AGRICULTURE, DEVELOPMENT AND
POVERTY REDUCTION IN SUDAN

AN ANALYSIS OF PERFORMANCE, POLICIES AND POSSIBILITIES

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I.   INTRODUCTION

Agriculture contributes close to 40 per cent of Sudan's GDP. An overwhelming proportion of the nearly two-thirds of the Sudanese who live in rural areas depend on agriculture for their livelihood. Seventy per cent of the labor force is principally employed in agricultural activities. It is evident that in the foreseeable future the welfare of Sudan's population, especially of the poor who are largely located in rural areas, will to a substantial degree depend on the performance of the agricultural sector.

While the above indicates the urgency of analyzing the performance and the possibilities of agriculture, there is a serious obstacle to a proper analysis of these issues due to the lack of information about the sector that it far more pervasive than is the case in an average developing country, even by Sub-Saharan African standards. Prolonged civil war and lack of resources have made it impossible to carry out the normal exercises for the generation of statistical material that is essential for the analysis of economic and social issues. The latest available surveys of household income and expenditure are more than a quarter century old. The most recent population census, with1993 as the reference year, and the most recent labor force survey, implemented for 1996, were limited to the provinces under the control of the central government. Usual economic statistics, including those related to production in agriculture, are similarly limited to the area under the control of the central government. One of the highest priorities for policymaking for the welfare of the poor and the general population is thus to set up an updated system of statistical information, one that encompasses the vast and intractable rural sector. Since the fulfillment of this task is contingent upon the cessation of major hostilities, this hopefully would be an integral part of the peace dividend that Sudan seems to be on the verge of achieving, subject to the commitment of resources that would be needed to institute a set of benchmark surveys.

This paper, operating within the severe constraint imposed by the very limited quality and quantity of information, begins by trying to piece together a picture of the institutional organization and the structure of production of Sudanese agriculture. It then tries to document the performance of different types of agricultural organization during the past decade or so. Next it tries to present as coherent a picture as possible of the impact that agricultural performance might have had on the incidence of rural poverty in Sudan in recent years. Finally, based on the analysis of recent performance, it tries to chart a course of reforms concerning incentives, institutions and investments in agriculture and the rural economy of Sudan.

In view of the very limited quality and quantity of information, the story that is pieced together and the conclusions that emerge must be considered tentative. One of the first tasks indicated by them is their verification by the generation and analysis of more reliable evidence.

II. THE STRUCTURE OF SUDANESE AGRICULTURE

Crop production contributes approximately 45 per cent of the GDP originating in agriculture, livestock contributing most of the remainder, with forestry and fishery contributing just over 5 per cent.[1] Of this vast country, only about 40 million feddans[2] of land – less than seven per cent of the surface area - is used for crop cultivation. Except for less than one per cent of it cultivated by registered private farmers, the remaining land is owned by the government and allocated for use under three distinct systems of farming: (a) over 4 million feddans of land, irrigated by large-scale projects (more than 75 per cent of such land being directly owned and managed by the Government) is cultivated by farmers under tenancy contract with the Government (or non-Government owners of irrigation projects); (b) about 11.5 million feddans of alkaline clay soils and loams are leased out to individual contractors for semi-mechanized farming under rain-fed condition (referred to as mechanized rain-fed agriculture); and (c) approximately 22

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[1] Source of data in this section, unless specifically mentioned otherwise, is the Central Bureau of Statistics.

[2] A feddan is 0.42 hectare or approximately 1.04 acres. As shown in section IV below, area under cultivation has increased over time. The figures in this section are the most-quoted ones in Sudan. They probably refer to some date around the early or the mid 1990s.

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million feddans of land are left to be managed by tribes and local communities under traditional farming. Broad features of the institutional characteristics of the three systems may be summarized as follows.

Irrigated Agriculture

Irrigated land is parceled out in average plots of approximately 15 feddans to tenants who are effectively under fixed rental contract operated under a complex system.[3] These tenants have little freedom to determine the composition of output or the technique of production, which are decided by the project management. According to laws guiding the operation of the Gezira scheme, "the tenant may not transfer, assign, sublet or part with the possession of the land comprised in the tenancy or any interest therein or in the crop grown thereon, except with the consent of the government".[4] In this sense these tenants are anything but farming entrepreneurs. They produce the crops according to the system of rotation determined by the management by using inputs supplied by the management and hand over the cash-crop produce to the management who sell them and, after deducting the cost of inputs and a variety of service charges, pay the tenant the residual proceeds. The system does not appear to be sufficiently transparent to make it possible to identify and/or justify the various categories of deductions, e.g., land rent, water charges, other taxes, and management fees. The system resembles huge state farms (or centralized private farms, where the irrigation project is not owned by the government) which practice contracting out of specific segments of the production plan to individuals under a complex system of payments and regulations. Tenant households supply a relatively small proportion of labor and rely upon hired migrant labor, which is estimated to be as much as 80 per cent of total labor needs.[5] These migrant workers are often seasonal migrants from traditional farms (see below).

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[3] In the Gezira scheme, which accounts for about half of all land under large-scale irrigation, the average size of tenancy was 16.2 feddans in the late 1990s. See, World Bank, *Sudan: Options for the Sustainable Development of the Gezira Scheme*, October 27, 2000, Washington, D.C., p.40.

[4] Ibid, p. 40.

[5] Ibid, p.39.

Irrigated agriculture practices a diversified system of cultivation (see Annex Table 2). It is almost the exclusive producer of cash crops like Cotton and Sugarcane and relatively new food crops like Wheat. In addition it produces Sorghum, Groundnut, fruits and vegetables. In the beginning livestock was not allowed on irrigated land. The system was changed later to allow the tenant farmers to have livestock.

Mechanized Rain-Fed Cultivation

Under this system, large parcels of land, typically more than a thousand feddans but sometimes ranging between 50,000 and a million feddans, are leased out to individuals. Economies of scale in mechanization, needed for the cultivation of clay land, is often cited as the justification for the large size of these farms while the capacity to invest in mechanization serves as the factor limiting entry into the market for such tenancy. Nothing is known about the rent charged for such tenancy, especially for the larger units. There is a widespread impression among those who have analyzed this system of cultivation that the opportunity cost to the tenants of holding land is very low so that a good deal of such land is left uncultivated or put to wasteful use. Leaseholders often engage in subletting land and themselves become absentee landlords. Once again, it is hard to attribute to them the kind of behavior that one would expect from farming entrepreneurs managing a scarce resource. Farm labor is again largely supplied by the households engaged in traditional farming (see below).

These farms are very heavily specialized in the production of Sorghum which accounts for nearly 90 per cent of the gross output (see Annex Table 2). Sesame, Sunflower and Millet account for the rest.

Traditional Rain-Fed Farming

While precise estimates are not available, it is widely believed that most rural households belong to this form of farming. Under this system, land is assigned to the tribe or the community which parcels it out in roughly equal amounts to its members. The community has the right to use, not the full right of ownership which vests in the

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Government. The community in turn transfers the usufruct right to individual members who typically have 4 to 5 feddans of land per *worker*. These traditional farmers are the closest thing in Sudan to individual family farms except that they do not have the right to landownership or even to transfer the lease. These farmers engage in farm operations for only up to four months a year. Little quantitative knowledge is available about their occupation at other times although it is known that they supply most of the wage labor to irrigated agriculture and mechanized rain-fed agriculture. They engage in a variety of other occupations. Small-scale livestock farming is the most important of such activities while a variety of non-farm production activities also appear to be prevalent. This sector is the reservoir of labor for the economy of Sudan.

Crop production in these farms is quite diversified (see Annex Table 2). Two food crops – Sorghum and Millet – and two cash crops – Sesame and Groundnuts – account for most of cropping. Fruits and vegetables dominate the rest.

Livestock

The livestock sector transcends all the above forms of cultivation by overlapping with cropping. In addition, a wide spectrum of livestock farming takes place on natural pasture with the vast majority of the herders operating on dry lands. Considerable conflict between herding and crop agriculture is reported to exist as a result of the encroachment of herding on cropland. It is widely believed that there is substantial inequality in the size distribution of livestock farms although no quantification of this inequality is possible. While subsistence farmers and tenants on irrigated land diversify into small-scale livestock farming, very large herders dominate production and export which dramatically expanded in the 1990s.

III PERFORMANCE OF DIFFERENT SYSTEMS OF AGRICULTURE

The admittedly limited data on Sudan's agriculture tell a story that is remarkable for the support that they provide for a break in the sector's growth performance around

the end of the 1980s, showing that Sudan's agriculture suffered from relative stagnation for a long period until the end of the 1980s whence its growth rate sharply accelerated. The main features of the story are documented in Table 1.

Table 1

Agricultural Performance and Related Indicators
(Per cent growth per year)

	Between 1979/81 and 1989/91	Between 1989/91 and 1999/2001	Between 1979/81 and 1999/2001
Crop Production	-2.60	4.79	1.02
Arable Land	-	-	1.35*
Food Crop Production	-0.50	4.92	2.18
Cereal Crop Yield per Ha	-	-	-1.43
Land under Cereal Crop Cultivation	-	-	2.12
Livestock Products	1.14	4.70	2.90
Fertilizer per Ha of Arable Land	-	-	-4.10**
Tractors per Ha of Arable Land	-	-	-1.50**
Rural Population	-	-	1.2

Note: These estimates are based on the data shown in World Bank, *World Development Indicators 2003*. * Means between 1980 and 2000 and ** means between 1979/81 and 1998/2000.

During the decade of the 1980s – more accurately, between three-year average periods of 1979/81 and 1989/91 – growth in agricultural production lagged far behind the growth of rural population. Crop production fell at an annual rate of 2.6 per cent. Food production fell at a much slower rate of 0.5 per cent per year, indicating a faster rate of fall in cash crop output, notably of cotton. Livestock output increased, though at a slower rate than rural population, which was increasing at an annual rate of over 2 per cent.[6]

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[6] Calculations using the data shown in World Bank, *World Development Report 1992*, show that Sudan's population increased at an annual rate 2.7 per cent between 1980 and 1990, 3.9 per cent in urban areas and 2.4 per cent in rural areas.

This dismal trend in agricultural performance was reversed in the period beginning the turn of the decade. Food crops output increased at an annual rate of close to five per cent. The overall growth rate in crops was a little lower than for food crops. This suggests that the rate of growth of cash crops was lower still. Livestock output increased almost as fast as crop output. Rural population during this period (after 1990) was growing at a slower rate than during the 1980s - partly due to a decline in the rate of population growth and partly due to rapid increase in the rate of rural-to-urban migration - perhaps at about one per cent per year.[7] Since agricultural output is the overwhelming determinant of rural output, both because of its predominance and because of it being the principal causative factor behind most rural non-farm activities, there must have been a rapid increase in rural output per capita during this period. Indeed it appears that rural output per capita increased at an annual rate of over three and a half per cent sustained over a decade, a remarkable performance by Sub-Saharan African standards.

There are a number of puzzles concerning the remarkable turnaround in agricultural performance since the late 1990s. First, this is not due to an improvement in agricultural practices or an increase in the use of productive inputs. While data are available for change over the entire two-decade period, there is no evidence to suggest that the trend in the use of fertilizer and tractors during the 1990s was any different from the long-term trend shown in Table 1. Like the rest of Sub-Saharan Africa, fertilizer use per unit of arable land fell in Sudan, but it fell at a much faster rate. The rate of fertilizer use per unit of arable land in Sudan fell from 32 per cent of that in Sub-Saharan Africa in 1979/81 to only 18 per cent in 1998/2000. Tractor use per unit of arable land – only about 40 per cent of that for Sub-Saharan Africa – fell significantly in this country where a good part of agricultural land needs mechanical power for cultivation. Irrigated land area remained unchanged and irrigated land, as a proportion of cropland, fell significantly. The only obvious source of increase in agricultural output was the increased use of land which led to a sharp fall of yield per unit of cultivated land (by the evidence of the data

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[7] World Bank, *World Development Indicators 2003*, p. 122 reports the growth rate of rural population between 1980 and 2001 of 1.2 per cent per year. If this is combined with the estimated growth rate of rural population during the 1980s, based also on World Bank sources, the rate of growth in rural population since 1990 turns out to be negligible. It seems that this implicit inconsistency is due a revision of World Bank's estimates for the 1980s some time before the publication of the 2003 WDI. While these inconsistencies are frustrating, there seems to be little doubt that the rate of growth of rural population during the 1990s was lower than during the 1980s.

about the change in yield of cereals in Table 1). This resembles the classic response of the rural population, driven by poverty and lack of access to productive resources, to cultivate increasingly more marginal land to eke out a living. The only difference between the classic survival strategy and what is reported to have happened according to the data in Table 1, is that in Sudan the strategy seems to have led to a rapid growth in output per capita, an outcome which is different from the more typical one of stagnant or declining output per capita that "diminishing returns" associated with survival strategies usually result in.

Table 2

Estimated Annual Growth Rates in Value Added (1989/90 – 2000)

	Without Dummy for 1990/91		With Dummy for 1990/91	
	Growth Rate	Adjusted R^2	Growth Rate	Adjusted R^2
Value Added in Agriculture	10.1**	0.95	9.9**	0.95
Irrigated Agricultural Crops	7.3**	0.69	7.4**	0.65
Mechanized Rain-Fed Crops	5.9	0.00	0.9	0.38
Traditional Rain-Fed Crops	20.1 **	0.93	19.8**	0.94
Livestock	12.6**	0.96	12.8**	0.95
Total GDP	5.6**	0.99	5.7**	0.99

Note: ** Means that the coefficient showing the growth rate is significant at 1% level and * means that it is significant at 5% level. Growth rate shown without an asterisk is not significant at any reasonable level of confidence. Adjusted R^2 refers to the proportion of variation explained by the fitted trend equation.

To get a better insight into Sudan's agricultural performance during the 1990s, an attempt is made next to estimate the rates of output growth for each of the four different forms of agriculture identified in the preceding section: irrigated cropping, mechanized rain-fed cropping, rain-fed subsistence cropping and livestock. To get a as close an estimate of the true rate of growth as possible under the difficult data situation, annual data on real value added from the Central Bureau of Statistics (CBS) are used. In estimating the trend rate of growth, allowance is made for the drought year of 1990/91. The details of the methods of making the estimates are reported in the Annex to the paper. The results are shown in Table 2.

Real value added in agriculture increased at an amazingly rapid rate of ten per cent per year, much faster than the rate of growth for the comparable (though not exactly the same) period shown in Table 1 which is based on World Bank data. Value added in livestock increased faster than the value added in crop production; but the rate of growth in the latter – estimated separately for the three sub-categories – was also very high, well over 7 per cent per year.[8] The insertion of the dummy to allow for the drought in the year 1990/91 slightly lowers the estimated trend rate of growth for rain-fed agriculture, but, understandably, not for irrigated agriculture. Nor does it reduce the estimated trend growth rate of livestock.

The trend rate of growth of mechanized rain-fed agriculture was not significantly different from zero. Output in this sector was highly variable from one year to another even after allowing for the effect of the drought of 1990/91.

Value added in irrigated agriculture increased at a statistically highly significant rate of 7.4 per cent although the relatively low proportion of the explained variation, represented by the adjusted R^2, indicates considerable instability in output from one year to another.

Value added in traditional rain-fed cropping increased at an amazingly high annual rate of 20 per cent with a very high degree of stability in the growth rate, as represented by the high R^2 of the fitted trend equation. In attempting to explore the source

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[8] Growth rates for different types of crop production are estimated and reported in Table 2. No estimate is made of the trend rate of growth for value added in total crop production. The rate of growth for non-livestock agricultural value added, residually estimated from the growth rates with dummies in Table 2, is 7.4 per cent.

of this growth, one faces some difficulty. Table 3 shows the annual rates of growth for Sorghum, Millet, Sesame and Groundnut grown in traditional rain-fed agriculture. Together these four crops account for 81 per cent of value added in crop production in rain-fed traditional agriculture. The remainder of the value added is contributed by fruits and vegetables. It can be seen that the rates of growth of the four major crops – Sorghum, Millet, Sesame and Groundnut have been far lower than the rate of growth in value added in traditional agriculture. Only groundnut, accounting for 2.4 per cent of value-added, increased at a rate comparable to the rate of growth claimed for real value added for the sector. Since the estimates of value added are at constant prices and allowance for inputs is made as a given proportion of output value, one would expect the rates of growth in physical output and value added to be similar.

Table 3

Estimated Annual Growth Rates in Crop Outputs of
Traditional Rain-Fed Agriculture (1989/90 – 2000/01)

	Without Dummy for 1990/91		With Dummy for 1990/91	
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	Growth Rate	Adjusted R^2	Growth Rate	Adjusted R^2
Sorghum	14.8**	0.60	11.7**	0.74
Millet	13.3*	0.41	9.8*	0.60
Sesame	12.4*	0.30	9.4	0.36
Groundnut	29.5**	0.80	23.9**	0.89

Note: See note to Table 2 for an explanation of notations and terms. Output data are from the Ministry of agriculture and are shown in Annex Table 1. For Traditional Groundnut the drought dummy is used for both 1990/91 and 1991/92 because the data suggest a sharp fall in area and output in those two years.

As can be seen from a comparison of Tables 2 and 3, the average rate of growth of the four crops, accounting for more than four-fifths of value added in traditional agriculture, was only about one-half of the growth rate of value added for the sector.[9] It seems inconceivable that the remainder of the sector, accounted for by fruits and vegetables, experienced high enough a rate of growth to make the overall growth rate as high as is claimed by the real value added in the GDP series. Nor can the difference be explained with reference to a possible shift in favor of crops with higher benchmark producers' price because the three main crops experienced broadly similar growth rates. A further problem about the averaging of the growth rates of individual crops is that the trend rate of growth for traditional Sesame is unrepresentative of the long-term growth of its output. Indeed Sesame had little long-term growth: total Sesame output of traditional agriculture was far lower during the turn of the century than during the 1970s and the early 1980s (see Annex Table 1). Annual average output of Sesame in traditional agriculture was 196,000 tons during the three years 1970/71-1972/73. It fell to 141,000 tons during the three years 1980/81-1982/83 and to only 85,000 tons during the three years 1998/99-2000/01. Thus the estimated growth rate shown in Table 3 is due to the limitation of the time period starting in 1989/90, when a modest, incomplete and unstable reversal of the sharp long-term decline in the preceding years began.

IV.   TOWARDS A PLAUSIBLE EXPLANATION OF THE
PERFORMANCE OF RAIN-FED TRADITIONAL AGRICULTURE

The preceding section juxtaposes the extremely high trend growth rate of traditional agriculture, based on the GDP accounts data, against the more moderate, though still very high, growth rate suggested by the increase in output of the major crops. If one takes the latter as the more accurate reflection of the performance of traditional agriculture, one still has the task of explaining the source of this growth which, by any standard, was extraordinarily high. How did the traditional farmers, operating on rain-fed land and with

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[9] The CBS made available to us the shares of these four crops in the output of traditional agriculture for 1994/95 (see Annex Table 2). Using these shares and the growth rates from the trend lines fitted with the dummy, the weighted growth rate for the four crops turns out to be 10.8 percent.

visible access to nothing but declining resources and material inputs, manage to attain more than ten per cent annual growth in output sustained over more than a decade with limited year-to-year variability in the rate of growth? An attempt is made in this section to provide a plausible explanation of the growth that traditional agriculture may have experienced since the late 1980s.

As discussed in section II, traditional farmers are not, and have never been, a group isolated from the rest of the rural economy. They have been the traditional source of labor supply for both irrigated and mechanized rain-fed agriculture. Traditional cultivation provides employment for only about a third of the year and it is unlikely that it provides adequate employment to all workers in the households of the traditional farmers even during the peak rain-fed agricultural season. It is customary for members of traditional farm households to seek employment outside their own family farms. One major source of such employment, especially during the lean season for rain-fed agriculture, is irrigated agriculture. As recently as the mid 1980s, cotton was cultivated on about 875,000 feddans of irrigated land.[10] Cotton is a highly labor intensive crop and, especially during the picking season, this was a large source of demand for the labor force in traditional agriculture. By the turn of the century, cotton had lost more than half a million feddans, the average area harvested having dropped to 336,000 feddans in the three years ending in 2000/01. This change was due to conscious state policy of crop rotation away from cotton and in favor of food crops, which require much less labor than cotton does, to promote self sufficiency in food. The result was a drastic fall in labor demand for traditional farm households. Mechanized rain-fed farming, another source of employment for traditional farm households, failed to achieve any growth in output during the period under review, a fact that was documented in the preceding section. The rate of absorption of labor from traditional sector in the mechanized rain-fed farms must also have fallen. Together these two factors must have led to a serious loss of livelihood for the traditional farmers, who had to look for alternative means of survival. Migration to urban areas may have provided an outlet; but it was limited due to the very slow growth of the non-agricultural urban activities. Thus the response on the part of the traditional farmers for

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[10] This was the average area under cotton harvesting during the three years ending in 1984/85.

survival appears to have been a more intensive effort to eke out a living from rain-fed traditional agriculture.

The primary form of the survival response was to extend rain-fed traditional cultivation on more land. In 1989/90 the four main crops of traditional farming accounted for 10,025 thousand feddan. By 2000/01 it had expanded to 19,764 thousand feddan, a 97 per cent increase![11] The response of the traditional farmers was however more complex than a mere extension of the area under cultivation.

Table 4 shows the trend growth rates in area and yield of the four traditional crops. Area under the two main food crops each increased at a very high annual rate of just over seven per cent per year. But the rate of change in yield per feddan was somewhat dissimilar: there was at least a weak increase in yield, averaging at close to three per cent per year, for Sorghum whereas yield for Millet experienced a negative through statistically insignificant rate of increase. The trend growth rate in Sorghum yield is admittedly highly variable, the coefficient being significant only at 13 per cent level in a two-sided test.

The performance between the two cash crops was even more asymmetrical. Sesame actually stagnated, both in area and yield, over the period under consideration while, considered over a longer time horizon, its growth in area and yield were both negative. In contrast, both the area and the yield for Groundnut increased at high rates.

There is little that this paper can say by way of identifying the factors behind the asymmetrical growth in yield of the two main food crops. It could be due to the asymmetry in relative values of the two crops or relative technological opportunities facing two crops (e.g., a greater availability of improved seed variety for Sorghum than for Millet for conditions of uncertain water availability). As Annex Table 1 shows, in each year the ratio of harvested land to planted land has been higher for Sorghum than for Millet, often by a big margin. This may indicate that the farmers allocate a higher proportion of land that is subject to less uncertain rainfall to Sorghum than to Millet.

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[11] The Ministry Agriculture data show area under cultivation separately as planted and harvested area from 1990/91. No such distinction is made for 1989/90 and prior years. As best one can surmise, the figures for 1989/90 and prior years refer to planted area. The figures reported here refer to changes in planted areas.

Alternatively, this may indicate that Sorghum is better able to withstand variation in rainfall than Millet.

Table 4

Estimated Annual Growth Rates in Area (1989/90 – 2000/01) and
Yield (1991/92 – 2000/01) of Crops under Traditional Rain-Fed Agriculture

	Without Dummy for 1990/91		*With Dummy for 1990/91*	
	Growth Rate	Adjusted R^2	Growth Rate	Adjusted R^2
AREA				
Sorghum	7.3**	0.74	7.1**	0.71
Millet	7.8**	0.65	7.2**	0.64
Sesame	1.9	-0.02	-	-
Groundnut	16.2**	0.82	12.4**	0.97
YIELD				
Sorghum	2.9	0.17	-	-
Millet	-1.4	-0.07	-	-
Sesame	1.4	-0.08	-	-
Groundnut	6.1*	0.38	-	-

Note: See Table 2 for an explanation of notations. Note that the yield equations are limited to the period 1991/92 to 2000/01 for which the reason is explained in the Annex. Accordingly, there is only one set of yield equations, that without dummies for 1990/91. Area equation for Sesame is limited to data from 1992/93 onwards because, as can be seen in Annex Table 1, the areas for the two preceding years were wide off the long-term trend.

Combining the information in Annex Table 1 with the information in Annex Table 2, one also finds that for 1994/95, the only year for which this information is available to the authors of this paper, gross revenue per feddan was 55 per cent higher for Sorghum than for Millet. These matters should be analyzed in greater depth in order to get insights into the kind of policies that are likely to promote continued growth of traditional agriculture.

In the case of cash crops, the contrasting performance between Sesame and Groundnut is probably due a change in relative profitability of the two crops as is indicated by the sharp fall in Sesame exports. Even over as short a period as between 2000 and 2002 the value of Sesame exports fell by almost a half.[12] It is probable that this was induced by a decline in the demand for exports which, if true, should have led to a fall in the price of Sesame relative to the price of Groundnut, an ascertainable fact which was not available to the authors of this report.

Thus the performance of traditional rain-fed agriculture was much more nuanced than is often supposed. The fact that the rapid growth in Sorghum and Groundnut output was due to a combination of a growth in area and a growth in yield – weak in the case of Sorghum but strong in the case of Groundnut - points to the fact that this most primitive agriculture can avoid the extremes of diminishing returns. While little is known about the source of increase in yield, it appears that a more intensive absorption of labor, released from irrigated and mechanized rain-fed farming where the demand for labor fell and/or stagnated, was one of its main elements. The sharply different performance in crops faced with what appears to have been different market and/or technological opportunities, stands as testament to the responsiveness of the traditional farmers to such factors.

One further aspect of the performance of traditional rain-fed agriculture deserves to be highlighted. The actual source of the doubling of cultivated land under the four major crops is not at all well documented. But it points to an elastic supply of land in this sector, indicating a relative absence of a pure land constraint for the sector. This hypothesis is further supported by the fact that the rising yield in two of the four principal crops

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[12] Economist Intelligence Unit, *Sudan Country Profile 2004*, available by subscription online at: www.store.eiu.com.

indicates that the marginal land was not of a significantly poorer quality than the average.[13]

V.   OUTPUT, INCOME, WELFARE AND POVERTY

Poverty Trends in the Past

Estimates of poverty on a "comparable" basis are available for four years: 1968, 1978, 1986 and 1992. The first two are based on household budget surveys, the third on a labor force survey and the last one on a survey specifically designed to measure poverty (the 1992 Poverty Line Survey). Comparable estimates of incomes and their distribution were made for these disparate surveys to arrive at the poverty estimates shown in Table 5. The Table shows only the headcount rate and the absolute number of families in poverty. Estimates of income gap ratios are also available from the same source and they show the same broad pattern of change.

It is impossible to know how accurate these estimates are, in view of the obvious problems of reconciling measurements of income/expenditure based on surveys that have different objectives and are usually different in their approach to capture the components of these indicators. And yet there is no obvious reason to doubt the broad trend indicated by these estimates.

Some of the features of poverty and its change over time are worth noting. The incidence of poverty has been higher in rural areas than in urban areas, a well known phenomenon for the developing countries. The rate of increase in the incidence of poverty has however been far greater for the urban areas than for the rural areas. This is almost certainly due in part to the migration of a part of the rural poor to urban areas. Despite the much faster *rate* of increase in urban poverty over any given time period

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[13] In trying to explain the different rates of performance of different crops, we considered the different rates of effective protection that these crops were subject to. An unpublished study by the Ministry of Finance, *Competitiveness of Sudanese Agricultural Products,* 2000, shows that the effective protection rate for Sorghum was the highest of the effective protection rates for all crops for which estimates are available, but, unfortunately, the study does not include an estimate for Millet. This line of seeking an explanation for differential growth performance is further thwarted by the fact that for most years the estimated effective protection rate was higher for Sesame than for Groundnut.

shown in the table, the increase in the *absolute number* of the poor has been higher for rural areas than for urban areas in each period.

Table 5

Families in Poverty in Sudan

	Per Cent of Total		Number (million)		Annual % Change in Number	
	Rural	Urban	Rural	Urban	Rural	Urban
1968	62.7	15.9	1.18	0.052		
					3.0	9.3
1978	64.2	20.5	1.58	0.127		
					4.9	14.3
1986	83.1	52.9	2.31	0.370		
					2.8	11.3
1992	93.6	84.4	2.73	0.705		

Source: Paper by Ali in Nur, *Income and Human Poverty in Sudan, An Empirical Assessment*, July 2003, quoted in the Background Paper on IPRSP by Ahmed Abusin, October 2003.

The variation in the rate of rural poverty over time is roughly in line with the variation in the rate of growth of agriculture. We do not have a continuous time series of the real value added in agriculture for the entire period. But available sources suggest that the real growth in agricultural GDP during the decade between 1968 and 1978 was approximately 3 per cent per year.[14] This was in excess of the rate of population growth for Sudan and was certainly in excess of the rate of growth of rural population. Per capita agricultural output increased, though at a very slow rate. The headcount ratio of poverty during this period increased very little.

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[14] World Bank, *World Development Report 1992* shows the growth rate of agriculture between 1965 and 1980 to have been 2.9 per cent per year and the *World Development Report 1993* shows the growth rate between 1970 and 1980 to have been 3.3 per cent per year.

During the next period, between 1978 and 1986 agricultural GDP may have declined absolutely.[15] During this period per capita agricultural output appears to have fallen rather sharply. This was the period of the most rapid increase in rural poverty.

Over the period between 1986 and 1992, agricultural GDP appears to have increased modestly, at about 3 per cent per year. Per capita agricultural output increased at a moderate rate of perhaps one and a half per cent per year or more. It should however be noted that for the two years prior to 1991/92, agricultural performance was extremely bleak so that some of the output growth in 1992 must have gone to offset a part of the debts and obligations accumulated by the poor during those adverse years. Even so, the rate of increase in poverty moderated during this period. Together with the acceleration in migration to urban areas, this led to the lowest rate of increase in the absolute number of rural poor during this period.

The estimates of Table 5 also demonstrate a very important point: an increase in agricultural output per capita is no guarantee for the avoidance of increased impoverishment. We do not know what actually caused the breakdown in the linkage between the two during 1968-78 and during 1986-92; but it could be due to any number of plausible factors. Personal income of the rural households may have failed to grow at the same rate as agricultural output due to the deterioration in agriculture's terms of trade or due to a slower increase in household income from non-agricultural sources. The distribution of rural income may also have changed adversely for the poor.

What Has Happened to
  Rural Poverty during the 1990s?

An unpublished report by the Ministry of Manpower in collaboration with the International Labour Organization includes estimates of poverty for the years 1990 and 1996. These are reproduced in Table 6.

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[15] CBS estimates available to us date back to 1981/82 and show that the real value added in agriculture fell after that year and did not recover to that level in absolute terms before 1988/89.

Table 6

Poverty Rates by Residence and Sector of Employment
(Per cent of respective population below the poverty line)

	1990	1996
Residence:		
Rural	75.4	94.8
Urban	79.6	81.4
Sector of Employment:		
Agriculture	76.0	96.1
Industry	79.9	83.3
Services	78.1	85.4

Note: The source of these estimates is: Ministry of Manpower and the ILO, "Trends and Profiles of Poverty in Sudan: 1990-1996", 1997 (unpublished), Tables 3-9, 4-9 and 4-12. The report also includes the estimates of proportionate poverty gap and the squared poverty gap which show similar changes.

The estimates of Table 6 are in apparent conflict with the estimates of Table 5 in so far as in Table 5 rural poverty incidence is substantially higher than urban poverty incidence for both 1986 and 1992 whereas in Table 6 the incidence of rural and agricultural poverty in 1990 is *lower* than the incidence of urban and non-agricultural poverty. It is impossible to know the extent to which this is due to the use of different poverty lines, asymmetrical short-term changes between rural and urban incomes in 1990 and other possible differences in methodology (e.g., the fact that the estimates of Table 5 are proportions of households and the estimates of Table 6 are apparently proportions of population). A more important question is why did rural and agricultural poverty increase so sharply between 1990 and 1996? Notice that during the same period the increase in urban and non-agricultural poverty was more modest. A possible explanation is that the 1995/96 crop year experienced a sharp fall in output of all major crops (see the figures for traditional rain-fed agriculture in Annex Table 1 which represent the change for the entire crop outputs for the year) and that the income figures for 1996 reflect a slightly lagged response of farm and rural income to that event. No numerical estimates

are available to suggest that the change shown in Table 6 between 1990 and 1996 persisted in subsequent years.

What can one then say about the possible effect of the sharp acceleration in agricultural growth during the 1990s as a whole on the living standard of rural population and the incidence of poverty among them? In particular, is it conceivable that the incidence of poverty among the traditional farmers might have remained undiminished despite the phenomenal growth that they appear to have achieved? As this paper has argued, one might want to discount the extraordinarily rapid growth that the GDP accounts attribute to this sector; but a careful look at the output trends of individual crops indicates that the rate of output growth has been higher than 10 per cent per year. Sustained over more than a decade this must have meant a more than doubling of per capita agricultural production in the traditional sector over the decade. Could this have failed to reduce the incidence of absolute poverty in the sector? Since most of the rural poverty in Sudan is concentrated in this sector, both by virtue of its overwhelming dominance in rural population and its lower average living standard than in the other two types of agriculture, could this have led to the avoidance of a reduction in absolute poverty in rural Sudan during this period? It is of particular importance to address the question in view of the often-reported and widespread perception that the incidence of rural poverty in Sudan has actually increased during the last decade, that the change between 1990 and 1996, as shown in Table 6, is symptomatic of the change in poverty among the traditional farmers over the entire decade.

This report takes the view that there is no way that one can be certain about the change in the incidence of poverty during the period over which it has analyzed the performance of Sudan's agriculture in the preceding section. It can however put together a perfectly plausible explanation should careful estimation establishes that the incidence of poverty has actually increased during this period. Indeed our analysis of the growth of traditional agriculture strongly hints at the possibility of such an outcome.

We do not have a clear idea of the sources of income of a traditional farm household. It is however obvious that farming, limited to rain-fed season, provides employment and income during only a part of the year, perhaps for no more than four months. A second traditional source of their income is wage employment. A third source of income

probably consists of livestock products. Finally, there may be other non-farm activities, e.g., cottage industries and services. Consider a traditional household which obtained a substantial proportion of its income from wage employment in irrigated and mechanized rain-fed farming. During the period of under consideration it is likely to have experienced a sharp fall in wage income. Consider further the possibility that it produces cash crops that faced deterioration in relative prices (we have hinted at the possibility that this may have happened to Sesame). Consider further the possibility that it faced a reduced price for livestock products due to the recent change in marketing arrangements concerning exports, an issue that is discussed more fully later.[16] The aggregate effect may be to reduce the per capita income and welfare of the household.

Indeed, our story in the preceding section, suggesting that the impetus for the recent spurt in the growth of traditional agriculture came from the reduction of wage employment, implies that this is the most likely outcome. If one assumes adequate knowledge and rational behavior on the part of the traditional farm households, then clearly they preferred the previous situation of responding to the higher labor demand from non-traditional agriculture than the alternative of a greater intensity of traditional farming, an option that they appear to have foregone when more wage employment was available.

It needs to be stressed that, given the current state of information, this is being suggested as simply a possible outcome. In the absence of a great deal of additional information, it is impossible to know what actually has happened or the proportion of rural households which has been affected by the above phenomenon.

Should significant impoverishment of traditional farm households have taken place, who were the beneficiaries of real output growth in agriculture? As this paper has argued, the high trend growth rate of agricultural value added claimed by the national accounts data may be an overstatement; it however seems hard to deny that overall agricultural output increased at a minimum of close to 5 per cent per year, as claimed in Table 1

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[16] A few years ago the Government of Sudan handed over the export of livestock, which has rapidly expanded, to a monopoly. While this may have created a bilateral monopoly situation for the large herders, it is quite likely that this has squeezed out the small livestock producers of the benefits of a more competitive market.

compiled from World Bank sources.[17] Who were the beneficiaries of this growth? A great deal of information is needed to answer this question with confidence. Given that nothing like that information is available at the time, all one can do is to make informed guesses. The first question that needs to be answered is whether some part of the benefit of this growth was transferred out of the agricultural sector through a deterioration of its terms of trade with the rest of the economy and the outside world. Sudan's net barter terms of trade fell as much as 24 per cent between 1990 and 1998 when exports were almost entirely agricultural.[18] This could have resulted in the growth of factor income in agriculture lagging behind the growth of output, although it seems unlikely that it could have offset all or most of agricultural growth. In irrigated agriculture, the distribution of factor income was determined by changes in input costs charged by the public and private owners of irrigation projects although it seems likely that the rapid output growth did result in higher earnings for larger, profitable farms. There is very little that is known about these changes. Large herders and the monopoly export agency appear to have benefited from the rapid growth in livestock exports. Altogether it points to a substantial worsening of the distribution of income in agriculture.

VI. AN OUTLINE OF POLICIES FOR POVERTY-ALLEVIATING DEVELOPMENT OF SUDAN'S AGRICULTURE

INFORMATION

Detailed policymaking for continued growth of Sudan's agriculture, combined with a steady reduction of rural poverty, will require information on many areas of gaps in knowledge which have been identified above. The first important task for poverty-alleviating policymaking for Sudan's agricultural and rural development thus consists of setting up a system of generating information for the sectors. The principal task is to

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[17] The growth rate shown in Table 1 is not seriously inconsistent with an approximately 7 per cent growth in irrigated agriculture, a 10 per cent growth in traditional agriculture and stagnation in mechanized rain-fed agriculture – a point of view that we have proposed in this paper . But its acceptance also requires a substantial lowering of the official output claims made for the livestock sector, an issue that has not been dealt with in this paper for want of any independent data.

[18] World Bank, *World Development Indicators 2001*. Since then the terms of trade have improved but agriculture has been replaced by oil as the main export earner.

institutionalize regular surveys of: (a) household income and expenditure, possibly expanded to cover basic information concerning costs and returns of household farms and non-farm activities; (b) an agricultural census (possibly beginning with a quick sample-census) covering both cropping and livestock; and (c) a labor force survey. The Government of Sudan could seek assistance from international agencies which are known to have expertise in instituting these surveys quickly. For example, the World Bank has a lot of expertise in carrying out quick Living Standard Measurement Surveys (LSMS) which could provide the framework for the household income and expenditure surveys. In many countries such surveys have been implemented with the gestation lag reduced to months rather than years. The FAO could help institute an agricultural census and the ILO could help institutionalize a labor force survey.

There are many other indicators on which information is currently not available on a regular and timely basis. These include prices of inputs and outputs, domestic and international, and wages. Their collection and dissemination should improve both policy-making by the Government and decision-making by farmers.

While an information base is essential for operationally detailed policy-making, the broad features of reform necessary for poverty-alleviating rural development can be delineated even with the current level of information. The remainder of the paper tries to provide an outline of these reforms. Work on these reforms can and should begin immediately while their refinement and implementation should interact with the process of improving the information base.

INSTITUTIONS

Vibrant growth presupposes that production in agriculture is organized by a group of entrepreneurial farmers operating under an efficient system of incentives with access to productive resources. It is possible to argue that the absence of such farmers is the most critical factor hindering long-term growth of Sudan's agriculture. Production in irrigated agriculture, the most valuable agricultural land in Sudan, is organized by tenants who have a passive role in production decisions. Mechanized rain-fed farming is carried

out by a set of shadowy leaseholders who do not seem to be motivated by the consideration of efficient land use. Traditional farmers, who appear to have made efficient use of their meager resources and demonstrated an ability to respond to incentives, have little access to productive inputs, finance, technology and other resources. Widespread institutional reform is needed to create farming entrepreneurs to lead agricultural development in each of the three systems of farming.

Irrigated agriculture

Institutional reform in irrigated agriculture should be carried out on two distinct fronts. The first concerns the public and private owners of large irrigation projects which should convert themselves into managers of irrigation water and divest themselves of all farming operations; the second consists of converting the tenant farmers into full-fledged entrepreneurial peasant farmers who make all decisions concerning cropping pattern, technology and output disposal.

Lots have been written about the first aspect of reform. The World Bank report on the reform of the Gezira Scheme is an example of a detailed study aimed at reversing the inefficient and unprofitable use of irrigation water and the drain on public resources that it constitutes.[19] This paper does not have anything to add to its findings except noting that the irrigation projects should be converted into agencies maintaining the irrigation system, expanding them where necessary and selling water at an appropriate price to ensure its best use. They must cease to operate as gigantic farms integrating irrigation with the management of farm production through lease contracts with tenants subject to crop rotations and input decisions centrally imposed upon them.

The tenant farmers must be given full control over land and other resources necessary to enable them to be truly entrepreneurial peasants. The current distribution of tenancy does not appear to be incompatible with the creation of a reasonably egalitarian system of peasant farming although this issue is worth studying at greater depth.

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[19] World Bank, *Sudan, Options for the Sustainable Development of the Gezira Scheme,* October 27, 2000. While the report makes valuable recommendations for an efficient management of irrigation water, it stops short of recommending a clear separation between the irrigation scheme and the remainder of agricultural operations involving the tenants.

The question of land rights is a thorny issue in Sudan. It will have to be reformed. The authors of this report do not claim the expertise necessary to work a solution out of the present maze of land laws. All that they recommend is that, pending the final settlement of this issue, the tenants be given enough rights to enable them to function as peasant farmers. In this context Sudan might learn from the experience of other countries. Some of the Asian countries provide examples of outstandingly successful reform along these lines. The remarkable agricultural growth of Vietnam since the late 1980s was spearheaded by decollectivization and endowing the peasant households with five kinds of rights - the right to use, inherit, transfer use right, rent out and use as collateral – while the state retained formal ownership.[20] There is also the example of China whose remarkable growth in the post-1978 reform period was led by the agricultural sector in which the central impetus behind output growth was provided by the transfer of peasant control over land and its use, while the state retained formal ownership. In neither case the creation of a land market was necessary to promote vibrant peasant entrepreneurship. Indeed caution needs to be exercised in creating a full-fledged market for land which could lead to a polarization of ownership and increased inequality. Safeguards need to be in place to avoid such an outcome.

Mechanized rain-fed agriculture

The need for reform is nowhere clearer than in this sector which failed to grow during the last decade when the rest of agriculture achieved robust growth.[21] This report has pictured this sector as one which is operated by shadowy leaseholders because of its failure to obtain information on the terms under which they were granted lease of land. It is essential to gather the information necessary to carry out the reform in this sector that

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[20] See A. R. Khan, "Vietnam's Rural Economy: Performance and Prospects", Chapter 5 of Keith griffin (editor), *Economic Reform in Vietnam*, Macmillan, London, 1998.
[21] This paper is actually focusing on the "dynamic inefficiency" of this sector, defined as its failure to generate growth. There is not enough information to carry out a fully study of the relative efficiencies of mechanized and traditional rain-fed crop production. Output per feddan between the two systems does not differ systemically for Sorghum, the overwhelmingly important crop in mechanized sector, or for Sesame, the next most important crop in the sector (data for output per feddan are from the same source as shown in Annex Table 1). Gross output per feddan is however an inadequate indicator to base the comparison of efficiency on. One needs information on costs.

would foster growth. Basic principles may however be laid out as follows. It needs to be determined if indeed efficient economies of scale, dictated by mechanization by the condition of land under this form of cultivation, require the size of leasehold to be as large as it actually is. A priori, this appears most unlikely. Secondly, leases should be auctioned, under an expanded market of potential leaseholders created by the provision of credit, to ensure that land is being used most efficiently.

Traditional rain-fed agriculture

By their remarkable performance in the face of adversity, the traditional farmers have demonstrated that they are the best potential agents for agricultural growth in Sudan. Indeed by focusing on the promotion of the traditional farmers, agricultural development in Sudan will combine growth with poverty reduction because most of these farm households are poor. The process of converting them into productive peasant entrepreneurs must begin by endowing them with the kind of basic right to land that has been recommended above for the farmers in irrigated agriculture. These rights, designed with due care to protect the necessary elements of the role of the tribal and community organizations, will expand the access of the traditional farmers to credit and other resources once complementary reforms, outlined below, are implemented.

INCENTIVES

For a basic overhaul of the system of incentives one needs to know about the major distortions towards the identification of which research must be directed. Some of the outstanding areas of reform of the system of incentives is however quite clear.

Sudan's agriculture contributed almost all the exports until the late 1990s. The emergence of oil has not just reduced their share of total exports, but has drastically reduced their absolute levels of exports. Sesame is the most outstanding example. Even livestock exports, after years of rapid growth, began to fall drastically after 1999.[22] All

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[22] The Economist Intelligence Unit, *Sudan Country Profile 2004*, referred to earlier provides the data.

these bear the marks of a Dutch disease.[23] Sudan's traditional agricultural exports are clearly in danger of further decline as oil exports rise. Careful management of the exchange rate and compensatory incentives for agriculture must be designed to forestall that possibility.

Even before the emergence of oil exports, Sudan's production and export of cotton had been declining due to the official policy of encouraging self-sufficiency in food by transferring irrigated land from cotton to food crops by the centrally-enforced system of crop rotation. There is no evidence that this policy made any economic sense. Its implementation deprived large numbers of agricultural workers of their livelihood due to the large net reduction in labor use brought about by the shift of cultivated area from cotton to food crops. This, as this paper has argued, was a major cause of the possible impoverishment of a large number of traditional farm households. If the institutional reform proposed above is implemented in irrigated agriculture, the principal instrument of this discrimination against cotton will be eliminated. It is however not clear if there are additional disincentives to cotton in the system of taxation, trade or input pricing. These discriminations, as indeed discrimination against agricultural products generally, especially those produced by, and/or employing, the poor, should be carefully identified and ended.

The creation of monopoly in the export marketing of livestock products had an adverse effect on both productive efficiency and income distribution. Marketing Board control over export of Gum Arabic also amounts to a tax on its producers. These disincentives should be ended and replaced by the promotion of competition in marketing. Indeed, the promotion of competition in the marketing of agricultural produce and the distribution of agricultural inputs is a general principle that should be aggressively pursued (more on this below).

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[23] A complete analysis of this problem is beyond the scope of this paper. But a look at the real exchange rate of Sudanese dinar (SD) against renminbi (RMB), the currency of China, its biggest trading partner, points to the nature of the emerging problem. Between 1999 and 2004, nominal units of SD exchanging for a RMB increased by 4 per cent. Sudanese CPI over the same period increased by 47.6 per cent while the Chinese CPI fell by 1 per cent. Thus the SD appreciated against the RMB in real terms by 30 per cent! The data for Sudan is from Economist Intelligence Unit, *op. cit.,* and the data for China is from National Bureau of Statistics, *China Statistical Yearbook 2003*.

INPUTS

Reforms of institutions and incentives can at best create an enabling environment for poverty-alleviating growth in agriculture. These reforms must be complemented by creating conditions for the access of the farmers to productive inputs. As this paper has shown, Sudan's agriculture not only had a dismally low level of use of these inputs even by the low standards of Sub-Saharan Africa, it experienced a drastic decline in the use of some of the most important inputs over recent decades. This trend must be reversed if the reform of institutions and incentives is to succeed in promoting sustained long-term growth and poverty alleviation.

It is necessary to identify an appropriate package of inputs and ensure their elastic supply. Domestic research capability needs to be created in the adaptation of the seeds that have been developed elsewhere for uncertain and inadequate rainfall that characterizes much of Sudan's agriculture. This needs to be complemented by the creation of a system of supply and marketing of seeds, fertilizer and pesticide that ensures the availability of these inputs at competitive international prices. The large difference between the planted and harvested area under major crops indicates the uncertainty that agricultural production is subject to due to the uncertainly of rainfall. The feasibility of mitigating this by exploring the technology of "water harvesting" has been emphasized by numerous analysts of Sudan's agriculture. Basic vaccination and veterinary services for the protection of the livestock is another high priority.

The infrastructure of large-scale irrigation in Sudan badly needs repair and maintenance. Additional investment in infrastructure is needed to fully tap the water that Sudan is entitled to draw under its treaty with Egypt.

Improved input supply needs to be backed by an improved access to credit. At the moment the access of the traditional farmers to credit is dismally low. The implementation of institutional reform proposed above should help mitigate the problem of lack of collateral. This needs to be backed by a banking infrastructure geared to serve small borrowers. The ability of the traditional farmers to make effective use of the input package and credit and other services will depend on an improved rate of literacy on their part.

The list, though carefully selective and specifically focused on the strategic needs that are currently unmet, looks long. What makes the task daunting is that the above indicates the need for large-scale and indivisible investment in infrastructure. The creation of a system of input supplies; transport network and other overheads for the facilitation of the marketing of output; banking services; basic educational services; repair, maintenance and expansion of irrigation infrastructure; and similar other services will require large and indivisible investment. Much of this will initially have to be funded by the public sector.

Sudan's macroeconomic accounts are unclear about the magnitude of the investment rate and its change in recent years. CBS data arguably indicate a decline in the rate of investment between the early 1990s and the late 1990s.[24] According to the IMF data, fixed investment as a proportion of GDP was steady at about 12.5 per cent in each year between 1996 and 2000, while stock-addition as a proportion of GDP often fluctuated substantially. The sum of the two, amounting to the overall rate of gross investment, hovered between 17 per cent and 18 per cent of GDP during these years.[25]

It is impossible to arrive at a quantitative estimate of the investment requirement in all the various areas of input needs for agriculture. But it is clear that in order to accommodate the resource need for a minimum infrastructure for healthy agricultural development, the rate of investment will need to have a discontinuous upward jump. The draft IPRSP document demonstrates an awareness of much of the need for resources for agriculture that is outlined above. It is much less clear if its macroeconomic projections

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[24] The unweighted average of the rate of investment according to the expenditure account of the GDP for the years 1991/92 to 1994/95 was 20.5 per cent. The average fell to 18.4 per cent for the years between 1996 and 1999 (Sudan adopted calendar year accounting starting with 1996). There was a sharp rise in the rate of investment in 1998 to 26.2 per cent due to an unusually high rate of net capital inflow of 16 per cent of GDP. If this year is excluded, the average rate of investment in the other three years – 1996, 1997 and 1999 – was only 15.8 per cent. These measurements are based on the unpublished CBS data made available to the authors of this report.

[25] It was somewhat higher in 1996 due to high stock-building according to the IMF data. The IMF data, from IMF, *Sudan: Recent Economic Development, Statistical Annex*, is quoted in Economist Intelligence Unit, *op. cit.*

are consistent with the kind of acceleration in the rate of investment that is necessary to satisfy these needs, while at the same time meeting the needs of the other sectors.[26]

THE PEACE AND BEYOND

The possibility of peace settlement in Sudan raises tantalizing prospects for agricultural restructuring which this paper has not considered. Whatever political shape the peace settlement takes, assuming that it would lead to full economic integration with the South, a great deal of restructuring of Sudan's agriculture will be desirable in order to accommodate the very different resource endowment of South's agriculture. Free trade with the South, with its agricultural prospects fully exploited by appropriate investment to connect its markets with those of the North, would probably lead to a kind of agricultural specialization in the North which is vastly different from the present. This requires careful study and preparation.

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ANNEX

Real GDP and value added in agriculture and its four main components – irrigated crops, semi-mechanized rain-fed crops, rain-fed traditional crops and livestock – are available at constant market prices of 1981/82 from the Central Bureau of Statistics (CBS). These estimates cover the 16 provinces which are under the control of the central

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[26] The IPRSP draft dated December 2003/January 2004 visualizes the investment rate to increase to 22 per cent. Using the past ratio of fixed investment to stock-addition, this means a rise in the rate of fixed investment to a little over 15 per cent, from a benchmark rate of about 12.5 per cent. This is unlikely to accommodate the kind of increase in investment need for agriculture that is outlined above.

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government, together representing an estimated 84 per cent of Sudan's population for 2003. Nothing is known about output and its growth in the remaining Southern region controlled by insurgent groups. The CBS obtains the estimates of area and yield, based on samples of crop-cutting estimates, from the Ministry of Agriculture and makes value added estimates based on very simple procedures. Allowances for inputs are given percentages of gross output values and are based on old surveys. They do not take into account possible changes in technology over time. Our attempt to probe these figures for one year, 1994/95, showed that intermediate inputs as a proportion of gross output value were 40 per cent for irrigated crops, 37 per cent for mechanized rain-fed crops and 11 per cent for traditional rain-fed crops (see Annex Table 2). Disaggregated data for different types of agriculture are not available as a continuous series in published form. We were able to obtain it, from a variety of CBS files, starting with 1989/90 fiscal year. It is possible that more persistent effort would have allowed the generation of similar data for earlier years. In Sudan the time lag in the preparation of GDP accounts is very long. At the time of the mission for the collection of material for the present paper (late March 2004) the latest year for which actual estimates were available was 2000. Another problem with the data is that fiscal year estimates are available up to 1993/94 after which there is a break and calendar year estimates are available starting1996. Thus we have ten observations spread over an eleven-and-a-half-year period.

To get insights into further details of agricultural growth, we obtained output, yield and area figures for individual crops from the Ministry of Agriculture. We estimated growth rates for them based on twelve annual observations for fiscal years 1989/90 to 2000/01.

In estimating growth rates we also allowed for the possibility that the drought in the year 1990/91 might bias the estimated rate of growth. Thus, besides fitting a simple semi-logarithmic function of the form:

$$\text{Log } x_t = a + bt$$

We also fit the following function:

$$\text{Log } x_t = a + b_1 t + b_2 zt$$

Where:

x_t = Output in period t

t = Time =1 for 1989/90, 2 for 1990/91 … 7.5 for 1996 … 12 for 2000/01

z = 1 for 1990/91 (the drought year) and zero for all other years

The coefficient b represents the "growth rates without dummy for 1990/91" in Tables 2, 3 and 4 while the coefficient b_1 represents the "growth rates with dummy for 1990/91". As shown in the tables, typically the equation with the dummy gives a better fit to the constant trend growth rate equation.

In estimating the trend growth rate in yield a problem is posed by the practice of the Ministry of Agriculture in making a distinction between *planted* and *harvested* area since 1990/91 and making no such distinction for prior years. Yield is thus per planted feddan for 1989/90 and before and per harvested feddan for 1990/91 onwards. This understates yield for 1989/90 and before relative to yield in later years. We have therefore estimated the yield equation for the period 1991/92 onwards (1990/91 being excluded because yield in that year was affected by drought). This means that there is only one set of equations for yield, the one without dummy for 1990/91.

Annex Table 1

Area, Production and Yield in Traditional Rain-Fed Agriculture

(Area in thousand Feddan, Production in Thousand Tons, Yield in Kg/Feddan)

	SORGHUM				MILLET			
	Area		Production	Yield		Area		Production	Yield
	Planted	Harvested				Planted	Harvested		
1989/90	2464	-	291	118	3568	-	142	72
1990/91	3190	1560	124	79	4250	1550	80	52
1991/92	3130	1600	267	167	5250	2520	281	112
1992/93	4565	3500	586	167	6006	3570	398	113
1993/94	3450	2352	311	132	6366	2381	193	81
1994/95	5358	4392	878	200	9962	7621	961	126
1995/96	4858	3697	542	147	8074	5692	375	66
1996/97	6334	4380	903	202	8272	3711	411	111
1997/98	5432	3672	652	195	10218	6577	624	95
1998/99	5823	4756	1179	230	9406	6414	636	99
1999/00	5980	5026	1022	203	7994	5498	465	97
2000/01	5508	4056	706	173	8289	5104	458	90

	SESAME				GROUNDNUT			
Av 1970/71- 1972/73	1653	-	196	119				
Av 1980/81- 1982/83	1304	-	141	108				
1989/90	1656	-	65	39	1136	-	99	87
1990/91	1160	435	14	32	819	403	22	53
1991/92	705	313	12	38	640	412	66	160
1992/93	1800	1140	26	54	1612	900	145	161
1993/94	2090	1650	82	50	2100	1565	174	111
1994/95	1954	1672	65	39	2158	1814	452	249
1995/96	1672	1184	50	42	2805	2230	412	185
1996/97	2203	1576	108	69	2551	1892	473	249
1997/98	1834	1396	63	45	4106	3321	794	239
1998/99	2013	1592	111	70	3692	3083	608	197
1999/00	2203	1830	86	47	3821	3335	829	222
2000/01	1600	1388	57	41	4367	3482	947	272

Note: Yield prior to 1990/91 is per planted feddan and since 1990/91 per harvested feddan. These data are from the Ministry of Agriculture.

Annex Table 2

Shares of Agricultural Crops in Total Output and Value Added: 1994/95

	Quantity (000 MT)	Value (Ls. Million)
IRRIGATED		
Cotton	256.0	123.4
Sorghum	721.0	128.3
Wheat	448.0	116.5
Groundnuts	262.0	56.6
Millet	2.0	-
Sugarcane	4615.0	69.2
Egyptian Beans	69.0	23.9
Fruits	854.0	359.5
Vegetable	972.0	255.6
Gross Output		*1133.1*
Intermediate Input		*453.2*
Value Added		*679.9*
RAINFED MECHANIZED		
Cotton	2.9	0.8
Sorghum	2040.0	363.1
Sesame	101.0	32.5
Millet	9.9	4.1
Sunflower	47.3	15.2
Gross Output		*415.7*
Intermediate Input		*153.8*
Value Added		*261.9*
RAINFED TRADITIONAL		
Sorghum	878.0	156.3
Millet	963.6	175.4
Sesame	453.0	145.9
Groundnuts	66.0	14.3
Fruits	143.0	60.2
Vegetables	201.0	52.9
Gross Output		*604.8*
Intermediate Input		*66.5*
Value Added		*538.3*

Source: Central Bureau of Statistics. – means negligible.