payments are automatically postponed, so there is a tendency to increase indebtedness. Poorer borrowers in particular are left with very low returns and can be caught in a situation of chronic indebtedness from which they may find it difficult to extricate themselves. Moneylenders are in a continual position to buy outputs from such tenants at the low prices and supply them with necessities (or loans) at a high prices, thus keeping them in debt. And yet these moneylenders are preferred to formal institutions<sup>11/</sup> because they are flexible in terms of the urgency and type of loan (including consumption loans) they are willing to give, are willing to lend small sums for short periods on the spot with minimal hassles, demand little or no security except the crop at harvest and will lend to the poorest without regard to their "financial position." They can incur higher risks because they know their clients personally. Formal institutions cannot successfully compete with them on these terms.

11. The dearth of formal credit and credit institutions in rural areas means that there are no alternatives to which rural producers can turn for their financial needs. Increased institutional credit available at reasonable terms, from credit branches located in rural

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<sup>8/</sup> Thus for example in 1983 in Gedaref the shell price was quoted at LS 5/sack of groundnut and LS 10/sack of sorghum three months before harvest. As harvest prices were LS 10 and LS 18 per sack respectively the implicit interest rate was 200% for groundnuts and 177% for sorghum. In the Gezira effective interest rates in the range of 115-280% have been reported on shell loans. In the Gezira area one survey estimated that 29% of the credit came from the SGB, 23% came from moneylenders and merchants, 31% from shopkeepers and 17% from relatives and friends. See Ahmed Homeida Ahmed: "Private Moneylenders in the Sudan Gezira Scheme," Faculty of Agriculture, University of Khartoum (undated draft).

<sup>9/</sup> Unlike in sharecropping where the links are between land, labor and credit contracts.

<sup>10/</sup> As cotton cannot be privately marketed, there is no "shell" in cotton in the schemes. Shell is limited to those crops whose marketing the lender can control--groundnuts, sorghum and to a limited extent wheat.

<sup>11/</sup> In Homeida's survey 64% of the sample preferred to borrow from moneylenders and relatives, op.cit. p.14.

areas, with minimum delay and formality, however, can go a long way in helping tenants break away from the informal credit system. At any rate increased credit in the sector will be required as production increases and greater areas are brought under cultivation.

12. We recommend that the resources available to the ABS and its branches (and other formal institutions) for loans to agriculture be increased significantly, ABS open many more branches in rural areas than it currently has, ABS increase the share of its portfolio going to short term working capital and private commercial banks be encouraged to set up rural branches and extend a larger share of their portfolio to the agricultural sector.

13. This will not eliminate the shell system but will offer farmers an alternative that they do not now possess. Lower rates from the formal sector (even after the transaction costs are included) will also mean higher real returns to producers who currently have to rely on the informal credit system. Furthermore, rural savings can be mobilized by offering higher interest rates on time deposits in rural areas.

Table 1  
TRANSPORTATION COSTS IN SUDAN (1981)

<u>A. Transport Costs by Mode</u>		<u>Market Prices</u> <u>(LS/ton/km in 1982)</u>		
Gezira light railway			0.055	
Medium Size Trucks (7MT)			0.088	
Truck/Trailer (25 MT)			0.059	
<u>B. Average Road Transport Costs</u>		<u>Distance</u> <u>(in km)</u>	<u>Border Price</u> <u>Equivalent</u> <u>Costs (LS/MT)</u>	<u>Rates Charged</u> <u>by Sudan</u> <u>Railways<sup>1/</sup></u>
<u>From/To</u>				
Port Sudan - Khartoum	1190	70	30	
Port Sudan-El Gedanef	776	46	30	
Port Sudan-Wad Medani	1043	59	-	
Port Sudan-Kosti	1220	72	34	
Port Sudan-El Okeid	1500	89	37	
Port-Sudan-Nyala	2105	124	49	
El Gedaref-El Obeid	705	42	-	
El Gedaref-Kadugli	890	53	-	
El Gedaref-Nyala	1280	76	-	
El Gedaref-Juka	1362	80	-	

Source: T. Moe, Sudan: Export Development Study, Report No.4263-Su, East Africa Regional Office, December 82, Annex 5, p.3.

1/ In effect in March 1981 for transportation of gasoline from Port Sudan.

**Table 2**  
**TRANSPORTATION COSTS FOR AGRICULTURAL COMMODITIES**  
**AS A PERCENTAGE OF NET VALUE OF OUTPUT**  
**(Both at Border Prices)**

	Moe Study (1982) <sup>a/</sup> (Percent)	Sattar Study 1980/81 <sup>b/</sup>
Cotton-LS-Gezira	3.2 (13.0)	3.9
Cotton-MS-Gezira	3.4 (12.1)	4.9
Cotton MS-Rahad	3.5 (12.1)	3.6 <sup>c/</sup>
Wheat-Irrigated-Gezira	2.8 (4.7)	8.5
Sorghum-Irrigated-Gezira	9.7 (21.1)	7.6
Sorghum-Traditional	9.7 (20.8)	17.5 <sup>d/</sup>
Groundnuts-Irrigated-Gezira	5.3 (21.3)	8.0
Groundnuts-Traditional	5.3 (21.2)	14.1 <sup>d/</sup>
Sesame-Mechanized-Rainfed	3.4	6.3 <sup>e/</sup>
Millet-Traditional	12.8 (15.4)	17.6 <sup>d/</sup>
Sorghum-Mechanized-Rainfed	9.6 (19.4)	10.1 <sup>e/</sup>
Cotton-Mechanized-Rainfed	4.0 (12.0)	-
Sesame-Traditional	-	17.3 <sup>d/</sup>

<sup>a/</sup> Figures in brackets give total marketing, distribution and transportation costs.

<sup>b/</sup> Transportation from fields to Port Sudan as a percentage of F.O.B. cost.

<sup>c/</sup> In Suki.

<sup>d/</sup> In North Kardofan and South Darfur.

<sup>e/</sup> In Gedaref.