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The Gezira Scheme:
Perspectives for Sustainable Development

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Preface and Acknowledgement

Despite a growing body of literature about the technical and economic aspects of crop production in the Gezira Scheme, there are hardly any studies about the scheme's performance with regard to cropping intensity, cropped areas, yields and output that take economic, institutional and infrastructure constraints into account. Therefore, the aim of this study is to analyse the constraints facing the scheme and their impact on its performance as well as the impact of the scheme's performance on farmers' incomes and welfare. The study goes beyond explaining the causes of past and present scheme performance to delineate the perspectives for sustainable development of the scheme.

The successful accomplishment of this study would not have been possible without the cooperation and support of the German Development Institute, which financed my stay at its premises in Bonn during the study period from June to September 2003 and enabled me to utilize its conducive research atmosphere and facilities. For that I owe unlimited appreciation to the GDI and its staff, which rendered me encouragement and the intellectual and social environment indispensable for such work. At this juncture I have to mention Prof. Dr. Hartmut Brandt for his interest in African agricultural issues in general and the agricultural performance of Sudan and the Gezira Scheme in particular as well as for the support, expert comments, direction and counsel he gave me given throughout my research period. My appreciations are extended to Dr. Stephan Klingebiel and Dr. Michael Brüntrup for their interest in my study, their encouragement and their constructive comments, to Mrs. Gisela Kuhlmann for formatting and laying out the study report and to the secretarial staff of GDI for their administrative support during my stay at the GDI.

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Khartoum, November 2003 A.M. Eldaw

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Abbreviations

ABS	Agricultural Bank of Sudan
ARC	Agricultural Research Corporation
BS	Bank of Sudan
CBs	Consortium of Commercial Banks
CPC	Cotton Public Corporation
DAE	Department of Agricultural Engineering
ELS	extra long staple cotton
EPC	Effective Protection Coefficient
FAO	Food and Agriculture Organization of the United Nations
GAC	Gum Arabic Company
GDP	Gross Domestic Product
GDI/DIE	German Development Institute / Deutsches Institut für Entwicklungspolitik
GLR	Gezira Light Railway
GRS	Gezira Research Station
IBRD	International Bank for Reconstruction and Development
IMF	International Monetary Fund
IWC	Irrigation Water Corporation
LMCC	Livestock and Meat Marketing Corporation
Ls	Sudanese Pound
MOIWR	Ministry of Irrigation and Water Resources
NIC	National Insurance Corporation
NPC	Nominal Protection Coefficient
NRC	National Research Council
OSC	Oil Seed Company
PAM	Policy Analysis Matrix
SCC	Sudan Cotton Company
VAT	value-added tax
WUG	Water User Group

Summary and Conclusions

Situation and Outlook in Brief

The Gezira Irrigation Scheme was established in 1925 and enlarged to its present capacity of 2.1 million feddans of irrigable area (882.000 ha) in the early 1960s. The scheme occupies the area between the Blue and the White Niles about one taxi hour north of Khartoum, the Sudan's capital. The scheme still contributes some 3 % to the GDP of the country. It provides the opportunity of a basic livelihood to 114.000 tenant families, other job opportunities for 0.5–1.0 million casual workers and employs a staff of about 7000 qualified administrators, technicians, scientists, clerks and craftsmen. The irrigable area cannot be run at capacity unless the overall infrastructure and central services of the scheme are in good shape.

The Gezira comprises about 42 % of the established irrigation area of the Sudan and uses about 35 % of the Nile waters allocated to the Sudan in the Nile Water Agreement with Egypt. With the economy of the Sudan regaining its balance and doing away with inflation in the course of its oil sector developments, prospects are favourable for overall economic development. In the context of such perspectives, the Gezira's contribution to the inland food markets – naturally protected by long road distances and high transport costs between Khartoum and Port Sudan – has eventually a central role to play. To what extent such possibilities will be realised depends, of course, very much on the country's future policies – in particular on its exchange rate policies and on its price, market and trade policies for the agricultural sector.

The management and service structure of an irrigation scheme as large as the Gezira can by necessity not do without a centrally organized and managed administration and centralised services. Future efforts to (further) liberalize management and services will have to look very carefully at which components can be liberalized and which not, since water allocation f.e. could not be liberalized for technical and organizational reasons, at least not without incurring costs for control and enforcement which would render the whole scheme grossly uneconomic.

The scheme's infrastructure and services have run down more or less continuously since the industry-centred development policies of the 1970s and during the precarious situation of government finances throughout the 1970s and 1980s up to the mid 1990s. In the course of all these years average crop profits per hectare have been reduced on average to some 75 % of the level of the early 1970s in real terms. At present they stand at about 90 % of this base line reference level. Furthermore the cropped area has undergone pronounced fluctuations, which, in certain years, grossly crippled the financial and economic performance of the scheme.

As to the future role and economic competitiveness of the scheme the prospects are principally very good for the following reasons:

— There are big, practically proven reserves of physical yields, which can be realised if infrastructure and services are thoroughly rehabilitated and adequately reorganized and, furthermore, favourable macro and agricultural policies are maintained.

— There is a considerable margin of "natural" import protection for food products (in particular perishables), as mentioned above.

— There are sound prospects of high growth rates for inland demand, particularly in the Khartoum area.

— In spite of a considerable brain drain in the past, there still are sufficient numbers of able and experienced administrators, economists, agronomists, technicians as well as clerical workers and craftsmen.

Dangers might in part lie in future temptations to overstaff and an ensuing renaissance of overcentralisation. Full government coffers tend to make for that – wherever in this world.

Perspectives for Sustained Development

The performance of the Gezira Scheme has been extensively studied during the past 30 years. Several scholars from various domestic academic institutions have conducted many of these studies, while a large body of literature has accrued from studies initiated by the government in collaboration with international institutions, including the World Bank, FAO, IBRD, GDI and others. In addition, the Gezira Research Station and other institutions of the Agricultural Research Corporation have conducted a bulk of research focussing on almost all aspects of crop technology development. While most of this research has located the roots of the inefficiency of the scheme's performance, almost all authors have acknowledged the potential of the scheme for sustainable development under the condition that proposed remedies be implemented. However, a variety of hindrances have impeded the implementation of proposed remedies. These include a wide range of elements that have evolved from the political and macro-economic developments of the country throughout the post-independent era. In addition, the attitude of the whole range of stakeholders of the scheme to changes and the posture of the international community in addressing cooperation relations with Sudan have contributed to encumbering the implementation of actions for sustained development.

Nonetheless, there are currently some notable developments that provide the required environment for changes and adjustments for sustainable development in the Gezira Scheme. Hence, there are broad indications of improvements of the country's economy, political stability and external relations. These developments, together with sound domestic and export market prospects for products from the Gezira Scheme, provide a good basis for sustainable development of the Gezira Scheme.

Political Stability and External Relations

After long years of political instability as well as international and regional isolation, in addition to civil war in the south, the Government of Sudan embarked on a wide range of political improvements. The government's conduct in containing internal political conflicts has changed from confrontation with opposing groups to consultation with these groups. This development has represented a turning point for the important opposing parties to depart from exile opposition and to engage in internal opposition. The government has undertaken further steps toward reforming the political atmosphere by widening its appreciation of human rights and the rights of self-determination and freedom of the press.

However, the government's most important achievement was commencement of intensive peace negotiations with the Sudanese Peoples' Liberation Army (SPLA), which has been in armed confrontation with the central government army in southern Sudan since 1983. As a result of these negotiations, which are running under the umbrella of IGAD, a cease-fire agreement was signed between the government and the SPLA about a year ago. Within the same context, the armed confrontations in the Nuba Mountains were terminated.

The improving internal political environment, especially the positive developments with regard to armed confrontations, have resulted in a further lessening of the tensions in Sudan's external relations. As a result, Sudan's political, financial and economic relations with the important international organizations and the principal political centres have improved substantially.

In consequence of the above, the Sudan now seems to have managed to start establishing a promising environment for a firmer political foundation than in most periods of the past two decades on which to build economic strength and development.

The Macro-Economic Environment

Sudan has made substantial progress over the past five years since 1998 in achieving macroeconomic stability and advancing structural reforms. The

economy responded positively to the reforms initiated in 1997/98. Following years of stagnation and triple digit inflation rates, economic growth averaged about 6.5 % while inflation declined to less than 5 % during 1998–2002. In addition, sustained efforts brought the fiscal position under control, with the budget deficit averaging about 1 % of GDP over the period 1999–2002. Substantial progress was also achieved with structural reforms. Price controls were lifted and all economic activities were opened to the private sector, while a liberal foreign trade regime was established and an ambitious privatization program was adopted. The exchange rate was unified and the exchange system was significantly liberalized, and currently there is no difference between official and unofficial exchange rates. As regards international trade, export earnings recorded increasing growth rates during the period 1998–2001 and became more diversified as a result of increasing petroleum exports and expanding exports of livestock products, sesame and gold. This development enabled Sudan to resume debt service. With regard to trade reform, non-tariff trade barriers were essentially eliminated and protective tariffs were heavily reduced. On the fiscal front, expenditure management has been strengthened and almost all price subsidies have been eliminated. Moreover, tax and customs administrations have been significantly improved and the value-added tax has been introduced. Similarly, more progress has been achieved in strengthening and restructuring the banking system and liberalizing the financial system.

Improving economic performance and growing confidence in the stability and growth of the national economy have provided a sound basis for investment in agricultural production in the Gezira Scheme. Thus, improving economic growth is expected to stimulate and expand demand for agricultural output, while reduction of the inflation rate is expected to reduce the pressure of financial costs on producers and decrease the interest rates for credit. Similarly, a positive balance of payments will make it possible to import more inputs, and a domestic budget surplus will increase financing for investments and development of infrastructure.

The Socio-Geographical Environment

The recent socio-demographic changes in Sudan, which have largely been due to environmental factors during the past decades, have given additional importance to irrigated agriculture in sustaining agricultural growth and providing food and employment. Within this context, the Gezira Scheme is assuming special importance because of its geographic location, size and potential for crop production. Thus, the location of the scheme in the centre of the country and, especially in the vicinity of the large urban centre Khartoum (with a population over 6 million inhabitants), provides additional prospects for an expanded market oriented food production. On this basis, more options will be available for crop diversification in the Gezira Scheme and hence at the same time for diversification and expansion of opportunities to raise producer incomes.

Stakeholder Attitudes to Changes

The major stakeholders of the Gezira Scheme have been concerned for many years about the Scheme's technical and economic efficiency as well as the heavy demands it places on public resources. Realizing the increasing pressure on the public budget and the need for competitive production for future agricultural trading opportunities, the government of Sudan, the Sudan Gezira Board and the Tenants' Union of the Gezira Scheme became aware of the need to search for strategies and policies to improve the efficiency of the scheme. This situation provoked a nation-wide intensive discussion of the problems of the Gezira Scheme and possible solutions to these problems. As a result, there is currently a growing consensus among stakeholders on the need for an expanded tenant participation in decision-making and the selection of cultivated crops and crop rotation as well as the need for institutional reform and enlargement of the involvement of the private sector in delivering services.

Market Prospects for the Gezira Scheme's Products

The available literature on the Gezira Scheme emphasizes the sound market prospects of the Gezira Scheme's products. Hence, although cotton markets are extremely competitive, there are still substantial market prospects for cotton from the Gezira Scheme (World Bank 2000). There are also sound market prospects for the other main products from the Gezira Scheme like sorghum and groundnuts. Market prospects may also be promising even for wheat, provided that yields can be increased to levels that render it competitive against imported wheat.

However, there are additional factors that enhance the market prospects for agricultural products from the Gezira Scheme. The increasing government endeavours to expand the export of livestock and horticultural products in order to diversify and expand the country's agricultural exports provide additional market prospects for the Gezira Scheme. Hence, the resources available within the Gezira Scheme provide excellent conditions for livestock production as well as for the production of a variety of horticultural products. These prospects are very promising not only because of the location of the Gezira Scheme and the available transportation infrastructure but also because of expanding demand for livestock and horticultural exports in the nearby markets of Saudi Arabia and the Gulf countries.

Agricultural Policy Perspectives

The declared government agricultural policy emphasizes continuation of the liberalization policies adopted since the early 1990s. Accordingly, measures were planned, with the support of the IMF, for further reduction of the role of the public sector in agricultural production, provision of services and agricultural marketing and a correspondingly enlarged private sector involvement in the delivery of services.

The government-planned policies aim at increasing the effectiveness of public sector organizations in focusing on the construction and maintenance of the major infrastructure and increasing the involvement of the private sector in taking primary responsibility in the provision of services. It is expected that public sector organizations like the Gezira Board will focus on the maintenance of the irrigation network for efficient distribution of irrigation water in addition to the provision of core support services like agricultural research, agricultural extension and market information. At the same time, it is expected that the private sector will take primary responsibility in the provision of services such as land preparation and sale of inputs. These policies are, therefore, expected to lead to wider tenant participation in decision-making for production, marketing and allocation of resources and hence to provide the basis for more incentives for tenants to improve the efficiency of their husbandry practices in order to increase their incomes.

Areas for International Cooperation

The Sudan is endowed with enormous agricultural resources. It has large land reserves, adequate water resources and a high livestock population. These resources, together with the geographical location of the country in the vicinity of the large markets of the Arab World (Saudi Arabia, the Gulf States and Libya) and the diversity of the Sudan's climate, qualify Sudan as a promising supplier of agricultural commodities.

In addition, the various subsectors of the Sudanese economy provide good opportunities for fruitful cooperation with respective industries from the industrialized world. These opportunities lie within the service industries for agriculture, the processing industry, the communication sector, and the transportation and trade sectors and, recently, in the emerging petroleum sector with all its associated industries.

Moreover, there are critical factors that underline the interesting position of the Sudan as a potential partner for economic cooperation. These include advances in political stability, recovering micro-

economic indicators and improving external relations.

Given the past development path of Sudan, the entire potential of the country has remained basically untapped. While Sudan still lacks the required capacities and resources for drafting and implementing development plans to utilize available resources and attain progress, the Government of Sudan is laying heavy emphasis on the importance of development cooperation with the international community, especially from Germany and the European Union.

The areas of required development cooperation include technical assistance to the government in the form of policy advice as well as capacity and institution building and provision of information, access and relevant arrangements for economic cooperation of the German private sector with the Sudanese private sector.

The fields open for policy advice include privatisation of state owned enterprises, development of private service industries and liberalization of trade. Thus, Sudan has already started out on a liberalization process for state owned enterprises. Many small agricultural schemes, for example the Blue Nile Agricultural Corporation, the White Nile agricultural Corporation and the Northern Province Agricultural Corporation, have been privatised. However, for lack of experience and capacities for planning and implementation of privatisation programs, severe difficulties have been encountered. Therefore, policy advice in this regard is of high priority. Similarly, the Sudan lacks the experience and capacities required for development of private sector enterprises to undertake activities which have previously been undertaken by state organizations, such as provision of services for the agricultural sector, credit provision and marketing.

As regards the field of capacity building, far more technical assistance is required to strengthen the base of economic research, policy planning and policy analysis. Such assistance can be rendered directly by strengthening specific education institutions, provision of study grants and launching of joint training programs with local universities and research institutions and indirectly through joint research projects and studies.

The technical assistance required in the field of institutional development includes training of personnel in management of financing, marketing and service industries, in addition to implementation of support programs for existing institutions through provision of experienced personnel to assist in the development of these institutions and enhancement of their capabilities.

Moreover, high priority should be given to facilitating the access of Sudanese private sector enterprises to respective German enterprises through relevant support for participation in exhibitions, provision of information about market regulation and rules and support of relations between trade chambers in Sudan and Germany.

1 Introduction

At present Sudan's economy is predominantly based on agriculture. The importance of agriculture rests on its contributions to GDP, exports, employment and production of food and raw materials for industries. The Sudanese agricultural sector comprises three subsystems: the irrigation subsystem, the mechanized subsystem and the traditional subsystem. Irrigated agriculture plays an important role in the Sudanese economy. It accounts for a substantial share of agricultural GDP and it produces most of the country's crop of cotton, sugar cane, wheat, legumes, peanuts, fruits and vegetables. In addition, irrigated agriculture accounts for a substantial share of groundnut and food production and represents an important base for livestock production.

Irrigated agriculture comprises many public schemes. Among these, the Gezira Scheme is the oldest and, area-wise, the largest one. The Scheme occupies a central position in the agricultural sector of Sudan. In relation to the total area under irrigation, the area of the Gezira Scheme accounts for about 42 %, and it utilizes some 35 % of Sudan's current allocation of irrigation water (Ahmed 2000). While irrigated agriculture contributes about 13 %[1], on average, to national GDP and about 33 % to agricultural GDP, the share of the Gezira Scheme's contribution to national and agricultural GDP is estimated at 3 % and 7 %, respectively (World Bank 2000). In terms of its physical contribution, the Gezira Scheme has contributed significant proportions to the country's agricultural production during the past decades. Thus, about 2/3 of Sudan's cotton exports and about 70 %, 30 % and 12 % of the country's total production of wheat, groundnuts and sorghum, respectively, originate from the Gezira Scheme (Magar 1986; Brandt et al. 1987).

Within the Gezira region, the Gezira Scheme is of overwhelming importance. The value of infrastructure within the Scheme is estimated at about US $ 8 billion (Omara 2002). The importance of the Scheme, however, increases when the value of infrastructure within other institutions that are directly or indirectly associated with the Gezira Scheme is taken into consideration. Moreover, the Gezira Scheme is eminently important because the whole of the economy and social life within the region are bound up with the Scheme's activities. Thus, the Scheme provides livelihoods for 114,000 tenant families as well as for some 7,000 permanent employees (previously, i.e. before 1990, 13,000 employees) and between 0.5–1 million casual labourers, and it accommodates over 2 million head of livestock (Galal 1997).

1.1 Context of the Problem

Long-term developments of performance indicators for major crops in the Gezira Scheme reveal a steady decline and/or stagnation of output of cotton, wheat and groundnuts. Thus, compared to an annual average acreage in the range of 0.5–0.6 million feddans during the 1970s, cotton cultivation dropped during the period 1995–2002 to the lowest level it has ever attained, in the range of 0.15–0.33 million feddans.[2] In addition, average cotton yields decreased and underwent heavy fluctuations through the 1980s and 1990s. The maximum average yield attained during the late 1990s was only 4 kantars/feddan, while this figure dropped sharply in 1999/01 to reach just about 2.5 kantars/feddan. These developments, however, caused cotton exports – once Sudan's major export product – to fall from 22 per cent of total export earnings in 1995 to 2.5 percent in 2000.

Like cotton, wheat and groundnut cultivation have declined during the past decades. The area under wheat production declined from over 0.5 million feddans during the early 1990s to a very low level in the range of 0.06–0.08 million feddans during 1999/00–2001/02. The decline in acreage was accompanied by high fluctuations and a falling trend in wheat yields, and thus wheat imports have had to be substantially expanded to meet domestic food requirements. Accordingly, the

1 Average of 1991–1997.

2 1 feddan = 0.4 ha.

value of Sudanese wheat imports increased from US $ 31.2 million in 1992 to over US $ 175 million in 2000 (Bank of Sudan 2001). Similarly, the declining trend in groundnut production contributed to a decrease in groundnut exports to about US $ 0.02 million in 1999 compared with about US $ 39 million in 1976.

In contrast to the development of cotton, wheat and groundnuts, sorghum cultivation and yields increased substantially during the 1990s. The area under sorghum increased from an average of about 0.3 million feddans during the 1970s to over 0.6 million feddans during the early 1990s. This is partly due to the government policy of providing for food security. In addition, shortage of finance and inputs for capital-intensive products like cotton and wheat and a shortage of irrigation water due to the run-down state of irrigation infrastructure have contributed to the expansion of sorghum cultivation at the expense of export and import substitution crops. To these bottlenecks must be added the incentive of a rising relative profitability of sorghum.

The origins of the above developments are multifold. Macroeconomic difficulties, in addition to institutional weaknesses, infrastructure and technology deficiencies as well as falling real crop profitabilities have contributed to generating the problems faced by Gezira farmers and other scheme stakeholders.

Based on a close interdependence between Sudan's agriculture and national economy, the fortunes of the Gezira Scheme are basically dependent on the performance of the economy. However, sustained economic growth in Sudan has been hampered throughout the past decades. Huge deficits in the balance of payments, a heavily overvalued exchange rate, escalating inflation and large budget deficits characterized the period from the late 1970s through the 1990s. The core problem here is a substantial and persistent budget deficit. In addition, the civil war in the south and frequent droughts, together with political isolation, brain drain and deterioration of basic infrastructure, have aggravated the situation.

Given the above state of affairs, rising inflation and heightened interest rates for credit have placed more financial cost pressure on producers, whereas the balance of payments deficit has made it more difficult to obtain imported inputs. Moreover, domestic budget deficits have decreased the financing opportunities for crop cultivation, investments and development of infrastructure.

In addition, the Gezira Scheme has always been encumbered by a unique institutional set-up which reduced the managerial and economic efficiency of the scheme. Hence, the Gezira Scheme has adopted a uniform crop rotation which constrains private economic choices on cropping patterns. The current production relations, including centralized decision-making on production and marketing for major crops and centralized management of irrigation water, limit the options of farmers for an efficient allocation of resources and affect their benefits substantially. Pan-territorial charges and payments provide fewer incentives to farmers.

The performance of irrigated agriculture is further aggravated by the deterioration of the scheme's infrastructure and absence of technical progress. Lack of funds and the Gezira Scheme's mounting debts, in addition to inefficient recovery of overhead costs at the tenant level, have made it impossible to replace the aging irrigation infrastructure and exacerbated maintenance problems of the silted canalisation system. As a result, inefficient and wasteful water distribution became the rule and expansion in acreage and productivity of crops was limited. Accordingly, the total cultivated area of the Scheme declined during the late 1990s to levels far below the developed capacity of the irrigated area. In addition, the financial shortages of the Gezira Scheme led, further, to inadequate maintenance of equipment, machinery and transport infrastructure and difficulties in replacing them, the outcome being inefficient processing of output (ginning of cotton) and transfer of inputs and outputs.

Based on the above, a typical Gezira farm has become unable to provide an income above the poverty line for an average farmer family in the

Gezira. As a result, the Gezira Scheme has become uneconomic from the national as well as from the farmer's viewpoint.

1.2 Future Prospects for Sustainable Developments

Given the importance of the Gezira Scheme for the Sudan, and the current state of affairs; i.e. the deterioration of its performance, the legitimate question to be answered would be: Are there any future prospects for sustainable development of the Scheme?

The available literature, especially that on potential crop yields in the Gezira, provides ample evidence for potential economic competitiveness. In addition, there are positive developments that enhance future prospects of irrigated agriculture in the Sudan. These include improving macroeconomic performance and growing confidence in the stability and growth of the national economy. Thus, recent reports and economic studies on Sudan note an improving economic situation, especially from 1997 through 2002 (IMF 2002). This assertion is based on recovering macroeconomic indicators and a perceived conducive economic environment. Hence, the Sudan's GDP and export earnings grew and inflation declined, while the exchange rate was freed and tariffs on international trade were sharply reduced. In addition, recent substantial oil exports and the livestock trade have rendered Sudan's foreign exchange earnings more diversified and relieved the government budget substantially.

On this basis, improved economic growth is expected to stimulate demand for agricultural output, while reduction of inflation rates and decreased interest rates for credit will mitigate the cost pressure on producers. Similarly, a positive balance of payments will make it possible to import more inputs, and rising public income will increase financing opportunities for investments and the development of infrastructure.

In addition, there are positive attitudes towards institutional and management change. The Government of Sudan has been concerned for many years about the Scheme's technical and economic efficiency as well as its heavy demands on public resources. Realizing the increasing pressure on the public budget and the need for competitive production for future agricultural trading opportunities, the government became aware of the need to search for strategies and policies to improve the efficiency of the Gezira Scheme.

1.3 Objectives of the Study

This study attempts to analyse the performance of the Gezira Scheme with the objective of identifying the institutional, infrastructural, policy and management constraints to sustainable development of crop production in the Scheme. In doing so, the specific objectives of the study include:

— An assessment of the available technology, infrastructure and institutional set-up for crop production and management in the Gezira Scheme.

— An analysis of past and present performance of the scheme with regard to development of cropping intensity, cropped areas, yield and output performance.

— Evaluation of the financial and economic profitability of specific crops in the standard rotation of the Gezira Scheme.

— Qualitative assessment of the impact of government policies on crop output and prices as well as on the competitiveness of cultivated crops.

1.4 Approach of the Study

The first part of this study provides a background as to the establishment of the Gezira Scheme and the organization of crop production and production relations. Next, the available infrastructure and institutions within the Scheme and the services provided are reviewed. Third, a review of policies adopted with regard to irrigated agriculture is provided and, in a fourth part, the devel-

opments in cultivated areas and crop performance resulting from adopted policies and prevailing constraints of infrastructure and institutional arrangements are analysed, based on three-year moving average growth rates. In addition, nominal and effective protection coefficients are calculated with the use of the technique of Policy Analysis Matrix, PAM. Finally, a review is provided of possible causes of unsatisfactory performance in years past as well as perspectives for sustainable development.

2 Overall Performance of the Economy of Sudan

The basic macroeconomic indicators during the early 1970s showed modest growth of agricultural production, GDP and agricultural GDP; all growing at about 3.5 % (FAO 1975). Although cotton exports grew at a higher rate than before, average annual export growth was estimated at 3.3 %. The increase in per capita income was very small, investments and savings stood at about 10 % and 2.5 % of GDP and the economic atmosphere was one of relative economic stagnation. The problems facing the economy became more serious towards the end of the 1970s. Growth of GDP fluctuated between 5.7 % in 1977/78 and -10.5 % and 2.8 % in 1978/79 and 1979/80, respectively (World Bank 1985). The balance of payments deteriorated rapidly from US $ -470 million in 1974/75 to US $ -750 million in 1979/80. Since Sudan's exports basically depend on agricultural production, especially cotton, the deterioration in the cotton sector has obviously contributed to the widening deficit in the balance of payments. Accordingly, reliance on external borrowing increased. The outstanding debt approached US $ 3 billion by the end of the 1970s, while the debt service ratio increased to 40 per cent (World Bank 1985).

The external imbalance was reflected in, and also caused by, an internal imbalance. Current and development expenditure increased to 27 % of GDP, while the percentage of revenue to GDP fell to 17, thus increasing the deficit in the total budget to about 10 % of GDP. According to Shaaeldin (1986), the composition of government revenue was such that tax revenue accounted for 80 % of total revenue. Taxes on international trade, consumption and production accounted for the largest proportion of tax revenue.

The rising budget deficit led to an increasing dependence on internal borrowing and reinforced inflationary trends. Internal borrowing from the Bank of Sudan increased net lending to public entities, with the largest proportion going to the public agricultural schemes. Borrowing by the Gezira Scheme and other similar schemes increased due to low productivity and declining revenue.

The performance of the economy deteriorated further during the 1980s (Eldaw 1999). The GDP growth rate was estimated at an annual average of 1.4 %, and recorded 4 negative annual growth rates during the 1980s. While the annual average growth rate of the population (about 2.8 %) was higher than that of GDP, per capita GDP declined during the 1980s. Although agricultural GDP grew substantially in 1981/82, at a rate of 32 %, it recorded negative growth rates in 6 years of the 1980s decade, thus recording an annual average growth rate of about 2.4 %. Total exports fluctuated during the 1980s between US $ 333 million and US $ 761 million, while imports increased significantly during the mid-1980s. The deficit in the balance of payments was about US $ one billion in 1980/81. It narrowed due to heavily restrictive import measures to about US $ 0.5 billion in 1988/89.

Average annual government revenue fell during the 1980s to about 12 % of GDP, while average annual expenditure during the decade increased to about 19 % of GDP. The budget deficit reached 14 % by 1989/90, resulting in increasing internal financing by the central bank (Abdelwahab 2001). On this basis, the rate of inflation increased from about 30 % in 1980 to about 60 % in 1989/90.

In addition, the economic difficulties of the 1980s were aggravated by political and environmental

problems. Internal political developments intensified the civil war in the southern part of the country. This led to substantially growing expenditure. The political instability of the then military regime increased and the regime adopted a new political ideology (Islamization). All these developments lead to decreasing external borrowing and assistance to compensate for poor export performance. Consequently, Sudan failed to meet its debt service obligations and total external debt started to mount, reaching about US $13 billion by the mid-1980s.

Moreover, drought conditions developing since the 1982 season ended with a serious production shortfalls and famine in 1984/85. The result was a food shortage. Despite substantial food assistance from the international community, internal political instability intensified, ending with the national uprising in early 1985 against the military regime.

Growth of GDP during 1990–1997 improved as compared to the situation of the 1980s (Eldaw 1999). The growth rates of GDP in 1991/92, 1992/93 and 1994/95 were 11.3 %, 12.3 % and 12.7 %, respectively. This result implied a positive annual average growth in real per capita GDP. This improvement was effected by a recovery of agricultural production. Thus, agricultural GDP grew by about 32 % in 1991/92 and by about 26 % in 1992/93. Agricultural GDP growth amounted to an annual average of about 12 % from 1990/91 to 1997/98.

However, although the growth of GDP improved, the other economic indicators revealed a weak performance of the economy. The balance of payments further deteriorated in the early 1990s as compared to the situation during the 1980s. Total export value fell from US $ 671 million in 1989/90 to only US $ 374 million in 1991/92. It decreased further, reaching just over US $ 300 million in both 1992/93 and 1993/94 and improving slowly to US $ 620 million in 1996/97. Total imports increased steadily, reaching over US $ 1.5 billion in 1997/98, and bringing the deficit in the balance of payments to about US $ 1.0 billion.

The early and mid-1990s marked a period of significant changes in the political and economic environment of Sudan. The civil war escalated and the political impact of the first Gulf war resulted in deepened isolation of Sudan. Arab financial assistance ceased and Sudan failed to meet its international obligations. Accumulated debt service obligations brought total external debt to US $ 22.4 billion (IMF 1999). The country's relations to the international financial institutions deteriorated further, leading to a near drying-up of international aid and credit, thus exacerbating domestic economic difficulties.

In addition, fiscal performance remained weak during the early and mid-1990s. Expenditure increased further, reaching about 31 % of GDP in 1992/93, while government revenue decreased to about 9 % of GDP. The budget deficit increased to reach about 21 % of GDP in 1996/97. As a result, inflation reached about 130 % (Abdelwahab 2001).

In general Sudan did not achieve sustained economic growth during the 1990s. Nevertheless, there are broad indications that the economy improved between the late 1990s and 2001/02. The GDP growth rate averaged 6.6 % from 1998 through 2001. The agricultural growth rate was up to about 8.5 % in 1999/00, back to less than 1 % in 2000/01, and amounted to about 5 % in 2001/02.

In addition, exports increased from about US $ 780 million in 1999/00 to US $ 1806.7 million in 2000/01 and to US $ 1698.7 million in 2001/02. The expansion of exports was due to the start of petroleum exports and expansion of exports of gold, livestock and sesame. Sudan's exports became more diversified, although exports of cotton, groundnuts and gum Arabic have decreased.

In addition, the exchange rate of the Sudanese pound has been liberalised since 1998, and the spreads between official and unofficial exchange rates have been gradually eliminated. Also, the rate of inflation decreased from 130 % in 1996 to about 8 % in 2001 (Table 1).

Table 1: Indicators of Macroeconomic Performance, Sudan, 1998/99–2001/02

	98/99	99/00	00/01	01/02
GDP value (Ls million) at 1981/82 prices	11730	12434	13462	14322
Growth rate of GDP (% p.a.)				
Share of agric. GDP in GDP	6.0	6.0	8.3	6.4
	48.7	49.8	46.4	45.6
Agric. GDP value (Ls. million)	5712.0	6197.0	6244.0	6537.0
Growth rate of agric. GDP (% p.a.)	8.5	8.5	0.8	4.7
Exports (US $ million)	595.7	780.1	1806.7	1698.7
Imports (US $ million)	1732.2	1254.2	1552.7	2964.9
Revenue (Ls billion)	1592	2052	3314	3652
Expenditure (Ls Billion)	1738	2270	3522	4188
Budget deficit (Ls billion)	163	218	208	536
Inflation rate (% p.a.)	58	28	18	8

Source: Ministry of Finance and Economic Planning (1999, 2000)
Bank of Sudan (1999, 2001)

3 Framework of National Agricultural Policy

3.1 An Overall Review

Poor performance indicators for the Sudanese agricultural sector during the late 1970s prompted the government to adopt various policies to alleviate the underlying problems. These policies were geared to rehabilitation and restructuring of agricultural production and removal of bottlenecks so as to improve and enhance the productive capacity of the sector. These policies were embodied in various programs implemented during the period from 1978 throughout the 1990s (Eldaw 1999).

With regard to the irrigated sub-sector, the policy adopted during the 1980s addressed itself to rehabilitation of existing projects and transformation of production relations and marketing systems. The objectives of the policy were to promote capacity utilization and productivity improvement in order to maximize production of export crops like cotton and groundnuts as well as to expand import substitution products like wheat. The first phase of the rehabilitation program started in 1980/81 and aimed at checking deterioration of yields per feddan in the Gezira Scheme and other irrigated schemes. Funds were earmarked for the rehabilitation of infrastructure and provision of production inputs. In addition, the crop sharing system practiced in the irrigated sector was replaced by a water charge and an individual account system. Reduction of direct and export taxes on agricultural products and changes in the marketing system, especially cotton marketing, matched these measures.

The policies adopted in the 1990s through 2002, were geared to reallocation of resources in favour of the agricultural sector and removal of bottlenecks so as to improve and enhance the productive capacity of the sector. The major objectives of these policies were liberalization of the economy in order to stimulate agricultural exports to generate more foreign exchange, attain self-sufficiency and food security, and achieve financial and social stability. The major instruments of the liberalization policy were removal of subsidies on agricultural inputs, lifting of price controls and government regulations on agricultural products, reduction of subsidies, abolition of monopolies of marketing parastatals and withdrawal of government financing of agricultural parastatals.

3.2 Price and Trade Policies

The major objective of policies adopted for the agricultural sector since independence and through the 1980s was to extract a surplus in terms of foreign exchange in the hand of government. These policies comprised measures including under-pricing of farm products, over-pricing of agricultural inputs handled by marketing boards as well as through various export taxes and import duties. Within the irrigated sector, the government employed its authority to establish monopolistic control of agricultural pricing to suppress[3] farm gate prices of products far below levels that would have prevailed if a free market had been allowed to operate. The price control system was implemented through a network of parastatal crop authorities like the Cotton Public Corporation, the Oil Seed Company and the Agricultural Bank of Sudan. Typically, these authorities were given a complete legal monopoly over purchasing, storage, processing and marketing, whether domestic or international, of almost all irrigated products except sorghum. In addition, agricultural products were subjected to various taxes, directly through export and local taxes, taxes on imported inputs, parastatal fees and indirectly through a complex system of multiple exchange rates. For wheat and groundnuts, explicit and implicit taxation increased from 6 % to 40 % of the producer price and from about 7 % to 32 % for groundnuts during the period from early 1970s to the mid-1980s, respectively (Abdelsalam 1987). In the case of cotton, taxes and other deductions had combined depressive effects on tenant incomes. Thus, taxes and duties absorbed between 42–52 % of the total export value of cotton during the mid-1980s and about 40 % of the border price equivalent of sorghum during the same period (D'Silva and Elbadawi 1988).

The agricultural policies adopted from the 1990s through 2003 have mainly focused on liberalizing the agricultural markets. The state monopolies were converted into private companies and all forms of price controls were completely eliminated. For example, the Cotton Public Corporation became a private company, with the Tenants' Union as its main shareholder. Direct taxes on agricultural products were reduced to 4.2 % in 1992/93 and then to 2.7 % in 1993/94 (Abdelwahab 2001). Various regional fees and local taxes were also reduced. With regard to export crops, export taxes were reduced to 5 % for all products except cotton, which remained taxed at 10 % (Abdelwahab 2001). Import taxes for agricultural inputs were reduced. In addition, all forms of export and import licenses were abolished.

Moreover, various attempts were made to adjust the exchange rate. In 1991, the official exchange rate for the dollar was increased from Ls 4.5 to Ls 15 and the parallel rate was increased from Ls 12.5 to Ls 30, while the free market rate stood at Ls 80. In 1992, the government's initial reform measures were followed by additional substantial reform packages. Within this context, all forms of price controls were lifted. The multiple exchange rates were replaced by a unified rate, which was closer to the parallel market rate. The right and procedure involved in determining the exchange rate were changed. A committee of representatives of commercial banks was charged with determining the exchange rate, and restrictions on holding and transferring foreign currencies were eliminated. In addition, export licenses were eliminated and export taxes were reduced to 7.5 % for cotton and gum Arabic, 2 % for oil seeds and livestock exports and to 1 % for other agricultural exports. Similarly, import licenses were abolished, with the exception of licences for products imported in the framework of trade protocols.

3.3 Institutional Policy

3.3.1 Production Credit

Formal seasonal loans to the state agricultural corporations continued to be provided by the cen-

3 The suppression of irrigated farm products was not begun by the post-independence Sudanese regimes. It was initiated by the colonial government, which established the foundation for irrigated agriculture, purposefully for cotton export and as a source of tax revenue and foreign exchange.

tral bank (Bank of Sudan) up to the end of the 1980s. These loans were mainly provided to finance the production of cotton and wheat, in addition to some inputs for sorghum production, whereas financing of groundnuts is entirely the responsibility of tenants. Interest rates charged for credit to public agricultural corporations are subject to revision in accordance with the overall financial policy of the government and the average interest rate prevailing in the country. The interest rate level increased from 6 % during the 1960s to 8 % during the 1970s and then to 9 % during the 1980s.

The total amount of credit provided by the Bank of Sudan to the state agricultural corporations amounted to Ls 187 million in 1980/81. The amount of this credit that was repaid was around Ls 150 million and the balance was added to the outstanding debt of Ls 180 million (Ahmed Humeida 1986). Between the late 1980s and early 1990s, costs of crop production in irrigated agriculture increased steadily, bringing the financial requirements of state agricultural corporations to high levels. Loan repayment, however, lagged substantially behind the loan limits, and the outstanding debts of the state agricultural corporations grew.

Within the reform programs of the early 1990s, the credit policy aimed not only at increasing the volume of credit to irrigated agriculture but also at diversifying sources of finance and facilitating access to credit. However, one of the major features of that policy was the withdrawal of government from financing state corporations. As a result, a consortium of commercial banks was established to finance the government agricultural corporations. The commercial banks were encouraged to establish additional branches in regional towns to provide wider coverage in rural areas. The credit ceilings of the commercial banks were increased and, because of high inflation levels, interest rates for loans were increased (Abdelwahab 2001). Additional specialized banks were established, e.g. the Bank for Animal Resources and the Farmers' Bank. As already mentioned, weak crop performance led to increasing tenant debts with the commercial banks, which as a result became reluctant to extend additional loans. As a consequence, the government stepped in to finance production in state owned agricultural corporations.

3.3.2 Output and Input Marketing

Already before independence in 1956, domestic and export marketing of Sudan's agricultural products had been almost entirely in the hand of indigenous and foreign private merchant capital. This included even the marketing of the products of state owned agricultural corporations like cotton. While private control extended over the entire range of marketing operations from the farm gate to export delivery, the interference of government in the marketing systems had been limited to a variety of direct and indirect taxes on domestic and export trade. The control of the private sector over the agricultural marketing systems extended till 1969, when the state's declared marketing policy assumed more control over the export market by establishing a system of public marketing organizations. In 1970, the government nationalized cotton marketing and established the CPC to undertake cotton export and domestic marketing on behalf of the government. During the same time, the government established the Oil Seed Company, OSC, and the Gum Arabic Company, GAC. Later on, the government established the Livestock and Meat Marketing Corporation, LMMC, to control the export market for livestock.

The establishment of these marketing parastatals in the early 1970s enabled the government to exert full control over the export and domestic marketing of cotton and the export of oil seeds (groundnuts, sesame) and oil seed products (edible oil and oil seed cakes) and gum Arabic, for which it set the (overvalued) exchange rate. However, indigenous private commercial capital still retained control of the domestic marketing of traditional non-export products in addition to minor export crops.

The full control of the government over the whole cotton trade continued till 1993, when the CPC was transformed within the context of liberalization policy into a private company (the SCC) and

sold to the Farmers' Union (71.8 %), the Pension Fund (14.6 %) and the Farmers' Commercial Bank (13.6 %). According to the government trade policy, cotton trade transactions were settled at the official exchange rate, which was substantially overvalued. Similarly, the government decided on the sale of lint cotton to domestic textile mills, which also took place on the basis of international prices in US dollars. Accordingly, lint cotton was priced at an overvalued exchange rate. For example, when the unified rate was about Ls 90 per US $ 1.0, the exchange rate used for cotton trade was Ls 25 per US $1.0. Thus a high margin of indirect tax was charged on traded cotton and hence producers received less in local currency than they would have realized at a market based exchange rate. The high margin of indirect tax on traded cotton was maintained for many years until it was decreased to a level of about 20 % and finally eliminated in 1998/99.

Until the early 1970s, the distribution of cottonseed to oil mills was the responsibility of the Ministry of Industry. The ministry allocated the available quantity of cottonseed to the then existing oil mills according to a ratio equivalent to their design capacity. This system was changed during the 1980s, when competition was introduced to determine the ceiling price of cottonseed. In the early 1990s, marketing of cottonseed became the responsibility of the managements of irrigation schemes and the farmers' unions, which otherwise resorted to advance sale of cottonseed because of financial difficulties.

3.3.3 Research and Extension

Agricultural research in Sudan dates back to 1902, when experimental cotton farms were established along the main Nile at Shendi and at the Blue Nile near Elkamlin (Hassan et al. 1986). In 1904, the Shambat Experimental Research Station was established and in 1918 the Gezira Research Station was set up to conduct research in irrigated agriculture. Subsequently, especially after independence, various research stations were established to conduct research in different fields of agriculture, livestock and forestry. In 1967, the ARC was created through merger and reorganization of various research stations under one umbrella. The mandate of the ARC covers the whole of Sudan through a network of research stations and centres.

Besides the ARC, the Agricultural Research Council, one of five specialized research councils of the National Research Council, the NRC, influences agricultural research by financing individuals, institutions and multidisciplinary teams to undertake research in areas not attended to by the ARC. All these institutions are state owned and are dedicated to undertaking applied research in line with state interests. Till very recently, the ARC was a subordinate institution of the Ministry of Agriculture, with an appointed Board of Directors which decided upon the broad lines of research policy for the ARC. The Minister of Agriculture appointed the director of the ARC. The Board of Directors and the Director of the ARC were both accountable to the Minister of Agriculture. Based on this, agricultural research has been in line with government interests. As a result field crops, the diversification and intensification of which have been the major objective of the government, have dominated research interest. Recently, policy makers felt the need for a coordinated multidisciplinary team approach to effectively tackle the problems affecting the agricultural sector.

The government finances the annual budget of the ARC and all agricultural research activities and provides budgets for the purchase of equipment and research material, in addition to provision of annual budgets for staff training at various levels. In addition, in previous years the ARC has received technical and financial support from outside in the framework of joint research projects and/or special programs aimed at building research capacity and maintaining built capacities. Similarly, various agricultural institutions like the Gezira Scheme, for example, have contributed, through provision of research costs, to the continuity of the ARC's research activities. However, in consequence of the political developments in Sudan, technical and financial support from outside started to decline in the early 1980s and fi-

nally ceased during the early 1990s. Similarly, government support for equipment, research material and staff training as well as financial support for agricultural schemes declined, taking on a sporadic and ad hoc character during the 1990s. The consequences of such developments have been stagnation of research activities and discontinuity of technology development, in addition to brain drain and lack of capacity building.

4 The Gezira Scheme: Organisation, Infrastructure, Services

The Gezira Scheme lies south of Khartoum between the Blue and White Niles (Map 1). At the time of its establishment in 1925, the total original area of the Scheme was about 1.135 million feddans. In the early 1960s, the original area was extended to the southwest to include the so-called Managil Extension, so that the scheme's total area under irrigation was brought up to 2.1 million feddans (882,000 hectares).

Since its establishment, the Gezira Scheme has experienced many changes. The Sudan Gezira Board replaced the former managing Sudan Plantation Syndicate in 1950. Production relations have undergone several modifications. The joint account system was modified in 1946, 1950 and in 1970, and was replaced by the individual account system in 1980/81 (Appendix 1). In addition, crop production was intensified and diversified by the introduction of groundnuts as a cash crop and wheat as an import substitute as well as by the expansion of vegetable cultivation. In the early 1980s, plans were made to introduce fodder cultivation as a basis for the integration of livestock production into the scheme's cropping system. All these developments lead to many changes of the cropping rotation adopted (see Table 2).

4.1 Structural Organization

4.1.1 Land Tenure

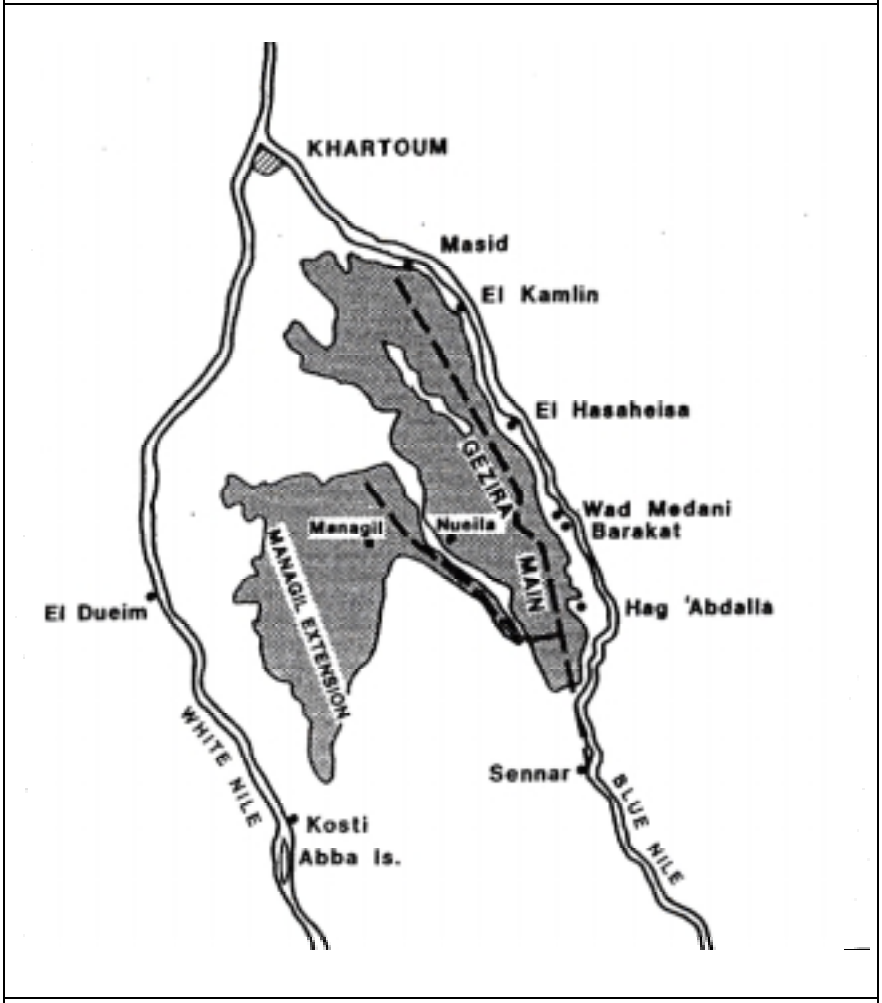
Arrangements for endorsement of land ownership existed in the Gezira area already before the establishment of the Gezira Scheme. With the advent of the irrigation system, legislation was passed to avoid speculation and to prevent sale of land to non-inhabitants (Awad 1987).

In establishing the Gezira Scheme, the government either bought or leased land from its owners under the 1921 Gezira Land Ordinance. As a result, up to 40 % resp. 60 % of the existing land of the Gezira Scheme is under tenant and government ownership. The privately owned land was leased to the government on a compulsory basis for a fixed annual rate of Ls 0.10 per feddan for 40 years[4]. Finally, land allotments of farms (tenancies) of 15 or 30 feddans, called hawashas, were made according to the size of land owned, and landowners became tenants.

Priority in allocation of tenancies was given first of all to title-holders. Landowners in possession of large landholdings (more than 80 feddans) were also allotted a 30 feddan tenancy, but, in addition, they were also given the right to nominate others to be tenants. The reason for this was that the Gezira Land Ordinance of 1921 specifies that farmers were not allowed to own more than one tenancy. Therefore, landowners with large holdings nominated family members (including sons, wives, daughters and other relatives), and where there were no nominees, the tenancies were allotted to other inhabitants. In 1934, the size of the standard tenancies was increased to 20 and 40 feddans. This upscaling was necessitated by the introduction of the then 8-course rotation, which aimed at combating the outbreak of plant diseases that occurred in 1933.

4 In 1965, when rent contracts expired, landowners raised claims to negotiate a new agreement; nevertheless, the whole issue remained pending.

Map 1: The Gezira Scheme



Source: Brandt et al. (1987)

The same procedure of tenancy allotment was adopted for the Managil Extension. However, the standard holding for tenants were smaller, i.e. 15 and 30 feddans, respectively.

The Gezira Land Ordinance of 1921 specifies, also, that farmers may not sell, rent or sublet their tenancies. A tenancy can be inherited, but officially it can only be broken down into half the size of a full tenancy.

As a result the present rigid land tenure system of the Gezira Scheme represents a source of inefficiency of resource allocation, both for the tenants and from a national perspective. The ban on sale of tenancies limits the options for aggregation of land to increase tenancy sizes to sizes that provide enough income under present producer price ratios and cost of living conditions.

4.1.2 Production Relations

The Gezira Scheme was established as a parastatal enterprise under which production is a joint responsibility of the government, the British company (Sudan Plantation Syndicate) and the tenants. The backbone of this triple relationship is the tenancy agreement, which, in essence, governs the obligations and rights of the three parties concerning the production of cotton and the sharing of its net proceeds. Within the context of the tenancy agreement, the government is responsible for input provision, supply of irrigation water and financing of cotton production. The Gezira Board, on the other hand, is responsible for administration and provision of central management as well as mechanized work (ploughing, sowing, spraying, maintenance of irrigation infrastructure), and the tenants are responsible for the whole of cotton

cultivation operations, including picking. After deduction of certain cotton production costs that are regarded as joint collective charges[5], the net proceeds are divided among the tenants, the government and the Gezira Board according to the rules of a joint account system (see Table 2). Production of other products like lubia, sorghum and, later on, groundnuts was not part of the tenancy agreement. The tenants are entirely responsible for financing, producing and marketing these products. However, tenants pay no water charges or taxes for the production of these products. Unlike these products, wheat was considered as a strategic product since its introduction in the early 1970s and was, therefore, financed and marketed by the Gezira Board.

The joint account system was abolished in 1980/81 and replaced by the individual account system. Under the new system, the tenants pay the costs of all inputs provided by the Gezira Board for the production of cotton as well as other crops. However, while the Gezira Board has no control over the proceeds of crops other than cotton, all irrigation, input and service costs borne by the government or the Board are recovered from the proceeds of cotton sales. This arrangement, however, contributed to the emergence of an economic bias against cotton husbandry. As a result, tenants tended not only to allocate the resources under their control (labour in particular) away from cotton in the direction of their own marketable crops, but also to divert inputs specified for cotton (for example fertilizer) for use with other crops.

4.1.3 The Cropping System

Based on the tenancy agreement, decisions on crop choice, crop mix and crop rotation are the domain of the Gezira Board. The Agricultural Committee (a sub-committee of the Board of Directors) is the body that makes decisions on crop rotation, though with technical support from the Gezira Research Station. These decisions extend to specifying the volume and quality of applied inputs and the timing of various agricultural activities, especially with regard to cotton. Once the Gezira Board approves these decisions, they have the character of law.

The initial crop mix in the Gezira Scheme included, besides cotton as a major crop, sorghum and lubia (dolichos lablab). These crops were grown in a three-course rotation: cotton – sorghum/lubia – fallow. The crop mix and crop rotation were subjected to various changes for technical and economic reasons in the course of time between the early 1930s and the early 2000s (see Table 2). Although cotton remained the main crop throughout, wheat, groundnuts and sorghum have become important crops since the late 1960s.

The first change of crop rotation took place in 1932/33 to extend the fallow area in order to combat the then heavy infestation of cotton with the devastating *black arm* disease. At the beginning of the era of the Sudan Gezira Board, which replaced the expatriate Plantation Syndicates in 1950, an eight-course rotation was established. The biggest change in crop rotation was effected by the diversification policy, which was introduced during the 1960s. Accordingly, rotation was revised to accommodate wheat, groundnuts and phillipesara (a legume fodder). When the Managil Extension was established, it started with a six-course rotation. Following the intensification policy in 1975/76, a unified four-course rotation was adopted all over the irrigated area. This rotation was expanded in the early 1980s to a five-course rotation to accommodate a fodder break in an attempt to integrate livestock production in the Scheme area.

5 The joint charges include: cost of seed, fertilizers, spraying, advances for cotton picking, transportation, ginning, storage, marketing and insurance.

Table 2: Development of Planned Crop Rotation in the Gezira Scheme		
Season	Crop rotation	Land use intensity[a]
Main Gezira:		
1925/26 – 1930/31	C – S/L[b] – F	66.30
1931/32 – 1932/33	C – F – F	33.30
1933/34 – 1960/61	C – F – F – C – F – S – L/F – F	44.75
1961/62 – 1974/75	C – W – F – C – G/L – S - P/F – F	69.75
1975/76 – 1980/81	C – W – G/S – F	75.00
1981/82 - onwards	C – W – G/S – F – F	75.00
Managil Extension:		
1933/34 – 1960/61	C – S – L/F	44.75
1961/62 – 1974/75	C – W – C – G/L – S - P/F	69.75
1975/76 - 1980/81	C – W – G/S – F	100.00
1981/82 – onwards	C – W – G/S – F – F	75.00
C = cotton; F = fallow; Fo = fodder; G = groundnuts; L = lubia; P = phillipisara; S = sorghum; W = wheat a This denotes the ratio of cropped land to total irrigated area b Cultivation of sorghum or lubia or a combination of them		
Source: Galal, M. Y. (1997)		

The total cultivable area of the Gezira scheme is divided up into 90-feddan fields known as numbers. According to crop rotation, each of these fields will be under different crops in the succession of years corresponding to the number of crops and fallows in the rotation. Each number is in turn divided into equal plots, each of which belongs to one tenant, and on which he cultivates one of his crops in the specified rotation, or a fallow plot is inserted. Based on that, under the currently adopted four-course rotation in the Main Gezira, a tenant will have his plot of cotton or any other crop along with other tenants in one number, so that the number will be entirely under one crop or fallow.

The need to abide by the rules imposed by a specific rotation limits tenant land allocation choices. Accordingly, the uniform crop rotation affects tenant costs and financial situation substantially.

4.2 Infrastructure

The infrastructure available within the Gezira Scheme includes the land, the canalisation system, machinery and equipment, in addition to buildings, transportation infrastructure and vehicles. The value of this infrastructure constitutes a crucial dimension of the importance of the Scheme. Unfortunately, there has been no formal valuation of this infrastructure. However, rough estimates suggest the value of infrastructure within the Scheme to amount to US $ 8 billion[6].

6 Including the value of dams and main canals.

4.2.1 Irrigation Infrastructure

4.2.1.1 Supply of Irrigation Water

Except for an area of about 70,000 feddans[7] of the total command area of the Gezira Scheme, most of the Scheme is irrigated by gravity irrigation. The Scheme is supplied with irrigation water from the Sennar and Roseires Dams on the Blue Nile. The annual water discharge of the Blue Nile is estimated at an average of about 50 billion cubic meters measured at Roseires (Ahmed 2000). However, this flow is characterized by heavy annual and seasonal variations. Thus, it rises steeply from the end of June to a maximum peak at the end of August, in order to decline sharply to a minimum of about 2 % of the peak at the end of April. Based on the Nile water agreement between Sudan and Egypt, Sudan's share amounts to 18.5 billion cubic meters. As already mentioned, the Gezira Scheme utilizes about 35 % of this share.

Water storage at the reservoirs of the Sennar and Roseires dams starts in early September, after the flood period, when the daily water discharge of the Blue Nile declines to the level of 350 million cubic meters (Ahmed 2000). The reason for this arrangement is to restrict the deposition of silt in the reservoirs to a minimum. The reservoirs are normally filled within 45 days. The designed storage capacity of the Sennar reservoir is 930 million cubic meters and that of Roseires is 3.024 million cubic meters. Water withdrawal for irrigation from the two reservoirs commences in December, with the two reservoirs operated as one combined reservoir.

4.2.1.2 The Irrigation Network

Irrigation water is delivered to the Scheme's areas through a network of canals covering the whole area. The network consists of 194 kilometres of Main Canals, 2300 kilometres of Major Canals and 8000 kilometres of Minor Canals (Galal 1997). Water is conveyed to the irrigated areas of the Scheme through 2 main canals (Gezira and Managil Main Canals) converging from the reservoir at Sennar. The two canals run 57 kilometres northward of the dam to a group of regulators, where the Managil Main Canal branches into four canals (Major Canals), which convey irrigation water to the Managil Extension. The Gezira Main Canal runs further northward for another 137 kilometres, and branches into many Major Canals to irrigate the various areas of the Main Gezira. The major canals branch in turn into Minor Canals, which convey the irrigation water through gated field outlet pipes to field ditches called Abu Ishreens. Every Abu Ishreen irrigates 90 feddans (Number) through 9 Abu Sitas. Each Abu Sita irrigates a field of 10 feddans.

The two main canals were designed to convey a daily maximum of 31.5 million cubic meters. Water flow in the network is continuous, especially during the irrigation season (July-April). Assuming no or minimum transit losses, the irrigation network is in the position to provide a monthly average of between 930–960 million cubic meters of irrigation water to the overall area. This amount is equivalent to a monthly average of about 450 cubic meters per feddan (110 mm/ha, month).

The only sources of water losses from the irrigation system of the Gezira Scheme are evaporation and breakage of canals. Water losses within the irrigation network are virtually negligible, because of the impermeable nature of the soil and subsoil, which does not allow irrigation water to percolate as deep as the groundwater table.

Besides the canalisation system, the irrigation network of the Gezira Scheme comprises a drainage system consisting of 1500 kilometres of major drains and about 6000 kilometres of minor drains. The major purpose of this drainage system is to siphon up surface runoff due to rain or excess irrigation.

7 Most of this area lies on the eastern bank of the Blue Nile (Hurga and Nur Eldin Blocks), in addition to a small area in Hag Abdallah Block (Southern Gezira), which is irrigated by pumps for topographic reasons.

4.2.1.3 Water Delivery and Distribution

The requirements of irrigation water are calculated at the beginning of each cropping season by field inspectors for each minor canal. These requirements are transmitted to the Division Water Engineers, who calculate the water requirements for the various reaches of the canals up to the dam. The minor canals were designed to store the water flowing during the night, so that irrigation can be undertaken during the daylight hours. The overall control of water movement from the dam up to the minor canals is regulated by various control structures operated by personnel of the Ministry of Irrigation and Water Resources, MOIWR. Gezira Scheme personnel operate the release of water from the minor canal to Abu Ishreen, while release of water from Abu Ishreen to Abu Sita and its control within the field is the responsibility of the tenant.

The expansion of the Gezira Scheme's area in early 1960s (Managil Extension) and the intensification and diversification of crop production in the mid 1960s, prompted the use of water distribution practices other than those used before. First, these developments required an increasing volume of water to be released at the dam into the system. Accordingly, total water flow from the dam increased from 2 billion cubic meters before 1960 to about 7.1 billion cubic meters afterwards. As a result of this expansion, more silt is carried to the system, since the expansion of the cultivated area water release has been diverted earlier than before, when the water still carries more silt. Second, to distribute the increased water requirements, the irrigation system must be operated at a capacity higher than is was designed for.

4.2.1.4 Irrigation Management

Until 1995, the management of the irrigation network and irrigation practices in the Gezira Scheme was a joint responsibility of and between the MOIWR and the Gezira Scheme. The Ministry of Irrigation was in charge of the maintenance of the irrigation network, with budgets allotted by the government. The Gezira Board was responsible for water management in the minor canals up to the field level, with a budget borne by the joint account system. When the shift to the individual account system was introduced, the budget for the maintenance of the irrigation system was raised from the water charges paid by tenants. However, problems in collecting water charges from tenants led to further difficulties, namely in securing the required budget with the Ministry of Irrigation in order to undertake the desired maintenance works. Following these problems, the responsibility for collecting water charges from tenants and operating and maintaining the irrigation system in the Gezira Scheme was transferred in 1995 to a financially independent parastatal, the Irrigation Water Corporation, IWC. However, the IWC, too, failed in managing the irrigation water in the Gezira, as did other similar schemes, because of financial difficulties due to problems of cost recovery for irrigation water. Therefore, the management of irrigation water in the minor canals up to the field level were made the responsibility of the Gezira Scheme. The Gezira Scheme also became responsible for collection of water rates and maintenance of the irrigation infrastructure from the minor canals down to the field level.

The difficulties of water cost recovery encountered by the IWC and later by the Gezira Scheme included adequate silt cleaning operations. In addition, the expansion in irrigation water requirements overloaded the designed capacity of the canalisation system, thus leading to continuous breakage and water losses. Moreover, due to lack of financial resources most of the canal regulators and structures have not received adequate maintenance and therefore their efficiency has widely deteriorated. As a result, water delivery became difficult at varying times and regions within the irrigated area. Reduced numbers and volumes of irrigations per crop and untimely irrigation practices became the rule, thus leading to declining crop yields and hence declining tenant and scheme income.

In appreciation of this problem, the Ministry of Agriculture, the Gezira Board and other stakeholders of the Gezira Scheme have persistently searched for solutions. Various committees and

study missions, including missions from the World Bank, have contributed to solving the problem of water management in the Gezira Scheme and other similar irrigation schemes. Most of the local consultants and decision makers in the Ministry of Irrigation, Ministry of Agriculture and the Gezira Board attribute the problem of water management to the financial shortages resulting from inadequate recovery of water costs and, in the last instance, low payment for irrigation water. Based on that, they propose resorting to the original system of joint water management by the Ministry of Irrigation and the Gezira Board and ensuring adequate provision of financial resources by strengthening the means of water cost recovery and revising water costs. The consultants from the World Bank attribute the water management problem to institutional problems and propose the establishment of Water User Groups, WUG, at the block level and transfer of the overall responsibility for water management to the WUGs. Thus far the argumentation of Sudanese organizations and the World Bank has tended to neglect the grossly deteriorated economy of tenants.

The water management problem, especially in an irrigation enterprise like the Gezira Scheme, is not merely a technical problem, as it is seen by the authorities of the Ministry of Irrigation, nor primarily an institutional problem, as it is seen by the World Bank and FAO authorities. As already mentioned, the irrigation network of the Gezira Scheme is extensive and the management of irrigation operations at any level of the network represents a constraint for the other levels. As such, the technical efficiency of the system calls for amalgamation of management responsibility under one authority which is technically capable of managing maintenance and future improvements. Responsibility for management of the system at any level is technically far beyond the capacity of the tenant Water User Groups. Management by WUGs would be difficult even though technical experts support the WUGs; this would mean a need for cooperation among over 100 WUGs[8] across the scheme's area, to say nothing of cooperation among the around 1000 tenants in one WUG[9].

4.2.2 Agricultural Engineering

The Gezira Board has a fleet of agricultural machinery under the supervision of the Department of Agricultural Engineering, DAE, which is in charge of various agricultural operations. These operations include cleaning and maintenance of Abu Ishreen canals, land preparation for cotton and wheat, application of pre-emergence herbicides and pesticides, broadcasting of fertilizers, harvesting of wheat and sorghum and threshing of groundnuts.

The DAE operates a fleet which currently comprises some 468 wheel-tractors of various sizes, 105 crawlers (for deep ploughing) and over 50 combine harvesters, in addition to a large array of agricultural implements (Galal 1997).

The DAE is centrally organized, with its headquarters at Barakat and three substations with central workshops in Maringan, Hasahiesa and 24-Gorashi. The machinery is operated on a team basis to accomplish the various work assignments in the different areas of the Scheme according to plans set by the DAE headquarters. The respective field inspectors in the different blocks define the magnitude and quality of the various agricultural operations to be undertaken. The levels of fees to be paid by the tenants for the various mechanical operations are set by the DAE and approved by the Gezira Board. Owing to the financial difficulties experienced by the Gezira Scheme since the early 1990s, there was a marked drop in the volume and quality of work accomplished by the DAE. In an attempt to increase its efficiency, the

8 If the WUGs are established at the block level, this will lead to the creation of about 100 WUGs because there are about 103 blocks in the Gezira Scheme.

9 If there are about 100 WUGs, each of them will be composed of about 1000 tenants, the total number of tenants being about 110000.

DAE was given commercial status (although it remained the property of the Gezira Board).

Despite that, the volume of work accomplished by the DAE is estimated to reach, on average, some 30 % of the planned/necessary volume of the work that needs to be done. The rest of the mechanized work is usually contracted out to the private sector at the same approved rates which are charged to tenants for DAE services through individual tenant accounts. Financial difficulties have impeded the provision of spare parts and the maintenance and overhauling of machinery required for it to be capable of a higher percentage of work. In addition, there is increasing dissatisfaction among tenants about the quality of work performed by the DAE and the levels of fees and costs charged.

4.2.3 The Cotton Ginneries

The Department of Cotton Ginneries of the Gezira Scheme operates 12 ginneries located in three stations (Maringan, Hasahiesa and Bagair). The Scheme's first ginneries date back to 1921. Additional ginneries were introduced in 1929, 1954, 1960, 1964 and 1972. Most of these ginneries have been renovated to varying degrees and some of them have been converted to suit the quality of the cotton cultivated.

All the cotton produced in the Gezira Scheme is ginned and packed in bales before being transported to Port Sudan for shipment for export. The costs of ginning and packing materials are deducted from tenant cotton sales through the individual accounting system. Although there is no shortage in the capacity of available ginneries, their operation has become a challenge in view of their age and spare parts requirements. In addition, difficulties in providing a continuous supply of electric power pose even more problems for the efficiency of the ginneries. Thus, the constraints currently facing the ginneries relate basically to their technical and economic efficiency.

4.2.4 Transportation Infrastructure

The major transportation infrastructure of the Gezira Scheme consists of the Gezira Light Railway, GLR. The first rail route was established in 1919 and had a rail length of 20 km. Subsequent expansion of the railway took place in 1950s to about 300 km, and was then continued with the establishment of Managil Extension, so that currently the total length of the railway network amounts to 1200 km. This railway network covers about 75 % of the Scheme. It connects 120 cotton collection stations, which are organized at 54 administrative points across the irrigated area. The hauling power of the GLR consists of 62 locomotives and 1841 railway wagons. However, the number of operational locomotives and rolling stock is seriously depleted, due to inadequate maintenance and shortage of spare parts.

Besides the GLR, the Gezira Scheme makes use of the triangle of asphalted tarmac roads connecting Khartoum–Kosti, Khartoum–Sennar and Kosti–Sennar. In addition, there is an intensive network of roads within the Scheme's area, connecting almost all towns and villages within the irrigated area. This network is composed of the roads along the canal system, which partly represent the main roads between the towns within the Gezira area and the secondary roads connecting the towns to the adjacent villages. Nevertheless, except for two roads connecting Medani to Managil (about 60 km) and Hasahiesa to Fireigab (50 km), all of the roads and tracks within the irrigated area are unsurfaced dirt roads, which become impassable during the rainy season.

The Gezira Scheme uses its rail network to transport seed cotton from the collection centres to the ginneries and to deliver agricultural inputs such as fertilizers, seeds, herbicides and sacks to the fields. The transportation capacity of the GLR is currently reduced to about 30 % of the Gezira Scheme's transportation demand. Privately owned and operated trucks undertake the rest of transportation. Transportation of cotton from the ginneries to Port Sudan and imported inputs from Port Sudan to the Gezira Scheme is undertaken by the private sector. However, the Gezira Scheme coor-

dinates its respective operations with the private transporters and deducts the costs incurred through the individual accounts of the tenants.

4.2.5 Other Infrastructure

The Gezira Scheme operates four workshops that undertake the various maintenance operations, including rehabilitation of GLR locomotives as well as other engines. In addition, they manufacture some spare parts for the ginneries and perform repairs on farm equipment as well as many other metal–working jobs. Also, the Gezira Scheme has a department for telecommunication, which operates a network of telephones covering the whole area of the scheme. In addition, the scheme possesses a fleet of vehicles of various makes for the use of field inspectors and extension workers. Most of the vehicles are obsolete models. Overload work, under the climatic conditions and road quality of the Gezira Scheme, as well as lack of spare parts and regular inspection and services have contributed to the deterioration of these vehicles.

In sum, it may be concluded that while the Gezira Scheme appears to be in possession of the basic infrastructure required for irrigation of this size, this entire infrastructure has deteriorated very much due to poor management resulting from the financial difficulties that have faced and still face the Gezira Scheme. The contribution of the deterioration of this infrastructure to the unsatisfactory production performance of the scheme cannot be overlooked. A huge enterprise like the Gezira Scheme cannot be operated without an integrated set of infrastructure that can provide the basis for management of improved production. Accordingly, rehabilitation of the available infrastructure represents a cornerstone of any strategy for sustainable development in the Gezira Scheme. Within this context, however, it must be determined to what extent some components of the infrastructure could be managed by the private sector.

4.2.6 Institutional Services

Based on the tenancy agreement, the Gezira Board is principally responsible for the central management of crop production, especially cotton production and, later on, wheat production. In complying with this task, the Gezira Board provides various services, like land preparation, supply of inputs as well as processing and transport of output, in addition to coordination of other operations performed by private institutions, like aerial spraying of insecticides, land preparation and mechanical crop harvesting. Moreover, the Gezira Board provides essential services like credit and product marketing.

4.2.6.1 Institutional Credit

Based on the tenancy agreement, the Gezira Board provides almost all the services and inputs for the production and marketing of cotton. The same credit arrangements for cotton were applied similarly to wheat production after its introduction in the early 1970s. Before the 1990s, all of the services and inputs provided were financed by the government (the central bank) and administered by the Gezira Board. The government also determines the interest rates charged for these loans. Up to the early 1990s, the interest rates charged stood at the level of 9 % (Galal 1997). The inputs and services supplied include seed, sacks, fertilizers and chemicals for plant protection, in addition to land preparation, application of fertilizers and spraying of chemicals. In addition, the Gezira Board finances the mechanical harvesting of wheat and provides cash advances, especially for cotton picking as well as for its cultivation and weeding. However, these cash advances have historically been below the actual costs incurred by tenants for the various farming activities (Magar 1987). Tenants are, therefore confronted with the problem of securing additional cash loans to cover the labour costs incurred for various agricultural practices. Many tenants are, for various reasons, not in the position to obtain break-even yields. For those tenants, payment of cash advances is deferred, in an attempt to avoid build-up of tenant debt.

With regard to other crops, the overall production process associated with these crops is the responsibility of tenants. Given the lack of formal sources of finance in the Gezira, many scholars have reported that a large percentage of tenants are reliant on informal credit facilities, especially the so-called shail system, with its alleged high cost of finance (Magar 1987; Ahmed Humeida 1987; Hassan 1993; Galal 1997). Since the cost of finance acquired through informal channels (shail) is relatively high, many tenants resorting to informal financial sources are forced further into debt. The immediate outcome of such problems has been an increasing tendency on the part of tenants to sub-leasing land and make crop sharing arrangements.

The credit arrangements for the Gezira Scheme remained unchanged after the implementation of the liberalization policy in early 1990s. The Gezira Board continued to administer loans that continued to be provided by the government for cotton and wheat. However, the credit requirements of the Gezira Scheme increased substantially in the early 1990s due to the implementation of the liberalization policy. The deteriorating balance of payments and weak fiscal performance, in addition to fading external finance, led to rampant inflation that resulted in a substantial expansion of the amount of finance required (Abdelwahab 2001). This situation prompted the government to resort to an alternative credit policy by establishing a Consortium of Commercial Banks in 1993 to provide the finance required for the Gezira Scheme.

However, weak agricultural performance impeded the recovery of loans and interest by the commercial banks for many years. As a result, the indebtedness of tenants grew and the financers became reluctant to continue providing the required loans, a fact that forced the government to resume financing the production of the Gezira Scheme. While government sources were not in the position to cover the finance required, the Gezira Board sought alternative sources of finance. Accordingly, the Sudan Cotton Company became involved in securing finance for the Gezira Scheme through the advance sale of cotton, in addition to the commercial banks, which resumed financing of the scheme under new regulations for repayment.

4.2.6.2 Agricultural Marketing

In the initial phases of the Gezira Scheme, export and domestic marketing of all crops was undertaken by the private sector. In 1970, the government nationalized the Cotton Marketing Company and assumed control of export and domestic marketing of cotton through the newly established Cotton Public Corporation, CPC. Tenant responsibility ends with harvesting, sacking and delivery of the crop to the nearest collection centre. The Gezira Board provides for transportation of the crop to the ginneries, processing of the crop and transportation of the lint cotton to the warehouses of the CPC in Port Sudan before export shipment.

The CPC bought all the seed cotton produced in the Gezira Scheme and elsewhere, on behalf of the government at prices fixed at the ginnery gate. These prices were based on annual world prices of cotton fob Port Sudan, less the cost of ginning, transportation of lint cotton to Port Sudan and other relevant charges. The prices of cotton lint for the local textile industry were also based on export prices adjusted for transportation to Port Sudan and export costs. The CPC deducted its marketing costs from cotton proceeds and the balance in Sudanese currency was delivered to the Gezira Board to pay the tenants after deduction of their respective production costs and charges. All cotton seed is distributed locally by the Ministry of Industry through a quota system to the oil mills at prices fixed annually at the ginnery gate.

In 1993, the CPC was transformed within the context of the liberalization policy into a private company (the Sudan Cotton Company; SCC) and sold to shareholders, including the Farmers' Union, the Pension Fund and the Farmers Commercial Bank. Under the new institutional arrangement, the SCC undertakes the same export procedures for cotton on behalf of tenants. The SCC deducts the costs incurred to export the cotton, in addition to 1 % of

the gross value of exported cotton as company fees.

As regards wheat marketing, up to the early 1990s, tenants were obliged to deliver their harvest to authorized wheat mills at procurement prices fixed by the Gezira Board. However, there was an unofficial market for wheat, where the prevailing prices were much higher than those fixed by the government. Currently, after the implementation of the liberalization policy, tenants are no longer obliged to deliver their wheat to the Gezira Board.

As to sorghum and groundnuts, there have been no official marketing arrangements. However, with increasing failure of the tenants to pay for water and administration costs, the Gezira Board arranges, at harvest time, for delivery of an imputed quantity of produce that is equivalent in value to the costs to be covered. The same procedure applies for wheat. The Gezira Board fixes the prices at which these products are delivered based on estimates made by its officials. These prices are at all times much higher than the prevailing market prices for these products.

4.2.7 Agricultural Technology

4.2.7.1 Agricultural Research

Technology development for crop management and production in the Gezira Scheme is the responsibility of the Gezira Research Station, GRS, which was originally established in 1918 to serve the Gezira Scheme. During the 1960s, the GRS was affiliated with the Agricultural Research Corporation, ARC. The GRS is relatively well equipped and has a well-trained research staff, especially with respect to the technical aspects of agricultural production. Appropriate research facilities in the previous years enabled GRS staff to develop suitable production technologies for the Gezira Scheme. The impact of these technologies was particularly pronounced as to breeding of new varieties, improvement of crop yields and control of insects, plant diseases and weeds.

In addition, the Gezira Scheme cooperates with other ARC research centres specialized in activities of interest to the Gezira Scheme. It can clearly be stated that the Gezira Scheme has capacities to develop technology for improved crop production.

4.2.7.2 Extension Service

The Gezira Scheme's department of extension services is relatively young and small. Thus, since the establishment of the Scheme, field inspectors have performed extension service activities simultaneously with their other responsibilities. In 1969, expert extension services were introduced to the Scheme in selected Blocks[10] and finally one position of extension officer was established in each of the 18 Groups of the Scheme (Galal 1997). The ratio of extension officers (field inspectors not counted) to tenants stands at 1:7000 (World Bank 2000). The activities performed by extension officers include dissemination of information about new products, improved crop varieties and animal breeds, effective methods of input use and application, improved crop and animal husbandry practices and basic knowledge about crop protection and animal hygiene. For the dissemination of this information, the extension officers use means that include organization of field days and field and village visits, in addition to the use of radio and television.

The structure of extension services on Group basis was abolished in 1996 and instead 300 field inspectors were assigned with extension work, thus increasing the ratio of extension officers substantially to 1:400. The functions attended by the extension officers were broadened to include training of field inspectors and tenants on relevant subject matters, while the means of communication were extended to include the use of Farmers' Field Schools.

10 The five Blocks are Elkumur, Abdel Hakam, El Madina Arab, El Tiboob and Wad Elbur.

5 Overview of the Gezira's Agricultural Performance

5.1 Cropping Intensity

The cropping intensity in the Gezira Scheme is basically related to rotation policy. The percentage of land use within the adopted rotations during the initial phases of the Scheme conformed to the designed cropping intensity (see Table 3). Hence, during that time rules of irrigation were strictly maintained and soil fertility and phytosanitary considerations were given high attention. In addition, it was assumed that the tenants' socio-economic necessities had been accounted for through arrangements for production of a staple grain. This situation continued until 1960, when cropping intensity started to increase steadily, as a result of the intensification and diversification policy, but remained within the designed limits up to 1972 (Table 3).

Afterwards, cropping intensity increased and approached its designed limit during 1973–1975 as a result of record areas of cotton and expanding acreages of wheat and groundnuts. Cropping intensity continued to increase further during 1975–1979 to reach an average of 80 %, thus expanding beyond the designed limit of land use intensity, 75 % of total irrigated area. Despite a decline in cotton acreage during 1975–1979, wheat, sorghum and groundnut cultivation expanded further, with a pronounced increase in wheat areas (see Figure 1).

Cropping intensity decreased during the 1980s, averaging some 62 %, with land use intensities in some years as low as 55 %. It then increased in 1990 to 78 % as a result of the government policy of expanding the production of food crops. Since then, however, declared government policies have resulted in a lack of financing of inputs, shortages in the maintenance of the irrigation network and a low management profile, thus depressing land use intensity, which reached its lowest level in 1998/99.

5.2 Development of Cultivated Areas

The area under cultivation in the Gezira Scheme expanded rapidly during the first stages of the Scheme to reach over 80 % of the total scheme's area in 1975/76 (see Figure 2). This expansion resulted from the intensification and diversification policy adopted in the early 1960s, which envisaged the introduction of additional crops, that is, wheat and groundnuts, and expansion of the cultivation of cotton and sorghum. In subsequent years, the total cultivated area dropped until the early 1980s and fluctuated thereafter without a clear trend in the periods between 1983/85 and 1986/87. The drop of total cultivated area from the late 1970s up to the early 1980s might be attributed to declining incentives to producers from

Table 3: Actual Cropping Intensity in the Gezira Scheme, 1925–2001

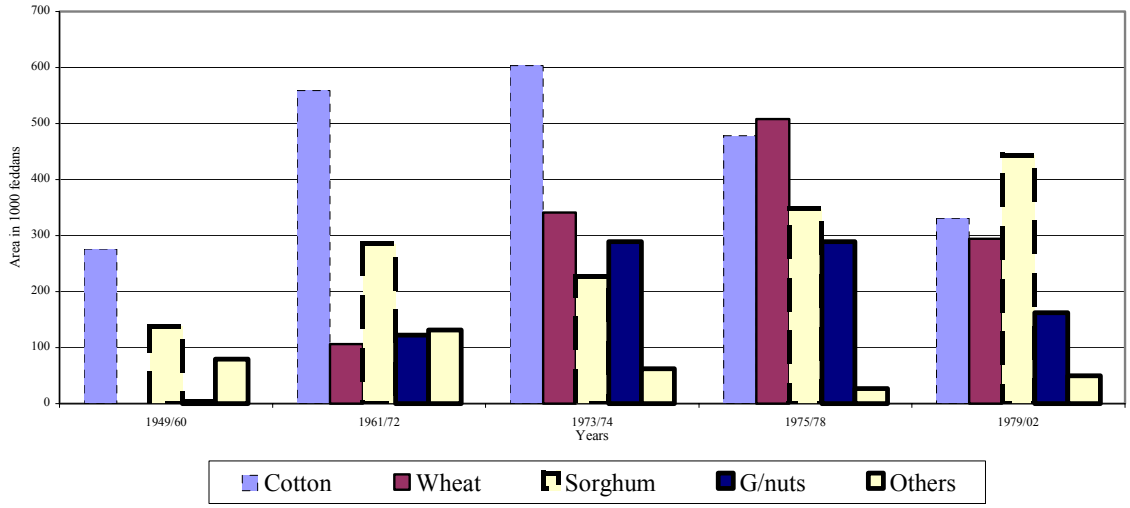
Years	No. of cultivated crops[a]	Cropping intensity (in %)[b]
1925-1931	3	n.a
1931-1933	1	n.a
1935-1960	3	57.0
1961–1972	6	62.0
1973 - 1975	6	75.0
1975-1978	5	80.0
1979-1980	5	70.0
1981–onwards	5	62.0

[a] Including only major crops like cotton, wheat sorghum, groundnuts and fodder

[b] % of cropped in total irrigable area

Source: Based on Appendix 2

Figure 1: Average Crop Acreage, Gezira Scheme, 1949–2002



Source: Based on Appendix 2

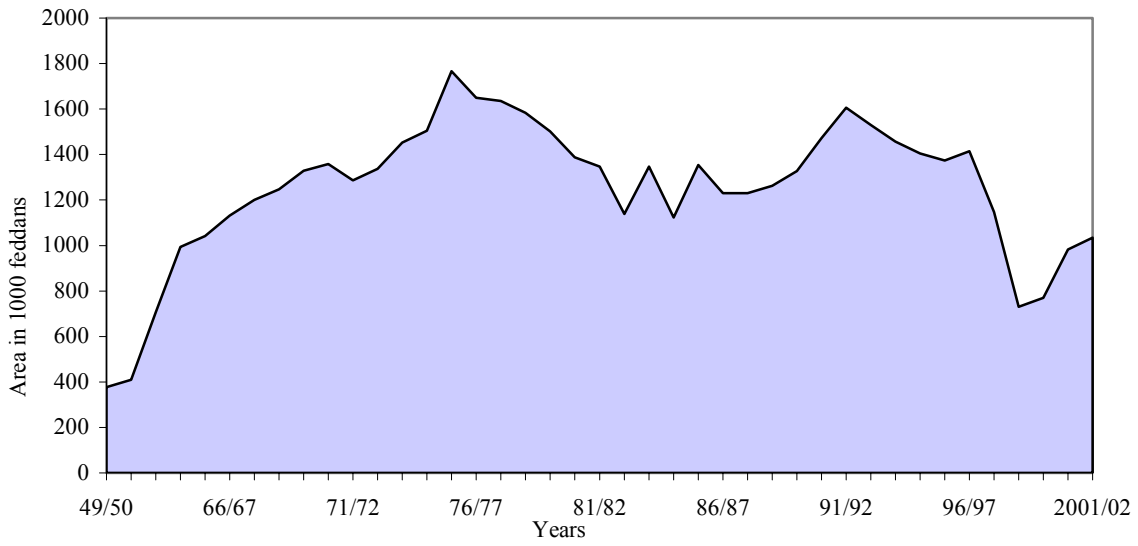
export earnings, since the drop in cultivated areas was mostly attributed to declining acreages of export products, namely cotton and groundnuts (see Figure 1).

Total cropped area increased steadily again from 1987/88 in order then to undergo successive drops and in 1998/99 to reach the lowest cultivated area recorded throughout the Scheme's history since 1960. Many scholars attribute this development to government policies adopted during the 1990s, namely withdrawal of government finance for maintenance of irrigation infrastructure and provision of inputs (Eltigani et al. 2000).

Variations in land allocation, or shares of different crop areas, are presented in Table 4. With regard to the development of acreages under individual crops, it appears that cotton acreage recorded a negative average growth rate from 1968–2001 (see Figure 3). Based on the intensification policy pursued since the early 1960s, the area under cotton increased steadily during the first phases of the Scheme to reach record areas of over 600 thousand feddans in 1973/74 and 1974/75. Thus, all of the crop rotations adopted have been designed to provide the best conditions for cotton cultivation, while most of the available finance, irrigation water and management capacities were allocated in the first line to cotton. However, since the 1975/76 season, cotton acreages started to decrease steadily until 1989 and then tumbled. The lowest recorded cotton acreages during that period were 358 thousand feddans in 1989/90 and 383 thousand feddans in 1987/88 (see Table A 2).

The strongest declines in cotton cultivation were recorded during the 1990s, when government financing gradually decreased and finally stopped altogether and budget funds for maintenance of the irrigation network became scarce. In the early 1990s, the government emphasized the role of irrigated agriculture in contributing to food self-sufficiency. Most available resources were allocated to the production of wheat and sorghum. Accordingly, wheat acreage was expanded substantially to over 600 thousand feddans in 1990/91 and was maintained at a level of over 500 thousand feddans up to 1993/95. Similarly, sorghum area reached 507 thousand feddans in 1990/91 and was expanded further to 725 thousand feddans in 1991/92 (see Table A 2). Due to limited resources, the expansion of food crop areas took place at the expense of cotton, the major export crop. There-

Figure 2: Development of Cultivated Areas in the Gezira Scheme, 1949/50–2001/02



Source: Based on Table A 2

fore, agricultural exports recorded their lowest performance during the past two decades and in the first years of 1990s.

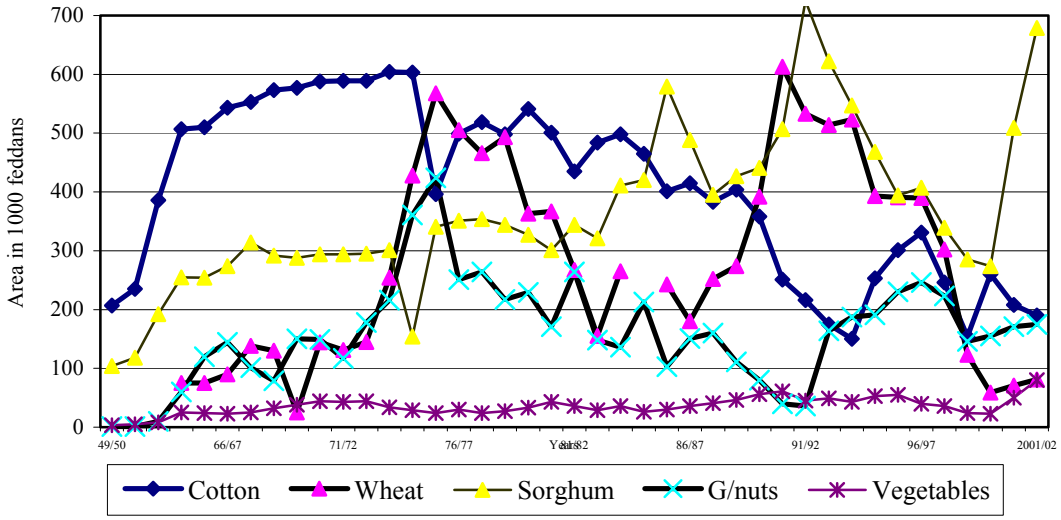
Table 4: Growth Rates of Crop Areas, Gezira Scheme, 1968–2002

Year	Growth rate (in %)			
	Cotton	Wheat	Sorghum	G/nuts
1968/70	9.2	22.5	15.2	1.9
1971/73	3.7	52.9	-1.3	35.5
1974/76	-9.3	197.9	-9.9	125.7
1977/79	-5.5	17.0	32.1	-26.9
1980/82	-2.6	-32.0	-7.5	-9.5
1983/85	-2.0	-57.8	18.5	-25.9
1986/88	-17.0	60.7	26.8	-16.9
1989/91	-15.5	88.9	-6.0	-55.2
1992/95	-56.7	23.1	37.8	67.5
1995/97	63.9	-25.2	-33.0	72.1
1998/00	-25.5	-58.8	-29.3	-21.2
2001/02	-31.8	-52.8	98.7	-1.1
Average	-5.7	18.9	11.6	12.2

Source: Based on Table A 2

As can be seen from Table 4, average growth rates of wheat areas, sorghum and groundnuts were positive during 1968–2002. Wheat areas grew successively up to the late 1970s as a result of the intensification and diversification policy. In the early 1980s, declining rainfall during the drought period, and hence limited water reserves, entailed a curtailment of wheat acreage, until wheat cultivation was completely given up in the 1985/86 season. As already mentioned, wheat cultivation was expanded in the early 1990s to increase food production. Substantial government support in the form of finance for inputs and land preparation and better crop management was then provided for wheat cultivation and also for sorghum production. However, the government policy changed in the late 1990s, leading to declining wheat cultivation as a direct result of the liberalization policies adopted, namely withdrawal of government finance.

Figure 3: Development of Crop Areas, Gezira Scheme, 1959–2002



Source: Based on Table A 2

5.3 Intensity of Input Use

Endeavours aimed at improved crop performance in the Gezira Scheme have continued since the establishment of the Scheme. Accordingly, the Gezira Research Station managed, in close collaboration with the agricultural administration of the Gezira Scheme, to develop and adapt well-defined technology packages, which are suitable for the Gezira environment, for all the products cultivated in the Scheme. These packages include a wide range of detailed information on individual crop input requirements, including quality and quantity of inputs as well as timing and methods of application (see Table 5).

However, most of the literature on the Gezira Scheme refers to inadequate use of inputs as a result of various bottlenecks, including inadequate irrigation arrangements and management, shortages of finance and problems related to adopted policies. For example, it has been reported frequently in almost all studies and reports about the Gezira Scheme that deteriorated irrigation infrastructure and practices represent one of the most serious problems facing the Scheme. The prob-

Table 5: Current Input Use in the Gezira Scheme

Crop	Seed (kg/ha)	Fertilizers (kg/ha)		Labour (mandays/ha)	Average No. of irrigations
		Urea	Super phos.		
ELS Cotton	17	80	0	68	13
MS Cotton	17	80	0	60	11
Wheat	60	80	50	11	6
Sorghum (improved)	3	50	0	27	6
Sorghum (traditional)	6	0	0	25	6
Groundnuts	21	0	0	52	8

Source: Galal, M.Y. (1997)

lems pertaining to the whole set of aspects of irrigation have been covered in detail in many studies (Barnett 1977; Brandt et al. 1987; World Bank, 2000; Gezira Scheme, 2001). Because of the rundown of irrigation infrastructure, inadequate supply of irrigation water became the rule rather than the exception, especially during the 1990s, when the deterioration of the irrigation network accelerated rapidly (Ahmed 2000). Table 6 presents reported actual numbers of irrigations in selected years.

Table 6: Actual Number of Irrigations, Selected Years

Year	Cotton	Wheat	Sorghum	Groundnuts
1980/81	9–11	5–6	5–5	5–5
1983/85	8–11	6–7	5–5	5–5
1986/87	8–12	5–7	5–6	5–6
1989/90	9–13	6–8	5–6	6–7
1992/93	9–13	6–7	5–6	6–7
1995/96	n.a	6–7	5–6	7–8
1998/99	10–12	5	5	5
2000/01	9–12	6–8	5–6	5–6

Source: The Gezira Scheme, Socio-economic Impact Study of the Pilot Program at Abdelhakam Block-Raising Productivity Through Broadening Farmer's Choice on Farm systems and water management, Barakat, unpublished records, 1980–2001

There is no discernable trend in the frequency of irrigations. The information in Table 6 confirms that the actual irrigations used by tenants have always been lower than the recommended numbers of irrigations (see Table 7). Lower numbers of irrigation imply longer intervals between irrigations, which under the climatic conditions of the Gezira Scheme would obviously restrict crop yields.

The irrigation problem in the Gezira Scheme is not limited to reduced numbers of irrigations. There are significant variations in the efficiency of irrigation that are brought about by the location of tenancies. Long-term observations in the Gezira detected substantial yield differences between head and tail locations of tenancies. A 2001 report on the Gezira Scheme estimates yield losses in the range of 30–50 % for different crops due to location at the tail of the canal (Table 8). These yield losses result from the use of lower than the recommended numbers of irrigations.

Table 7: Recommended Number of Irrigations

Crop	Number of irrigations
Cotton	16
Wheat	8
Groundnuts	8
Sorghum	8

Source: The Gezira Scheme (2002)

The problem of declining intensity of input use is not limited to irrigation water. Financial, management and policy constraints have hindered the application of recommended inputs in quantity, quality or time horizon. Unfortunately, there are no data on actually applied type and quantity of inputs. However, a look at the growth of real costs of inputs used per feddan for cultivation of cotton (Barakat) in comparison to the growth of real prices of fertilizer and growth of the free market exchange rate of the Sudanese pound may shed some light on the development of input use intensity and its anticipated effects on crop yield performance.

Table 8: Head to Tail Effects in Yields

Crop	Gezira		Managil	
	Head	Tail	Head	Tail
Cotton (Ka/fed)	5.15	2.99	5.58	2.20
Wheat (t/fed)	0.57	0.39	0.51	0.30
Groundnuts (t/fed)	0.50	0.31	0.55	0.27
Sorghum (t/fed)	0.51	0.35	0.57	0.39

Source: The Gezira Scheme (2002)

5.4 Availability and Cost of Finance

The immediate implication of the liberalization policy of the early 1990s for the Gezira Board was the need to become independent of government finance. Based on these policies, the Gezira Scheme could no longer rely, as usually, on the Bank of Sudan for financing of its foreign exchange requirements and production activities. Under such conditions, the Gezira Board, which channels the finance for the Gezira Scheme, had to rely on loans from commercial banks. While the financial needs of the Gezira Scheme are enormous and could not be secured from an individual bank, the government established a consortium of commercial banks in 1993 to secure the financial needs of the Gezira Scheme. In addition, other specialized banks like the newly established Farmers' Bank and the Agricultural Bank of Sudan as well as other corporations like the Sudan Cotton Company have also been involved in financing the Gezira Scheme.

In the course of the late 1990s, the Gezira Board faced a difficult situation, since rising inflation placed more cost pressure on producers and raised interest rates for credit and domestic budget deficits decreased financing opportunities for crop cultivation, investments and development of infrastructure. The financial requirements of the Gezira Scheme grew faster than the funds made available by the consortium of commercial banks. The total finance demanded by the Gezira Board increased in 1998/99 to reach about three times the total sum of agricultural credit offered by all commercial banks at that time. The development of the financial requirements of the Gezira Scheme and the corresponding available finance is presented in Table 9.

Table 9: Required and Available Finance and Source of Finance for the Gezira Scheme, Selected Years

Year	Required (Ls mio.)	Available (Ls mio.)	Shortfall (Ls mio.)	Source[b]
1987/88[a]	630	315	315	BS
1988/89[a]	1110	561	639	BS
1989/90[a]	1735	837	898	BS
1990/91	2000.0	1755.20	255.8	CBs
1991/92	3852.5	3050.1	812.3	CBs
1992/93	6072.0	5236.0	836.0	CBs
1993/95	n.a	3500.0	-	CBs
1997/98	58320.0	19572.0	38858.0	CBs, ABS, NIC, SCC
1998/99	69670.0	68073.0	1597.0	BS,CBs, ABS, NIC, SCC
1999/00	127620.0	69770.0	58850.0	BS,CBs, ABS, NIC, SCC
2000/01	178380.0	33590.0	155530.0	BS,CBs, ABS, NIC, SCC
2001/02	n.a	97880.0	-	BS,CBs, ABS, NIC, SCC
2002/03	n.a	82860.0	-	BS,CBs, ABS, NIC, SCC

a = in Ls/feddan

b BS = Bank of Sudan; CBs = Consortium of commercial banks;

ABS = Agricultural Bank of Sudan; NIC = National Insurance corporation; SCC Sudan Cotton Company

Source: Gezira Scheme, unpublished records, 1987–2003, Barakat

The information in Table 9 reflects the growing financial deficit experienced by the Gezira Scheme since the late 1980s. Simultaneously, the pressure on production costs continued and the provision of imported inputs became more difficult as a result of an increasing deficit in the balance of payments, thus leading to dropping yield performance, declining crop and tenant profits, and finally growing inability to repay loans. This situation forced the consortium of commercial banks to reduce their finance to the Scheme and, finally, to cease financing the Gezira Scheme. Debt accumulation for cotton and wheat is shown in Table 10.

The debt crises led to the idling of large crop areas and deferred salary payments for the staffs of the Gezira Board. Confronted with this situation, the Government of Sudan again started providing loans to the Gezira Board as a result of the mounting pressure from the tenants' and workers' unions and as an attempt to stop the deterioration of the Scheme. In addition, the Gezira Board continued borrowing.

5.5 Development of Crop Yields

The development of crop yields in the Gezira Scheme is presented in Table 11, based on tri-annual averages of growth rates from 1970–2001. The figures in the table document the absurd development of growth yields of irrigated crops in the most important agricultural scheme. Thus, whereas yields of wheat, sorghum and groundnuts recorded rather weak average growth rates during the above-mentioned period, yields of cotton, the most important crop in the irrigated agriculture sector, recorded negative average growth rates. Cotton yields during the past three decades have consistently been declining, except for 1983–1985. This exception was most probably due to the change from the joint account system to the individual account system, which was effectively introduced beginning in 1981/82. The long-term poor performance of cotton can be attributed to the unfavourable incentives that emerged for cotton producers since the introduction of the irrigation system in early 1920s. Based on the original partnership arrangement prior to the introduction of the individual account system in 1981/82, tenants received about 50 % of their net income from the sale of cotton. This arrangement, together with the impact of cost allocation under the joint account system, which subsidizes low yield producers and penalizes high yield producers, resulted in disincentives to tenants. With the introduction of additional crops (wheat and groundnuts) into the cultivation system, the bias against cotton husbandry increased; since all costs borne by the government or the Gezira Board were recovered

Table 10: Cumulative Debts and Collection Ratio, Gezira Scheme, 1992/93–2000/01

	Cotton			Wheat		
Year	Cumulative arrears plus seasonal costs	Collection	Ratio of collections to arrears	Cumulative arrears plus seasonal costs	Collection	Ratio of collections to arrears
1992/93	752.9	0	-	1912.1	0	0
1993/95	985.6	129.7	13.2	3821.5	0.328	0.01
1995/95	1239.3	563.5	55.5	7303.8	308.5	5.2
1995/96	2027.0	337.7	16.7	10803.9	1559.5	13.5
1996/97	7972.5	0	-	25000.0	1115.3	5.6
1997/98	92755.8	75999.0	88.9	-	-	-
1998/99	75615.1	51522.5	68.0	85600.0	51900.0	59.6
1999/00	105382.8	65829.7	62.0	0	0	-
2000/01	395530.0	-	-	0	0	-

Source: Suleiman, S.A. (2002)

Table 11: Growth Rates of Crop Yields, Gezira Scheme, 1973/75–2001/02 (in % p.a.)

Year	Barakat	Acala	Wheat	Sorghum	G/nuts
1973/75	-13.9	-15.6	0.6	-5.10	52.1
1976/78	-8.9	-8.9	-17.7	0.53	-19.6
1979/81	-22.1	-22.1	-18.5	-20.21	-58.2
1983/85	95.7	59.0	10.5	-6.67	55.5
1986/88	-2.1	-15.2	12.0	-6.53	10.1
1989/91	-3.9	-10.7	26.7	16.79	6.9
1992/95	-15.6	12.2	19.9	55.75	25.6
1996/98	-13.2	-15.5	-5.0	20.63	5.3
1999/01	0.5	-3.6	-20.1	-7.06	-7.5
2001/02	-19.6	-10.9	0.7	-22.80	-38.2
Average	-0.3	-1.9	0.9	1.6	1.9

Source: See Table A 4

from the proceeds of cotton sales. The reason why the Gezira Board adopts this procedure of cost recovery of irrigation cost, inputs and service costs is that it does not control the distribution of the proceeds from non-cotton crops. Moreover, non-cotton crops are favoured by allocation of appropriate levels of inputs under the control of the tenant; i.e. mainly labour input and by the possibility of shifting some of the inputs provided by the Gezira Board from cotton to tenant own non-cotton crops (wheat, sorghum and groundnuts). All these factors contributed to the bias against cotton husbandry. All in all, the poor yield performance of cotton and almost all other crops since 1996 through 2001 is a direct effect of less favourable marketing and pricing arrangements, combined with inappropriate financial policies and deteriorating infrastructure that have characterized the period from the late 1960s up to the present time.

Yield growth rates of wheat were also negative during the periods 1976–1978 and 1979–1981. Low wheat procurement prices (20–30 % lower than market prices) set by the government and forced delivery of harvests to authorized mills, presented disincentives for better husbandry management to increase productivity (Babiker 1986). Yield growth rates of sorghum were negative during most of the 1980s, mainly because of the widespread low level of technology adoption in sorghum cultivation at that time. The crop was not important from the view point of the Gezira Board and therefore there were no arrangements for provision of inputs and services for the crop other than those made by tenants. Furthermore, most of the cultivated seed used during that time was of low quality and tenants often applied no or wholly insufficient amounts of fertilizers, whereas there were no arrangements for plant protection measures.

The moderate growth rates of wheat as well as the substantial yield growth rates of sorghum during the early 1990s are a result of the heavy support of the then new government aimed at expanding food production. In the early 1990s, the Sudanese agricultural sector was characterized by a policy aimed at increasing self-sufficiency in food production. Areas under food crops were expanded and more production inputs and services were provided to tenants at favourable conditions. However, severe financial problems, the increasing deterioration of irrigation infrastructure, combined with an inadequate supply of inputs, insufficient mechanization for land preparation, not to

forget unfavourable weather conditions, depressed wheat yields again during the late 1990s.

As can be seen from Table 11, groundnuts performed poorly during the late 1970s, positive growth rates prevailed during the 1980s and 1990s and a downward turn followed during 1999–2001. The poor yields of groundnuts during the late 1970s are mainly attributable to the tenants' lack of finance for employment of the labour required by the labour intensive husbandry practices of the crop. This is an implication of the policy pursued by the Gezira Board when the crop was introduced to the cropping system in the framework of the diversification policy in the early 1960s. And its cultivation was substantially expanded during the mid-1970s without any arrangements for financing, provision of inputs and services and marketing of the crop. Tenant attempts to cope with this situation resulted in increased engagement in crop sharing arrangements. Babiker (1986) reports that poor management and a lack of marketing facilities, in addition to problems involving the monopolized export trade in the crop, were some of the main reasons for the poor performance of groundnuts. The growth rates of groundnut yields during 1980–1998 can be associated with decreased crop acreage during that period, which was followed by adjustments that led to a concentration of the cultivation of the crop in the hands of capable tenants in promising areas.

5.6 Development of Costs of Production

Nominal annual costs of crops produced in the Gezira Scheme during the past three decades are presented in Table A 5. These include costs of land preparation, costs of cultural operations as well as costs of material inputs, irrigation, harvesting, transportation and services. Total costs of production are highest for cotton; due mainly to higher pesticide and herbicide inputs as well as to higher labour costs. This implies that cotton is by far the most expensive crop to grow.

Costs of crop production in the Gezira Scheme increased substantially during the 1990s. Table 12 presents average growth rates of these costs for the period 1971–2002. It appears that costs of production of all crops increased between 1971–2002 at a nominal annual rate of 50–55 %. This substantial increase is attributable to the high inflation experienced during the past decades. The negligible rate of inflation in Sudan in the early 1970s increased steadily due to increasing dependence on central bank financing (money printing). Due to the launching of the bread-basket plan, the budget deficit during the early 1970s was huge, so that central bank finance was needed to supplement financing development expenditure from external sources. However, in the early 1980s, finance flows from external sources were interrupted for political reasons and the government was forced to resort heavily to central bank finance. As a result, the average annual rate of inflation reached 20 % during the 1970s. Stagnation of the domestic economy coupled with problems bound up with balance of payments and increased reliance on deficit financing during the 1980s and early 1990s led to steady increases in the rate of inflation, which reached its highest level in June of 1996 (Abdelwahab 2001).

Average growth in costs of crop production for all crops appears more or less to match the rate of inflation. During the early 1970s, the increase in crop production costs is more pronounced in the case of wheat. This might be due to the expensive land preparation needed for wheat and the relatively high volume of fertilizer input. Compared to cost levels during the 1970s, production costs for cotton appear to have more than doubled in the 1980s, presumably due to the introduction of the individual account system. The same trend applied for sorghum during that period. However, the most pronounced increase in crop production costs during the past three decades was recorded during the early 1990s, most probably due to the liberalization policy, which affected input markets much more than output markets.

The impact of the substantial expansion of costs of crop production was vital for the Gezira Scheme. The immediate impact was a pronounced increase in financial requirements, a fact that led the government to seek alternative arrangements

Table 12: Growth of Nominal Costs of Production, Gezira Scheme, 1971–2002, (in % p.a.)

Year	Cotton	Wheat	Sorghum	G/nuts	Inflation (%)
1971/73	5.6	12.2	-5.8	0.5	11.3
1975/76	21.1	30.6	12.3	16.6	19.7
1977/79	15.7	59.6	16.8	21.2	19.0
1980/82	52.3	51.6	56.0	35.5	30.7
1983/85	51.5	n.a	55.9	33.0	35.7
1986/88	28.0	30.5	35.7	35.0	35.0
1989/91	66.6	109.8	95.3	122.3	57.3
1992/95	121.5	91.0	130.2	97.6	115.0
1996/98	95.1	99.2	81.7	82.3	95.3
1999/01	5.8	8.2	19.6	5.3	71.3
2001/02	8.7	6.7	12.1	5.1	9.3
Average	50.8	55.5	55.5	51.1	55.7

Source: See Table A 5

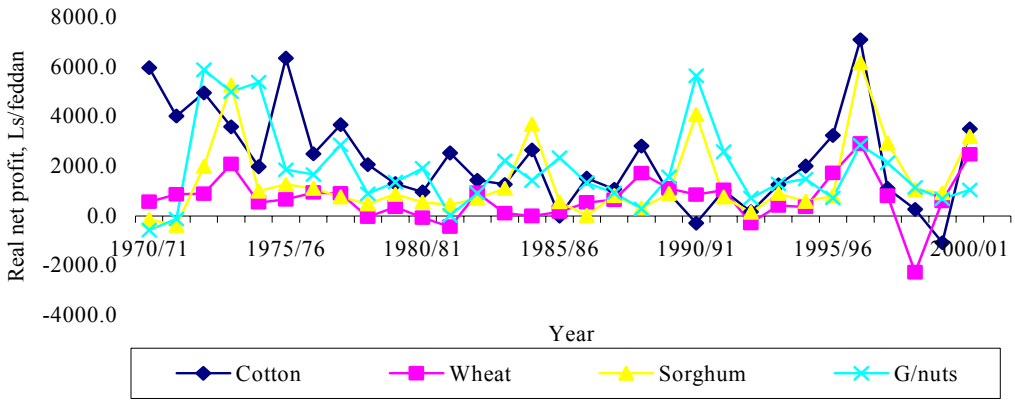
for financing the Gezira Scheme by establishing the consortium of commercial banks. However, improved performance of crop production in the Gezira Scheme remained a remote option. As a result, tenant and Scheme debts owed to banks grew further, leading the commercial banks to discontinue financing the Scheme, and finally pushing the government to step in again to finance the Gezira Scheme.

5.7 Net Profits by Crop and Tenant

The development of real net profits per crop from 1970–2001 are presented in Figure 4. Real net crop profits are obtained by deflating nominal crop profits (see Table A 6 a) using the consumer price index. As Figure 4 shows, real crop profits underwent heavy fluctuations during the period analysed. This is mainly due to fluctuations in crop yields during the period under consideration. However, it appears that real crop profits, especially for cotton and groundnuts, generally decreased during the 1990s as compared to their levels during the 1970s. Otherwise, it appears that there is no clear trend for the development of real net profits for sorghum and wheat. Most probably real net crop profits for the latter did not increase because of persistently low crop yields.

The highest real net profit for cotton was recorded in the 1975/76 season. However, cotton realized neither a profit nor a loss in 1985, while it recorded negative profits in the 1990/91 and 1999/00 seasons. The negative profits can be attributed to a variety of reasons like increasing costs of production and low crop prices, but basically it is due to low crop yields. For example, in 1985/86, real costs of material inputs for cotton increased by about 55 % as compared to the previous year, whereas cotton yield growth was negative, about 3.5 kantars/feddan. A similar trend, i.e. increasing costs and decreasing yields was registered for cotton in 1990/91, while the negative profit of cotton in 1999/00 was attributable solely to a substantial drop in per feddan yields to the lowest figure recorded during the period from 1970–2001. Low crop yields were responsible for negative crop profits for wheat in 1978/79 (0.25 ton/feddan), 1980/81 (0.257 ton/feddan), 1981/82

Figure 4: Development of Real Net Crop Profit, Gezira Scheme, 1970–2001



Source: Based on Table A 6a

(0.33 ton/feddan) and in 1998/99 (0.31 ton/feddan).

On this basis, it appears that cotton was by far the most profitable crop during the above-mentioned period of time, even though it is the most expensive crop to grow. Also, the estimated 10-year average per feddan in real crop profits for the crops of the Gezira Scheme show that cotton was the most profitable crop (see Table 13). Among typical yields, groundnuts appear to be the next most profitable crop after cotton, followed by sorghum, whereas wheat has always been the least profitable crop. The increase in real crop profits

Table 13: Ten-Year Average Real[a] Net Per Feddan Crop Profit, Gezira Scheme, 1970/71–2001/02

Period	Cotton Ls/feddan	Wheat Ls/feddan	Sorghum Ls/feddan	G/nuts Ls/feddan
1970/71–1979/80	364.15	78.19	122.57	242.39
1980/81–1989/90	151.81	47.00	91.56	129.65
1990/91–1999/00	148.23	61.74	183.82	192.93
1970/71–1999/00	225.55	68.30	138.71	185.65
2000/01–2001/02	350.13	248.15	320.74	105.58

a Deflated with consumer price index (CPI) base year 1990=100

Source: Based on Table A 6a

per feddan of cotton in the past two years was brought about by the expanded cotton yield (5.3 kantars/feddan) in the 2001/02 season.

In the light of reduced crop areas (see Table A 2) and real crop profits per feddan (see Table A 6b), it can clearly be seen that tenant real annual income from crop production has rather deteriorated since the 1970s. The immediate repercussion of deteriorating annual tenant incomes is a growing tenant perception that a typical Gezira farm is unable to provide an income above the poverty line for an average tenant family. As a consequence, tenants tended to resort more and more to crop sharing arrangements as a means of seeking alternative sources of income. The available literature suggests that tenants of the Gezira Scheme earn about 60–70 % of their annual incomes from off-farm employments nowadays (World Bank 2000). Also, it is reported that about 50 % of the Gezira Scheme's tenants earn additional income from livestock production. It should, however, not be overlooked that the major cause for this effect has not been real crop profit developments but reduced crop acreages, which in 1998/2000 stood at just about 50 % of 1974/79 levels. Reduced acreages in turn are due to grossly run-down infrastructure and service capacities.

Increases in tenant annual incomes would only be possible with increased crop acreage and crop yield levels. Although poor crop performance has been a chronic problem in the Gezira Scheme, there is a potential for significant increases in crop yields. There are substantial yield gaps between the research yield levels and the long-term average crop yield levels of the Gezira Scheme (see Table 14).

The result of the pilot scheme implemented with support of the FAO at the Abdel Hakam Block during 2000/01–2002/03 points to the possibility of attaining higher yield levels in the Gezira Scheme with improved husbandry practices and better management practices, especially as regards water resources (Table 16). Moreover, the infor-

Table 14: Research and the Gezira Scheme's Attained Yields

	Cotton Kantar/fedd.		Other crops ton/fedd.		
	Barakat	Acala	Wheat	Sorghum	G/nuts
Research yield levels [a]	12.3	13.0	1.8	2.0	1.5
Highest yields attained [b]	9.3	9.8	1.1	1.5	0.93
Abdelhakam Block yield level[c]	n.a[e]	6.1	0.94	1.23	0.84
Average yield of Gezira Scheme[d]	4.5	4.0	0.5	0.6	0.7
Yield gap between [a] and [b]	3.0	4.0	0.7	0.5	0.57
Yield gap between [a] and [d]	7.8	9.0	1.3	1.4	0.8
Yield gap between [b] and [d]	4.8	5.8	0.6	0.9	0.23
Yield gap between [c] and [d]	n.a	2.1	0.44	0.63	0.14

[a] Frequently attained yield under research conditions

[b] Frequently attained highest yield in the Gezira Scheme

[c] Abdelhakam Block yield level[f]

[d] Average yield of Gezira Scheme during 1970 - 2001

[e] There was no cultivation of barakat cotton at Abdelhakam Block in 2000/01

[f] In season 2000/2001, the Gezira Scheme implemented a pilot project with the support of the FAO to increase crop productivity.

Source: a) Gezira Scheme, Planning and Economic Administration (2001)
b) World Bank (2000)

mation in Table 14 shows that there is ample potential for high yield levels in the Gezira Scheme if underlying problems are solved.

5.8 Repercussions of Agricultural Performance

5.8.1 Development of Production Output

Average growth rates of annual crop output in the Gezira Scheme during the periods from 1970–2001 are presented in Table 16. Most notable is, however, the absurd growth of cotton output in most of the years from 1971–2001. Except for moderate improvements during the periods 1980/82 and 1986/88, growth rates of cotton output either declined or showed weak improvement throughout the period analysed. The improved output growth rate for cotton in the period 1980/82 can be attributed to the introduction of the individual account system in 1981/82. Cotton output recorded negative growth rates during 1989/91 and 1998/00. The decline in cotton output for 1989/91 was the result of the implementation of the food self-sufficiency policy, which expanded food crop areas at the expense of cotton cultivation. During 1998/00, cotton acreage was substantially reduced because of severe financial difficulties, deteriorated irrigation infrastructure and declining yields.

Average growth rates for output for wheat, sorghum and groundnuts recorded improved levels in the early 1970s, within the framework of the intensification policy. Also, wheat and sorghum recorded positive output growth rates during the early 1990s as a result of the food-production-led government policy. However, while sorghum output continued to grow positively throughout the 1990s, wheat output recorded negative growth rates between 1995–2000. The reasons underlying this development are the difficulties in financing the cultivation of capital-intensive wheat production, the deteriorated irrigation infrastructure, and hence declining yields of wheat. In contrast to wheat, sorghum production is not fully dependent on irrigation and imported inputs, a fact that facilitated the expansion of its cultivation during the end of the 1990s.

Table 15: Average Annual Growth Rates of Production Output, Gezira Scheme, 1971/73–2001/2002 (in % p.a.)

Year	Cotton	Wheat	Sorghum	G/nuts
1971/73	0.5	57.8	30.3	99.9
1975/76	-0.3	15.7	39.5	10.6
1977/79	-6.1	-10.2	19.5	-17.2
1980/82	20.6	-15.5	-2.5	15.9
1983/85	-11.3	-30.6	38.2	7.2
1986/88	16.5	20.2	-5.2	11.8
1989/91	-12.0	52.9	33.9	-23.0
1992/95	3.1	20.2	5.9	115.6
1995/97	5.1	-2.5	7.8	11.2
1998/00	-0.3	-5.0	36.3	-6.2
2001/02	7.3	15.1	37.6	-70.0
Average	2.0	7.1	20.9	15.1

Source: Based on Table A 8

5.8.2 Development of Farm Gate Prices

As regards the development of nominal farm gate prices of outputs, Table 16 shows that cotton prices increased during the period of the intensification policy, i.e. during the 1970s. However, farm gate prices for cotton recorded negative growth rates during the early 1980s and late 1990s. In the early 1990s, growth rates for farm gate prices of sorghum and groundnuts were high, whereas they were moderate for wheat due, presumably, to the then implemented government food self-sufficiency policy. However, the prices of these products recorded negative growth rates during 1992/95 because product prices decreased generally in 1993/95 as a result of expanded crop supplies due to the good rains at that period. The decrease in farm gate prices continued for wheat, sorghum and groundnuts from the late 1990s throughout 2001/02.

Table 16: Average Annual Growth Rate of Nominal Farm Gate Prices, Gezira Scheme, 1971/73–2001/02, (in %)

Year	Cotton	Wheat	Sorghum	G/nuts
1971/73	13.8	5.6	38.7	50.1
1975/76	65.3	20.3	21.1	3.2
1977/79	16.9	15.1	51.8	15.2
1980/82	-25.3	-8.1	-28.5	10.6
1983/85	-3.3	6.5	-6.6	35.6
1986/88	6.3	21.9	11.5	-27.3
1889/91	3.1	15.3	118.7	110.7
1992/95	12.5	-9.6	-8.9	-6.3
1995/97	5.2	18.2	11.7	-5.8
1998/00	-6.0	1.6	5.6	-3.5
2001/02	18.1	-9.1	-0.5	-6.5
Average	9.5	6.9	19.5	15.1

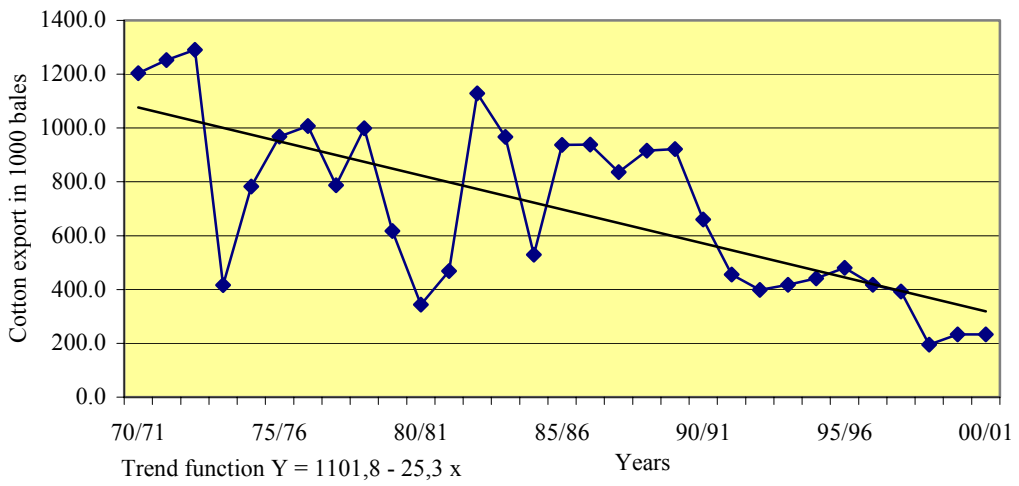
Source: Based on Table A 9

5.8.3 Development of Agricultural Exports

As can be seen from Figure 5, the volume of cotton exports shows a negative trend during 1971–2001. The highest cotton export volume was recorded in the early 1970s, while the lowest export volume was registered in the late 1990s. Endeavours to expand cotton trade started in the post-independence era. Accordingly, the focal point of Sudanese agricultural policy after independence was growth of the cotton trade. As a result, the Managil Extension of the Gezira Scheme was completed in the early 1960s to double the area sown with cotton. Additional schemes for cotton production (Rahad, New Halfa and Suki, in addition to the pump scheme alongside the Blue and White Nile), were established on the pattern of the Gezira Scheme during the 1970s and 1980s. Thereby, total cotton acreage grew from a little over 0.2 million feddans during the 1950s to reach over one million feddans during the 1970s. The substantial expansion in cotton area, coupled with improved production management and availability of good irrigation infrastructure, engendered substantial growth of cotton production. Consequently, Sudan's cotton exports (consisting up to the early 1980s mainly of long staple cotton) grew substantially during early 1970s to reach 1.3 million bales in 1972/73. This volume of cotton exports accounted for about 50 % of the international trade in extra long staple cotton, ELS, at that time, and represented about 61 % of Sudan's total export revenue (Abdeen 2000).

After a sharp drop in 1973/75, the volume of cotton exports increased during the mid-1970s to about 80 % of its level in the early 1970s, in order to drop towards the late 1970s to reach 353 thousand bales in 1980/81. An increase in cotton exports was then recorded in the early 1980s after the implementation of the individual account system. In 1985/85 and 1985/86, bad weather condi-

Figure 5: Development of Cotton Export Volume, Sudan, 1974–2001



Source: Based on Table A 10

tions (drought) lead to decreasing volumes of cotton exports. However, the volume of cotton exports showed a decreasing trend throughout the 1990s. As already mentioned, expanding food crop acreage in the early 1990s necessitated a decrease in cotton cultivation. In subsequent years, severe deterioration of irrigation infrastructure, financial difficulties and inappropriate incentive policies led to decreased cotton exports.

The impact of the development of the volume of cotton exports is depicted in Table 17. Although the growth rates presented here relate to the value of total Sudanese cotton exports, it appears that these growth rates coincide closely with the development of cotton production in the Gezira Scheme. Hence, as already mentioned, about 2/3 of cotton exports originate from the Gezira Scheme. Moderate growth rates for cotton export values were registered during 1976/78 and 1982/85. The drop in cotton production and exports in the late 1970s was followed by the change of the joint account system to the individual account system in 1981/82. This policy improved the incentives for cotton production and resulted in higher production and export of cotton in the following year. In the mid-1980s, drought affected cotton and other crop production, leading to a decreasing export value for cotton. Similarly, the expansion of food crops under the food self-sufficiency policy of the government in the early 1990s was effected at the expense of cotton, thus leading to decreased output and, finally, decreased

Table 17: Growth Rate of Export Value of Cotton, Sudan, 1972–2001

Year	% p.a.
1973/75	-10.3
1976/78	55.5
1979/81	-15.6
1982/85	55.9
1985/87	-33.5
1988/90	29.1
1991/93	-19
1995/96	28
1997/99	-7.8
2000/02	-16.7

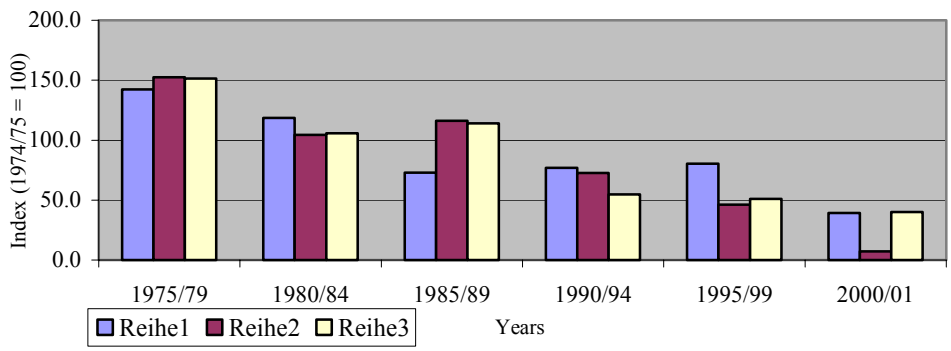
Source: Based on Appendix 11

cotton exports. However, the decrease in cotton exports from the late 1990s through 2002 is above all a result of deteriorating production infrastructure and lack of finance, which resulted from the liberalization policy adopted.

Figure 6 shows the development of cotton export value and cotton's share in total and agricultural export value during the mid-1970s through 2001. All appear to have decreased steadily throughout the period analysed. One exception is a limited expansion of cotton's share in total and agricultural export value during 1985/89, which increased compared to the level recorded in the early 1980s. The share of cotton export value in total export revenue was almost equivalent to the share of cotton in agricultural export value during the periods 1975/76–1985/89. However, cotton's share in total export value was higher than cotton's share in agricultural exports in the early 1990s. Cotton's share in total export decreased slightly beyond the share of cotton in agricultural exports during the late 1990s. This decrease became notable in 2000/01. However, since the result shown is calculated on an average basis, it conceals the fact that the dramatic decrease in cotton's share in total export value had started already during the late 1990s. Exports of cotton - traditionally the Sudan's major export product – fell from 50 % of total export earnings during the 1980s to reach 22 % in 1995. The deterioration of cotton exports continued throughout the late 1990s, finally representing only 2.5 % of total export earnings in 2000.

As regards groundnuts, the export volume increased in the mid 1970s to reach over 280 thousand tons in 1976/77 (see Figure 7). This expansion was a result of expanding groundnut production due to the intensification policy. Afterwards, groundnut exports decreased from the late 1970s throughout 2001. This is, however, not a reflection of declining groundnut production but rather of the increased diversion of groundnut production for local processing into edible oil for domestic markets and also for export. The value of exports of groundnut oil reached US $ 10.3 million in 1976 and increased to US $ 19.7 million in 1978 (Bank of Sudan 1980). Although the export value of groundnut oil fluctuated heavily during the 1980s and 1990s, it recorded levels as high as US $ 57.7 million in 1997 (Bank of Sudan).

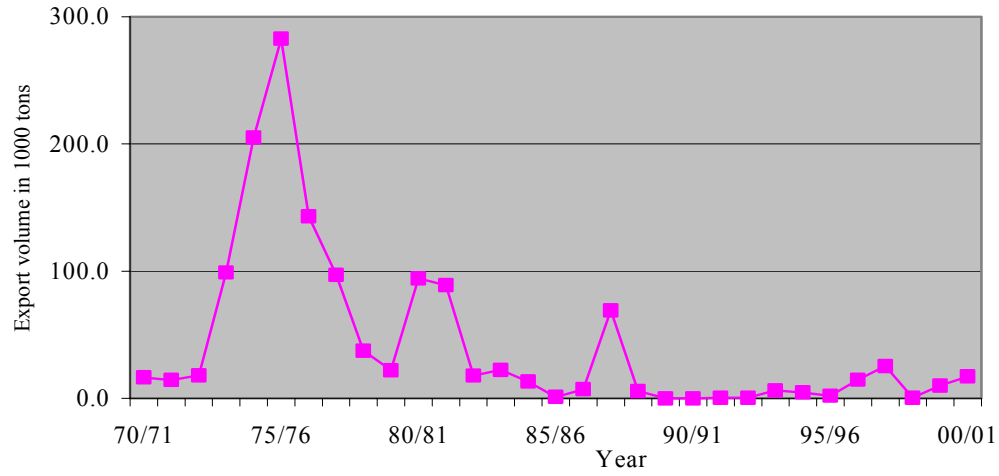
Figure 6: Index of Cotton Export Value, Cotton Share of Total and Agricultural Export Value, Sudan, 1975/76–2001/02



Series1: Cotton Exports
Series 2: Share of Total Exports
Series 3: Share of Agricultural Exports

Source: Based on Table A 11

Figure 7: Development of Groundnut Export Volume, Sudan, 1970–2001



Source: Based on Table A 10

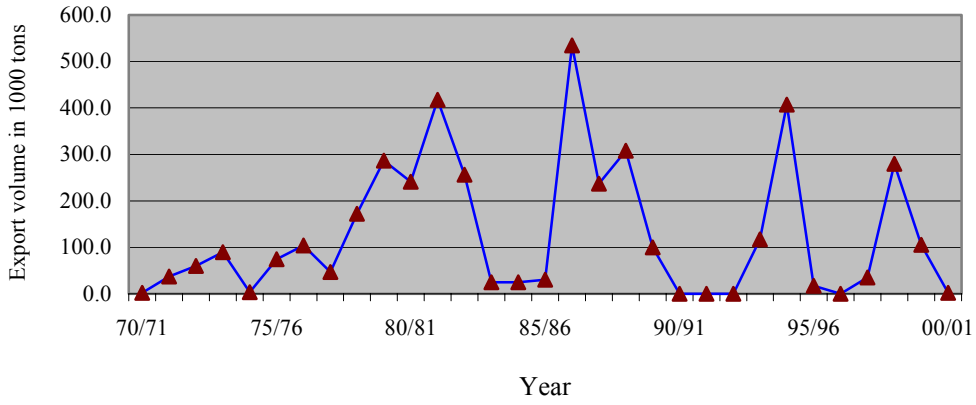
Although sorghum is not a traditional export product of the Sudan, the crop is exported from time to time, especially when there is a record harvest as a result of suitable weather conditions. Sorghum is cultivated in huge areas (between 15–20 million feddans) under rain-fed conditions on large mechanized farms and on traditional small farms. However, sorghum yields under rain-fed agriculture are low as compared to yields under irrigated agriculture. Sorghum cultivation under irrigated agriculture underwent substantial expansion during the past decade. As already mentioned, current sorghum cultivation in the Gezira Scheme amounts to an average of about 0.5 million feddans. Taking into account the relatively higher sorghum yields under irrigated agriculture, the role of irrigated agriculture in domestic and export production of sorghum cannot be overlooked.

As can be seen from Figure 8, the volume of sorghum exports increased from less than 50 thousand tons in 1970/71 to over 500 thousand tons in the early 1980s. This volume dropped during the famous drought in Sudan between the years 1983–1985 and increased afterwards, as a result of good weather conditions, to over 500 thousand tons in the 1986/87 season.

6 Home-Made Causes of the Gezira's Weak Performance

The weak performance of the Gezira Scheme in the 1980s and 1990s is a result of constraints stemming from institutional weaknesses, deterioration of infrastructure and inappropriate incentive policies. While rigid land policies discouraged investments, inflexible cropping patterns and cost-fixing procedures led to a separation of resource prices from resource-use decisions. These constraints combined with monopolized marketing of input and output, in addition to the absence of institutional credit, worked to the effect of impeding the expansion of crop productivity and finally hindered growth in tenant and Scheme incomes. All this developed, of course, against the background of a declining trend in real world market prices.

Figure 8: Development of Sorghum Export Volume, Sudan, 1970–2001



Source: Based on Table A 10

6.1 Institutional Weakness

Since the establishment of the Gezira Scheme, marked transformations have taken place. These include changes in the technology used, changes in the degree of commercialisation of production and changes in the socio-economic environment of tenants (Eldaw 1999). Thus, at present more mechanization is involved in crop production, while the cultivation of crops has become largely based on improved seeds and application of fertilizers and chemicals. These changes have paved the way for the introduction of new crops and improved varieties that have provided a high potential for vertical expansion of crop production. Similarly, market oriented production intensified through the introduction of cash crops, whereas links to international markets were strengthened through increased cultivation of export crops and greater imports of inputs and equipment. Finally, these transformations have led to a changing socio-economic environment, which has in turn affected the prices of inputs, costs of services and the profitability of crops. In spite of all that, the original institutional arrangements conditioning the whole process of crop production in the Gezira Scheme, like the land tenure system, the cropping system and production relations as well as the credit and marketing arrangements, have remained, in essence, in their original form.

6.1.1 Land Tenure

The original land tenure system has had many impacts on tenants, especially on the land owners. The first step taken was the government's compulsory land tenancy policy and allotment of tenancies to right-holders and non-right-holders alike, in order to cultivate the land under the prescribed tenancy agreement. This step has severely constrained the property rights of right-holders. Hence, except for a symbolic rent, they could neither terminate the compulsory lease nor cultivate their tenancies with crops other than those stipulated by the Gezira Board. On this basis, tenant incentives to invest and work more to maintain and improve the fertility of the land were limited due to the effective control of the land by the government (Gezira Board). Under the current land tenure system most such investments, for example land levelling, have became the responsibility of the Gezira Board, which has neglected such activities since about 1970 due to financial and infrastructure constraints.

In addition, the compulsory rent level[11] and its continuation without annual revision and adjustments has resulted in low land value. Had it not been for the current land tenure arrangements, the landless tenants would have paid higher rents to the land owners and land rent payments would have been adjusted to the marginal productivity of land. This prevented land owners from accumulating capital for more investments. Moreover, while formal sale of tenancies is forbidden by law under the land tenure system adopted, investments in the form of aggregation of land to sizes necessary for higher incomes are not possible.

6.1.2 The Cropping System

As already mentioned, decisions on crop choice, crop mix and order of crop cultivation are the domain of the Gezira Board. However, these decisions are reflected in a uniform crop rotation that is applicable to all regions and tenants of the scheme. In this way the crop rotation adopted bypasses any differences in environmental endowments of the various regions of the scheme and neglects marked differences in the socio-economic situation of tenants. Uniform crop rotation therefore represents a source of inefficiency. It constrains tenant management choices concerning cultivated crops with regard to environmental situation and the socio-economic conditions it implies.

In addition, the Gezira Board imposes a mandatory requirement on tenants to abide by specified husbandry practices, at least for cotton. Accordingly, the Gezira Board decides on the volume and quality of inputs applied as well as on type and timing of various agricultural activities, including land preparation. These decisions apply, also, uniformly for all regions and all tenants, thus intensifying the constraint on tenant management choices, substantially affecting tenant financial costs and, finally, incomes.

6.1.3 Production Relations

Based on the production relations in the Gezira Scheme, the Gezira Board charges the tenants for irrigation and administrative services, inputs supplied as well as for any other services provided. The levels of the charges and costs paid by tenants are fixed discretionally by the Gezira Board, on an average basis, and are applied uniformly to all tenants. As already mentioned, the Gezira Board applies a flat rate for water costs for a fixed number of irrigations for each crop, irrespective of a tenancy's regional and canal location, a fact which leads to marked differences in the volume, timeliness and number of irrigations received by any crop. And this in turn causes substantial yield variability and hence significant income differences.

Similarly, all tenants pay the same amount for each of the inputs supplied or services provided. Nevertheless, the actual costs of inputs supplied vary from location to location (transportation costs), while variations in times of application lead to variations in yields. Also, different land types lead to variations in the costs of mechanical operations (land preparation), while the timeliness of their completion leads to yield variability. Accordingly, the uniform pattern of costing supplied inputs and services separates resource prices from resource-use decisions. As a result, it constrains tenant management choices and provides fewer incentives for tenants to improve the efficiency of their husbandry practices in order to increase their incomes.

6.1.4 Institutional Credit

The decision to confine formal loans for crop production in the Gezira Scheme to cotton and wheat leaves the tenants with the problem of securing finance for the production and marketing of the other crops. This problem is further aggra-

11 According to Abdel Salam (1987), the customary payment for land, from which the tenancy agreement should have departed, was 10% of the crop, whereas land owners were offered only Ls 0.10 per feddan per annum. The land rent offered was fixed at this low level to avoid any reduction in the government's expected revenue.

vated by the inadequacy of the Gezira Board's cash advances for agricultural activities as well as by an increasing reliance on hired labour as a result of the increase in number of cultivated crops after the implementation of the diversification and intensification policy in 1960. Given the absence of formal finance in the Gezira, the options open for most tenants were: either underutilization of capacities through "un-intensive" production, or resort to the informal credit market, with its alleged high costs of finance (Magar 1987; Ahmed Humeida 1987; Hassan 1993; Galal 1997). While sustained profitable production in the Gezira Scheme has been hampered by a variety of institutional, infrastructure and policy problems, the burden of capacity underutilization and the high cost of informal loans have forced tenants into debt. As already mentioned, the immediate outcome of this development has been an increasing tenant tendency to sublease land and engage in crop sharing arrangements, in addition to illegal sale of tenancies, though at rather low prices.

Tenant financial problems were further aggravated by the implementation of the liberalization policy in the early 1990s. The impact of these policies was more pronounced in input markets than in output markets. As a result, prices of inputs, especially imported inputs, and the costs of labour and services increased substantially. In addition, the deteriorating balance of payments and weak fiscal performance that characterized the economy between the late 1970s and the 1990s, together with the fading out of external finance, led to rampant inflation that resulted in a substantial expansion of the amount of finance required during the 1990s (Abdelwahab 2001). Although this development encouraged the adoption of an alternative credit policy for the whole agricultural sector, the original credit arrangements for the Gezira Scheme remained unchanged. While commercial bank loans replaced the government loans, the loans provided continued to be confined to cotton and wheat and the administration of loans remained under the management of the Gezira Board. Tenant problems in finding finance not only remained unsolved but were even aggravated due to the high costs of the finance provided by the commercial banks. This has led to further underutilization of available capacities that prevents tenants from attaining break-even yields, in addition to increasing outmovements of young tenants and labourers and more sub-leasing of tenancies and crop sharing arrangements.

6.1.5 Agricultural Marketing

The dominance of the state marketing parastatals in important input and output markets has had negative impacts on the development of crop yields and crop output in the Gezira Scheme. The major objectives of the government have been maximization of crop production and the related domestic and foreign exchange earnings rather than maximization of tenant incomes or economic efficiency. As already mentioned, various measures were adopted to realize the state's objectives. These included under-pricing of farm products and over-pricing of agricultural inputs, in addition to marketing boards and various export taxes and import duties as well as local taxes. Accordingly, farm gate prices of products have always been far below levels of free market prices. D'Silva and Elbadawi (1988) reported that during the 1970–1984 period farm gate prices for cotton and groundnuts were lower by about 46–52 %, and by about 30–41 % of their border price equivalent, respectively. Similarly, Babiker (1987) stated that wheat could be sold unofficially at prices 20–30 % higher than the procurement prices offered by the Gezira Board. Although the producer prices of some products have increased as a result of state policies during the 1990s, the practice of selling in advance, which was frequently adopted by the Gezira Board during the 1990s to secure credit (mainly for cotton), has inflicted significant injustice upon tenants and contributed to eroding tenant incentives.

As regards the local marketing of sorghum and groundnuts, most tenants are forced to market their produce through the shail system due to their persistent credit needs during the cultivation period (Magar 1987). The literature, however, suggests significant negative impacts of the shail credit system on the producer prices of these

products (Magar 1987; Ahmed Humeida 1987; Babiker 1987).

Government control over input marketing in the Gezira Scheme is practiced through the Gezira Board, which closely cooperates in this respect with the Agricultural Bank of Sudan and the Farmers' Bank, which supplies inputs. The prices of inputs supplied are fixed by the Gezira Board at higher levels than the prevailing input prices in the free market. In addition, the prices of inputs are always declared at the end of the season, and thus the Gezira Board is always able to add on any price increases incurred during the season. The result of this pattern of input pricing is not only substantially higher prices, compared to free market prices, for inputs at the beginning of the season but also a separation of prices from resource-use decisions. This behaviour suggests, also, that the involvement of the Gezira Board and other similar governmental parastatals in input marketing has been a source of disincentives to a more efficient producer contribution to the production process.

6.1.6 Agricultural Technology

6.1.6.1 Agricultural Research

Although the Gezira Research Station (GRS) has been closely involved in researching the problems of the Gezira Scheme, its affiliation with the national Agricultural Research Corporation (ARC) has lessened its direct commitment and dedication to the research problems of the Gezira Scheme. Hence, under this pattern of organization, decisions on research programs, provision of funds, equipment and materials for research as well as training of research staffs are strongly driven by national objectives rather than by the research needs of the Gezira Scheme. As a result, field crops, the diversification and intensification of which have been the major objective of government, have dominated research interest.

In spite of that, a conducive research atmosphere[12] in recent years has enabled the staff of the Gezira Research Station to develop suitable production technologies for the Gezira Scheme. However, the research focus has been more on technical aspects and, hence these technologies have been developed with no/or minimal consideration of their socio-economic impacts. Capacities for improvement of socio-economic aspects of irrigated agriculture seem to be lacking within the ARC and the Gezira Scheme. In this respect, Zahlan (1986) notes that the annual reports of the Gezira Research Station imply an intensive research coverage of almost all disciplines of agriculture with the exception of agricultural economics. The major reasons behind this inadequate socio-economic research are the lack of capacities for socio-economic research and shortage of funds for training and capacity building.

In addition, involvement of the Gezira Research Station in researching the problems of the Gezira Scheme has substantially narrowed in consequence of recent economic and political developments in Sudan. Technical and financial support from outside started to decline in the early 1980s and finally ceased during the 1990s. Moreover, government financial support for the provision of equipment, research material and for staff training has also significantly declined. Similarly, financial support from agricultural schemes declined and took on an ad hoc form during the 1990s. The consequences of such developments have been stagnation of research activities and discontinuity of technology development, in addition to brain drain and lack of capacity building, which are in turn reflected in declining crop performance and, finally, declining tenant incomes.

6.1.6.2 Extension Services

Before 1969, general agricultural inspectors carried out the responsibilities of agricultural exten-

12 Facilitated by the government as well as by international support and provision of research funds from the Gezira Scheme.

sion. Expert extension services were introduced in the Gezira Scheme after 1969, when 17 extension workers were assigned to carry out the responsibilities of agricultural extension there (Hassan et al. 1986). The focus of the field inspectors has largely been on commodity development (mainly cotton) rather than community development. This seems to indicate, however, not only inadequate manpower but also inadequate extension service programs. In spite of that, the Department of Extension Services of the Gezira Scheme managed, with the support of partners like the FAO, to contribute to testing research results in demonstration fields and dissemination of information through field days, radio and television and through group discussions and field visits.

The ratio of extension officers to tenants has improved considerably, reaching 1:400 in 1996. However, the department is working under considerable difficulties due to limited funds for transportation, audiovisual equipment and printing materials. Similarly, the department lacks funds for training of extension officers and support staff and also for seminars and workshops for tenants. All of these obstacles have reduced the quality and coverage of extension services to unsatisfactory levels.

6.2 Infrastructure Deterioration

Financial difficulties and shortage of foreign exchange during the past decades has hindered the required improvements in the infrastructures of the Gezira Scheme. Thus, increasing silt deposits, inadequate and delayed silt removal operations and insufficient maintenance of hydraulic structures has underlined the deterioration of the irrigation network during the few past years. Similarly, shortage of spare parts, equipment and lack of replacement machinery has led to decreasing technical efficiency and increasing repair frequency and costs. All these difficulties, however, have resulted in inadequate production services and hence weak yield performance and increased production costs and, finally, uneconomic production from the tenant and national point of view.

6.2.1 Irrigation Infrastructure

The capacity of the irrigation network of the Gezira Scheme has experienced a significant drop during the past two decades. The major reasons behind this deterioration are the annual deposition of silt and lack of silt removal, in addition to overloading of the capacity of the irrigation network and lack and inadequate routine maintenance of the irrigation network. According to estimates of the Ministry of Irrigation (2002), the storage capacity of the reservoirs of the Sennar and Roseires dams had already decreased by about 34 % and 25 %, respectively, in 1985. The negative impact of this declining reservoir capacity is borne mainly by wheat cultivation, which depends entirely on irrigation, whereas the other crops like cotton, sorghum and groundnuts, which are cultivated during the rainy season, largely benefit from rainfall.

The volume of the silt entering the canals of the Gezira Scheme increased substantially after the establishment of the Managil Extension in 1960 and the implementation of the intensification and diversification policy in the early 1960s. The irrigation water released from the dam has increased substantially as a result of the successive expansion of cultivated areas of crops. Accordingly, the amount of irrigation water released from the dam increased to about 7.1 billion cubic meters compared with the roughly 2 billion cubic meters of released from the dam before the 1960s. The silt carried with the irrigation water settles in varying volumes in various types of canals. According to the Ministry of Irrigation (2002), the minor canals receive the highest amount of silt entering the canalisation system (33 %). The accumulation of silt over the years (due to inadequate silt removal operations) has not only depressed the capacity of the minor canals, it has also created conducive conditions for canal infestation by abundant weed growth, further aggravating the situation. Consequently, the efficiency of delivery of irrigation water has dropped substantially. This has resulted, in turn, in reduced numbers of irrigations per crop, decreased volume of watering per irrigation and delayed irrigation in many areas of the scheme, and this has lead to declining yields.

6.2.2 Infrastructure for Production Services

Like the deterioration in irrigation services, the efficiency of other infrastructure for production services has decreased as a result of financial difficulties and shortage of foreign exchange. This applies for the Department of Agricultural Engineering, the Gezira Light Railway and the Cotton Ginneries as well as to the telecommunication infrastructure, workshops, buildings and vehicles of the Gezira Board. The deterioration of these infrastructures resulted in reduced quality and volume of the services produced by them as well as growing maintenance frequencies and repair costs.

6.3 Price and Production Incentives

Since independence, the Sudanese government has intervened in the agricultural sector in a variety of ways. The driving force for government intervention is the dominant role of agriculture in the economy. Hence, agricultural performance necessarily conditions the basic features of the overall economic process, domestically as well as in relation to the outside world. The various government policies adopted in the agricultural sector have provided varying producer incentives or disincentives, which in turn have distinctly affected the performance of agriculture, especially in terms of crop yields.

6.3.1 Output Price Incentives

Table 18 highlights the trend of the impact of adopted policies on producer prices for the major crops of the Gezira Scheme based on their nominal protection coefficients (NPCs)[13]. The NPCs[14] presented indicate that, with the exception of sorghum, all crops were subjected to various magnitudes of taxation up to 1998. In the framework of its liberalization policy, the government emphasized the role of agricultural exports, import substitution and food self-sufficiency. Various measures were adopted to implement this policy. The government effected a gradual reduction of export taxes, abolished state marketing and export monopolies and lifted price controls to encourage the production of export and import substitution crops. The results of the NPCs presented closely coincide with the government policy adopted. The estimated NPCs for sorghum reveal the support of government policy for production of food crops. Also, this trend is reflected in the wheat NPCs up to 1997, before the complete liberalization of wheat production in 1998, while cotton producer incentives have improved only since 1999. As regards groundnuts, the NPCs presented reveal the continuation of price distortions caused by the activities of the Oil Seed Marketing Board, which still enjoys its monopoly status in exporting oil seed crops.

6.3.2 Overall Production Incentives

The information in Table 19 shows the impact of policies adopted on input and output prices. This effect of policies is measured on the basis of the Effective Protection Coefficient (EPC)[15]. The result in Table 19 confirms the impact of the adopted policy mentioned above. Thus, cotton and groundnut production was taxed in the early 1990s and food crop production was heavily sup-

13 The nominal protection coefficient (NPC) is defined as the ratio of the price of a product received by the local producer to the c.i.f. price of the product minus marketing and processing costs. An NPC ratio of a product that is greater than one indicates subsidization of the crop in question, while a ratio of less than one indicates taxation.

14 The calculations of NPCs are based on the procedure adopted by Eldaw (1999).

15 The Effective Protection Coefficient (EPC) measures the combined impact of exchange rate and trade policies on prices of outputs and tradable inputs and thereby on producer incentives. The EPC is the quotient of the difference of traded output and inputs at market prices to the respective difference valued at economic prices. An EPC greater than one indicates an incentive to producers through the protective measures adopted indirect and direct subsidies. An EPC of less than one implies disincentives and implicit and/or explicit taxation.

Table 18: Nominal Rate of Protection for Major Crops in the Gezira Scheme, 1990/91–2001/02

Season	Crops				
	Long Staple cotton	Medium staple cotton	Wheat	Sorghum	G/nuts
1990/91	0.36	0.30	0.65	2.67	0.43
1992/94	0.60	0.65	0.73	0.90	0.21
1995/97	0.80	0.69	0.76	1.05	0.27
1998/99	0.87	0.76	0.22	0.98	0.16
1999/00	1.06	0.84	0.41	1.09	0.22
2000/01	0.91	1.04	0.64	1.80	0.25
2001/02	1.59	1.48	0.49	1.46	0.21

Source: Results of own calculations, for method of calculation see Table A 11

Table 19: Effective Protection Coefficients for Major Crops in the Gezira Scheme, Selected Periods

Season	Crops				
	Long Staple cotton	Medium staple cotton	Wheat	Sorghum	G/nuts
1990–1991	0.51	0.49	6.80	9.10	0.44
1992–1994	0.79	0.97	1.26	1.39	0.22
1995–1997	1.27	1.12	1.38	1.56	0.43
1998/99	1.74	1.37	0.22	1.52	0.17
1999/00	2.40	1.98	0.53	1.72	0.23
2000/01	1.30	1.61	0.88	3.16	0.27
2001/02	2.23	3.10	0.68	2.80	0.25

Source: Results of own calculations, based on method exemplified in Table A 11

ported. While the production incentives for cotton have improved since the mid-1990s, and government support continued for sorghum production, the liberalization of wheat production after 1998 brought disincentives for producers. As regards groundnuts, the estimated EPCs reveal a negative impact of the policies adopted or of the indirect taxation they have involved.

However, it is worth mentioning at this juncture that, in spite of an improving tendency in the production environment as a result of policies adopted, the performance of crop production in the Gezira Scheme tended more to deteriorate than to improve, especially from 1998 through 2001. This result is, however, to a large extent attributable to the prevailing weakness of institutional arrangements and the advanced state of deterioration of all production infrastructures. A further decisive role has been played by falling real world market prices, which, after an intermittent hausse during 1991–97, have slumped precipitously since 1998.

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Appendix

Appendix 1: The Joint Account System

The joint account system is an account procedure adopted by the Gezira Scheme to divide the balance of cotton production costs and total cotton proceeds between tenants, the Government of Sudan and the Gezira Board according to specified shares. Development of the joint account system up to its abolition in 1980/81 is given in the table below.

Table A 1: Development of Respective Shares Within the Joint Account System

Year	Tenants	Government	SGB	Farmer's Reserve Fund	Social Services	Municipalities
1925–1949/50	40	40	20	-	-	-
1950/51–1962/63	42	42	10	2	2	2
1963/64–1964/65	44	40	10	2	2	2
1965/66–1968/69	48	36	10	2	3	2
1969/70–1970/71	47	36	10	2	3	2
1981–	Abolition of the joint account system					

Source: Galal, M. Y. (1997)

Appendix 2: Basic Tables of Production Performance, Gezira Scheme, 1949/50–2001/02

Table A 2: **Actual Cropped Area of Various Crops Gezira Scheme, 1949/50–2001/2002 (in 1000 feddans)**

Year	Cotton	Wheat	Sorghum	G/nuts	Others[a]	Total
1949/50	207	-	104	1	65	377
1954/55	235	-	118	1	55	409
1959/60	386	-	192	10	118	707
1964/65	507	75	255	60	95	994
1965/66	510	75	254	120	84	1.042
1966/67	543	90	274	144	91	1.142
1967/68	553	138	314	101	102	1.208
1968/69	573	130	292	79	173	1.247
1969/70	577	25	288	150	173	1.328
1970/71	588	144	294	149	302	1.358
1971/72	589	131	294	117	156	1.287
1972/73	589	145	295	178	130	1.337
1973/74	604	254	301	216	76	1.452
1974/75	603	428	154	361	49	1.605
1975/76	396	568	341	424	26	1.767
1976/77	499	505	351	251	31	1.650
1977/78	519	466	354	264	24	1.636
1978/79	498	493	344	217	27	1.584
1979/80	541	363	327	229	33	1.502
1980/81	501	367	301	171	43	1.388
1981/82	435	267	344	264	36	1.347
1982/83	484	155	321	148	29	1.138
1983/84	498	265	411	136	36	1.347
1984/85	465	-	420	213	26	1.123
1985/86	401	243	579	103	30	1.354
1986/87	415	180	488	151	36	1.270
1987/88	383	252	395	160	41	1.231
1988/89	404	274	427	111	46	1.262
1989/90	358	392	441	80	56	1.327
1990/91	251	613	507	40	91	1.472
1991/92	216	533	725	36	62	1.606
1992/93	175	514	622	164	52	1.530
1993/94	150	523	547	187	49	1.457
1994/95	253	393	468	191	100	1.404
1995/96	301	391	394	230	57	1.373
1996/97	331	390	407	246	40	1.414
1997/98	246	302	339	223	36	1.147
1998/99	154	123	285	146	24	731
1999/00	260	59	274	155	23	856
2000/01	208	71	509	171	70	1.011
2001/02	190	81	679	45	130	1.230

a Includes vegetable, lubia, phillipisara and fodders

Source: Unpublished records of the Gezira Scheme, Barakat, 1950–2002

Table A 3: Nominal Costs of Material Inputs for Cotton (Barakat) Cultivation in the Gezira Scheme and Market Exchange Rate, 1985/86–1995/96

Season	Cost of material input Ls/feddan	Price of fertilizer Ls/ton	Market exchange rate US $/Ls
1985/86	330	199.4	4.25
1986/87	1020	436.22	5
1987/88	611	396.9	8
1988/89	648.2	426.86	10
1989/90	1140	593.03	10
1990/91	1340	565.8	12.5
1991/92	3380.0	1015.2	30
1992/93	8040.0	2614.0	143
1993/94	26160.0	13058.2	335
1994/95	50720.0	17610.0	525
1995/96	105707.2	26913.0	905
1996/97	249700.0	112395.0	1795

Source: Galal, M. Y. (1997)

Table A 4: Average Annual Crop Yields for Cotton, Wheat, Sorghum and Groundnuts in the Gezira Scheme, 1970/71–2001/2002

Year	Barakat Kantar/feddan	Accala Kantar/feddan	Wheat ton/feddan	Sorghum ton/feddan	G/nuts ton/feddan
1970/71	5.42	5.42	0.39	0.51	0.4
1971/72	5	5	0.51	0.44	0.5
1972/73	4.1	4.1	0.67	1	1.25
1973/74	5.1	5.1	0.8	0.75	1.25
1974/75	4.6	4.6	0.39	0.5	1.25
1975/76	2.7	2.7	0.39	0.62	0.77
1976/77	3.7	3.7	0.58	0.66	1.2
1977/78	4.3	4.3	0.47	0.35	1.01
1978/79	3.3	3.3	0.25	0.87	0.42
1979/80	2.6	2.6	0.47	0.58	0.5
1980/81	2.3	2.3	0.26	0.49	0.23
1981/82	3.9	3.9	0.33	0.4	0.37
1982/83	4.7	4.7	0.6	0.52	0.41
1983/84	4.9	4.9	0.38	0.53	0.67
1984/85	7.62	4.39	-	0.35	0.51
1985/86	5.43	3.42	0.4	0.55	0.55
1986/87	5.7	4.72	0.44	0.4	0.6
1987/88	5.73	3.87	0.47	0.36	0.6
1988/89	6.52	4.12	0.56	0.51	0.6
1989/90	5.12	3.74	0.66	0.49	0.54
1990/91	4.56	2.86	0.44	0.53	0.73
1991/92	5.83	4.96	0.94	0.66	0.8
1992/93	3.98	4.38	0.53	0.77	0.71
1993/94	3.87	3.72	0.52	0.8	0.82
1994/95	3.61	3.93	0.59	0.85	0.89
1995/96	4.2	3.66	0.66	0.66	0.75
1996/97	4.07	3.58	0.64	1.18	0.79
1997/98	4.62	4.04	0.7	1.04	1.1
1998/99	4.72	4.13	0.31	0.79	0.5
1999/00	2.6	2.6	0.5	0.67	0.65
2000/01	4.4	4.4	0.72	0.95	0.66
2001/02	5.2	5.2	0.8	0.98	0.73
Average	4.5	4.0	0.5	0.6	0.7

Source: Unpublished records of the Gezira Scheme, Barakat, 1970–2002

Table A 5: Average Annual Nominal Costs of Crop Production in the Gezira Scheme, 1970/71–2001/2002 (in LS/feddan)

Year	Cotton	Wheat	Sorghum	G/nuts
1970/71	41.55	10	11	14
1971/72	44.91	12	12	15
1972/73	44.76	12	11	13
1973/74	48.82	14	9	14
1974/75	58.57	18	13	18
1975/76	81.14	15	12	20
1976/77	84.96	27	12	22
1977/78	92.26	29	13	24
1978/79	105.7	22	15	26
1979/80	127.72	65	19	38
1980/81	107.86	40.8	24	46.91
1981/82	233.89	93.41	44.91	73.77
1982/83	293.95	124.28	55.99	90.51
1983/84	426.2	140.8	96.89	135.11
1984/85	443.62	n.a	102.26	132.83
1985/86	777.59	273.21	159.73	200.96
1986/87	834.93	275.78	158.68	262.66
1987/88	1035.85	320.91	207.95	379.48
1988/89	1580.7	558.71	367.66	480.93
1989/90	1959.25	959.92	685.81	829.91
1990/91	3319.13	2109.95	1594.05	2320.9
1991/92	6853.44	5015	2613	4985.7
1992/93	18556.91	8710	5900	7228.26
1993/94	30585.07	18598	11210	15017
1994/95	70000.33	34567	30811	36058
1995/96	182307	86552	40455	58968
1996/97	298624	191436	127770	149017
1997/98	471855.84	241225	125333	194866
1998/99	470909	244951	146326	191219
1999/00	398785	269540	167190	211610
2000/01	518570	304710	213690	226440
2001/02	498315.5	325772	231640	245240

Source: Unpublished records of the Gezira Scheme, Barakat, 1970–2002

Table A 6 a: Average Nominal Per Feddan Profits of Main Crops in the Gezira Scheme, 1970/71–2001/2002

Year	Cotton* Ls/feddan	Wheat* Ls/feddan	Sorghum* Ls/feddan	G/nuts* Ls/feddan	Consumer price index**
1970/71	41.82	4	-1	-4	0.7
1971/72	32.17	7	-3	-1	0.8
1972/73	44.56	8	18	53	0.9
1973/74	39.52	23	58	55	1.1
1974/75	25.78	7	13	70	1.3
1975/76	95.35	10	19	28	1.5
1976/77	44.95	17	20	30	1.8
1977/78	80.73	20	17	63	2.2
1978/79	59.94	-1	14	26	2.9
1979/80	49.5	14	33	52	3.8
1980/81	46.14	-3.46	26.5	92.31	4.8
1981/82	151.91	-26.31	26.5	1.26	6.0
1982/83	107.81	69.72	53.55	68.51	7.5
1983/84	122.6	10	107.35	215.3	9.7
1984/85	258.1	n.a	358.35	137.89	13.1
1985/86	-0.01	30.1	101.02	414.8	17.7
1986/87	375.7	133.93	5.37	330.11	24.7
1987/88	334.28	201.26	254.64	289.98	31.1
1988/89	1299.58	790.09	152.8	131.45	46.2
1989/90	746.91	903.08	737.36	1278.99	81.5
1990/91	-285.58	861.67	4081.48	5642.36	100.0
1991/92	3147.18	3164	2330	7895.29	305.0
1992/93	1105.8	-1872	941	4688.6	650.9
1993/94	16478.94	5580	11844	16983	1310.9
1994/95	57033	10433	16839	42335	2843.1
1995/96	155314	82628	38595	34997	4787.5
1996/97	162815	66721	141230	65304	2293.7
1997/98	38502	27772	101377	73634	3452.1
1998/99	11420	-97591	45724	49526	4299.8
1999/00	-54770.3	30460	47310	35190	5073.0
2000/01	190887	135290	174862	57560	5451.9
2001/02	577882	34228	84440	55500	5860[a]

a estimate

Source: * Unpublished records of the Gezira Scheme, Barakat, 1970–2002
** Appendix 5.2a

Table A 6 b: Average Net Per Feddan Real Profits of Main Crops in the Gezira Scheme, 1970/71–2001/2002 (in Deflated Ls, 1990/91 = 100)

Year	Cotton	Wheat	Sorghum	G/nuts
1970/71	59.7	5.7	-1.4	-5.7
1971/72	40.2	8.8	-3.8	-1.3
1972/73	49.5	8.9	20.0	58.9
1973/74	35.9	20.9	52.7	50.0
1974/75	19.8	5.4	10.0	53.8
1975/76	63.6	6.7	12.4	18.7
1976/77	25.0	9.4	11.1	16.7
1977/78	36.7	9.1	7.7	28.6
1978/79	20.7	-0.3	4.8	9.0
1979/80	13.0	3.7	8.7	13.7
1980/81	9.6	-0.7	5.5	19.2
1981/82	25.3	-4.4	4.4	0.2
1982/83	14.4	9.3	7.1	9.1
1983/84	12.6	1.0	11.1	22.2
1984/85	19.7	-	27.4	10.5
1985/86	0.0	1.7	5.7	23.4
1986/87	15.2	5.4	0.2	13.4
1987/88	10.7	6.5	8.2	9.3
1988/89	28.1	17.1	3.3	2.8
1989/90	9.2	11.1	9.0	15.7
1990/91	-2.9	8.6	40.8	56.4
1991/92	10.3	10.4	7.6	25.9
1992/93	1.7	-2.9	1.4	7.2
1993/94	12.7	4.3	9.0	20.1
1994/95	20.1	3.7	5.9	14.9
1995/96	32.4	17.3	8.1	7.3
1996/97	70.1	29.1	61.6	28.5
1997/98	11.2	8.0	29.4	21.3
1998/99	2.7	-22.7	10.6	11.5
1999/00	-10.8	6.0	9.3	6.9
2000/01	35.0	24.8	32.1	10.6
2001/02	98.6	5.8	14.4	9.5

Source: Unpublished Records of the Gezira Scheme, 1970–2000

Table A 7: Average Crop Output of Main Crops in the Gezira Scheme, 1970/71–2001/2002

Year	Cotton (1000 kantar)	Wheat (1000 ton)	Sorghum (1000 ton)	G/nuts (1000 ton)
1970/71	3187.0	56.2	149.9	59.6
1971/72	2939.1	66.8	129.4	58.5
1972/73	2403.1	97.2	295.0	222.5
1973/74	3056.2	203.2	225.8	270.0
1974/75	2773.8	166.9	77.0	451.3
1975/76	1077.1	221.5	211.4	326.5
1976/77	1826.3	292.9	231.7	301.2
1977/78	2226.5	219.0	123.9	266.6
1978/79	1628.5	123.3	299.3	91.1
1979/80	1412.0	170.6	189.7	114.5
1980/81	1157.3	95.4	147.5	39.3
1981/82	1683.5	88.1	137.6	97.7
1982/83	2260.3	93.0	166.9	60.7
1983/84	2455.1	100.7	217.8	91.1
1984/85	2427.3	n.a	147.0	108.6
1985/86	1419.5	97.2	318.5	56.7
1986/87	2033.5	79.2	195.2	90.6
1987/88	1750.3	118.4	142.2	96.0
1988/89	2100.8	153.4	217.8	66.6
1989/90	1482.1	258.7	216.1	43.2
1990/91	928.7	269.7	268.7	29.2
1991/92	1213.9	501.0	478.5	28.8
1992/93	726.3	272.4	478.9	116.4
1993/94	580.5	272.0	437.6	153.3
1994/95	984.2	231.9	397.8	170.0
1995/96	1246.1	258.1	260.0	172.5
1996/97	1267.7	249.6	480.3	194.3
1997/98	1102.1	211.4	352.6	231.9
1998/99	680.7	38.1	225.2	73.0
1999/00	668.2	29.5	183.6	100.8
2000/01	929.8	56.8	483.6	112.9
2001/02	997.5	64.8	665.4	32.9

Source: Unpublished records of the Gezira Scheme, Barakat, 1970–2002

Table A 8: Average Nominal Farm Gate Price for the Main Crops in the Gezira Scheme, 1970/71–2001/2002

Year	Cotton (Ls/kantar)	Wheat (Ls/ton/)	Sorghum (Ls/ton)	G/nuts (Ls/ton
1970/71	15.4	35.0	20.0	22.0
1971/72	15.4	37.3	20.0	27.7
1972/73	21.9	37.3	43.2	52.4
1973/74	21.8	40.0	43.2	55.2
1974/75	18.3	63.3	71.0	58.6
1975/76	64.9	65.0	31.3	62.8
1976/77	35.5	65.0	48.5	60.4
1977/78	40.3	75.0	80.4	69.6
1978/79	50.7	85.0	84.3	131.0
1979/80	67.9	118.0	180.0	78.0
1980/81	67.0	160.0	180.0	263.0
1981/82	98.9	230.0	250.0	165.0
1982/83	85.5	280.0	200.0	150.0
1983/84	112.0	360.0	224.0	280.0
1984/85	134.9	1200.0	275.0	531.0
1985/86	222.2	700.0	474.0	1130.0
1986/87	247.1	770.0	410.0	983.0
1987/88	297.4	1010.0	1292.0	1108.0
1988/89	553.9	2400.0	1033.0	1021.0
1989/90	660.0	3000.0	2904.0	3905.0
1990/91	819.9	6000.0	12724.0	8192.0
1991/92	1785.8	8750.0	7500.0	16061.0
1992/93	4681.6	19000.0	8850.0	16784.0
1993/94	12067.7	70000.0	27000.0	39200.0
1994/95	32572.6	75000.0	50000.0	98000.0
1995/96	82346.6	220000.0	110000.0	112000.0
1996/97	118317.7	400000.0	220000.0	232708.0
1997/98	113412.9	380849.0	240577.0	273000.0
1998/99	109620.2	450000.0	220000.0	364000.0
1999/00	132313.5	600000.0	300000.0	375200.0
2000/01	128992.2	550000.0	357500.0	346000.0
2001/02	203056.1	450000.0	288000.0	308000.0

Source: Unpublished records of the Gezira Scheme, Barakat, 1970–2002

Table A 9: Volume of Annual Exports of Cotton, Groundnuts and Sorghum, Sudan, 1970/71–2001/2002

Year	Cotton (1000 bales)	Groundnut (1000 tons)	Sorghum (1000 tons)
1970/71	1204.2	16.6	2.0
1971/72	1252.2	14.4	37.4
1972/73	1291.1	18.2	59.9
1973/74	416.6	99.1	89.2
1974/75	783.3	205.0	3.6
1975/76	968.6	282.8	74.5
1976/77	1007.7	143.3	103.8
1977/78	787.6	97.2	46.9
1978/79	998.9	37.4	172.0
1979/80	617.1	22.1	286.2
1980/81	343.3	94.3	241.3
1981/82	468.1	89.0	417.8
1982/83	1128.5	18.0	256.2
1983/84	967.1	22.5	24.9
1984/85	529.3	13.3	24.9
1985/86	936.9	1.1	30.5
1986/87	938.8	7.3	534.2
1987/88	836.2	69.1	237.1
1988/89	915.4	5.7	308.0
1989/90	921.7	0.0	100.0
1990/91	659.7	0.0	0.0
1991/92	455.5	0.5	0.0
1992/93	397.9	0.5	0.0
1993/94	417.0	6.2	117.0
1994/95	441.5	4.6	406.9
1995/96	480.9	2.2	17.3
1996/97	417.8	14.8	0.0
1997/98	392.5	25.4	35.1
1998/99	194.5	0.4	279.7
1999/00	232.8	10.0	105.3
2000/01	233.7	17.3	2.2

Source: Bank of Sudan (1970–2002)

Table A 10: Value of Annual Cotton Exports, Total Exports and Agricultural Exports, Sudan, 1974/75–2001/2002

Year	Cotton exports US $	Total exports US $	Agricultural exports US $
1974/75	123605.7	348600.0	331368.6
1975/76	200551.4	435622.9	411780.0
1976/77	279437.1	551445.7	525508.6
1977/78	375888.6	657660.0	631480.0
1978/79	276136.8	532476.3	512244.7
1979/80	360142.9	553969.0	536181.0
1980/81	177601.5	417450.8	393696.9
1981/82	62415.5	324541.8	302588.2
1982/83	93176.9	371616.2	319067.7
1983/84	263979.3	540437.3	520952.7
1984/85	135000.0	272431.0	260739.3
1985/86	88061.2	198756.2	191978.4
1986/87	73344.2	166641.0	160675.8
1987/88	56899.5	187135.1	179863.9
1988/89	97843.5	229088.0	222593.2
1989/90	134879.4	302310.5	296194.7
1990/91	140000.0	365000.0	n.a.
1991/92	116000.0	305000.0	n.a.
1992/93	65300.0	319300.0	n.a.
1993/94	57100.0	417300.0	n.a.
1994/95	96634.0	523891.0	472399
1995/96	122951.0	555674.0	495441
1996/97	128209.0	620186.0	551074
1997/98	105662.0	594182.0	540108
1998/99	95124.0	595741.0	545000
1999/00	44259.0	780058.0	439884
2000/01	52863.0	1806708.0	399239
2001/02	44378.0	1698703.0	265516

Source: 1. Bank of Sudan (1970–2002)
2. Ministry of Finance and Economic Planning (1997–2001)

Table A 11: Example for Calculation of Social Prices of Various Crops for PAM Analysis: Social Price of Acala Cotton, 1998/99	
FOB export parity price at	
Port Sudan (US Cent/Lb) =	53.3
FOB export parity price at	
Port Sudan (US $/Bale[a]) =	223.9
Multiplied by SER[b]	2219.2
Equals: Export parity prices at Port Sudan, Ls/bale =	496790.1
Less:	
Fees of sea port corporations, Ls/bale =	24839.5
Export tax, Ls/bale =	39743.2
Handling costs, Ls/bale =	2087.0
SCC[c] fees, Ls/bale =	4967.9
Fees of export companies, Ls/bale =	4967.9
Others[d], Ls/bale =	16000.0
Transportation to Port Sudan, Ls/bale =	15000.0
Total, Ls/bale =	107605.5
Price at factory, Ls/bale =	389184.6
Price of 115 Lb[e] lint cotton, Ls =	106562.4
Price of 185 Lb[e] cotton seed, Ls =	44736.6
Price of 6 Lb[e] scard cotton, Ls =	4864.4
Price of one kantar[e] of seed cotton =	156163.5
Cost of ginning, Ls/kantar =	22000.0
Farm gate parity price of seed cotton at	
Gezira, Ls/kantar =	134163.5

a One bale of lint cotton equals 420 pounds
b SER stands for shadow exchange rate
c SCC stands for Sudan cotton Company
d and e One kantar of seed cotton equals 315 ponds. One kantar of barakat seed cotton yields 115 pounds lint cotton plus 185 pounds of cotton seed plus 6 pounds scard cotton.

Source:
1. Sudan Cotton Company (1997–2002)
2. Bank of Sudan (1997–2002)
3. Ministry of Finance and Economic Planning (1997–2002)