

THE REPUBLIC OF THE SUDAN

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CONSTRUCTION OF FOOD GRAIN WAREHOUSES

August 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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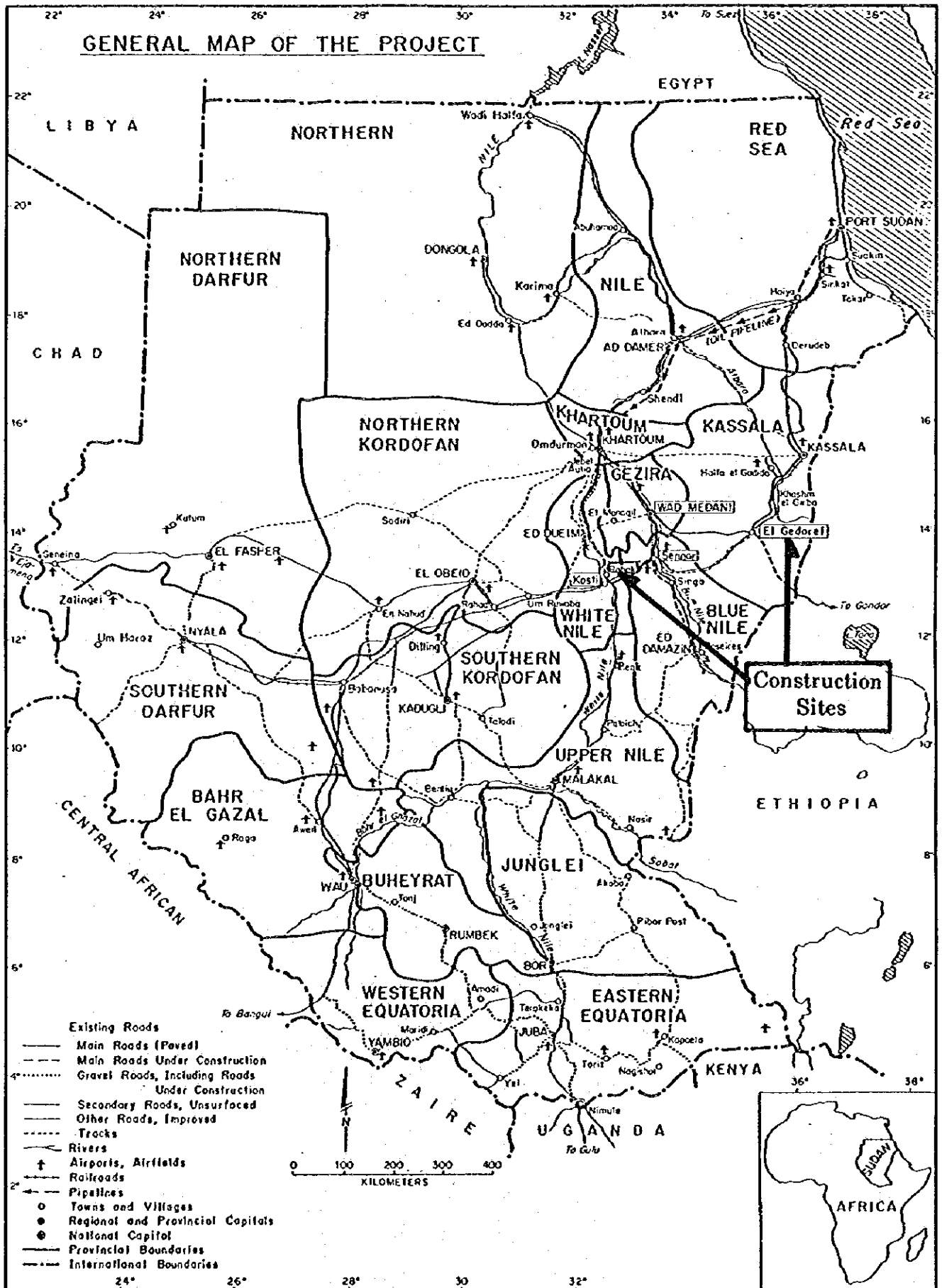
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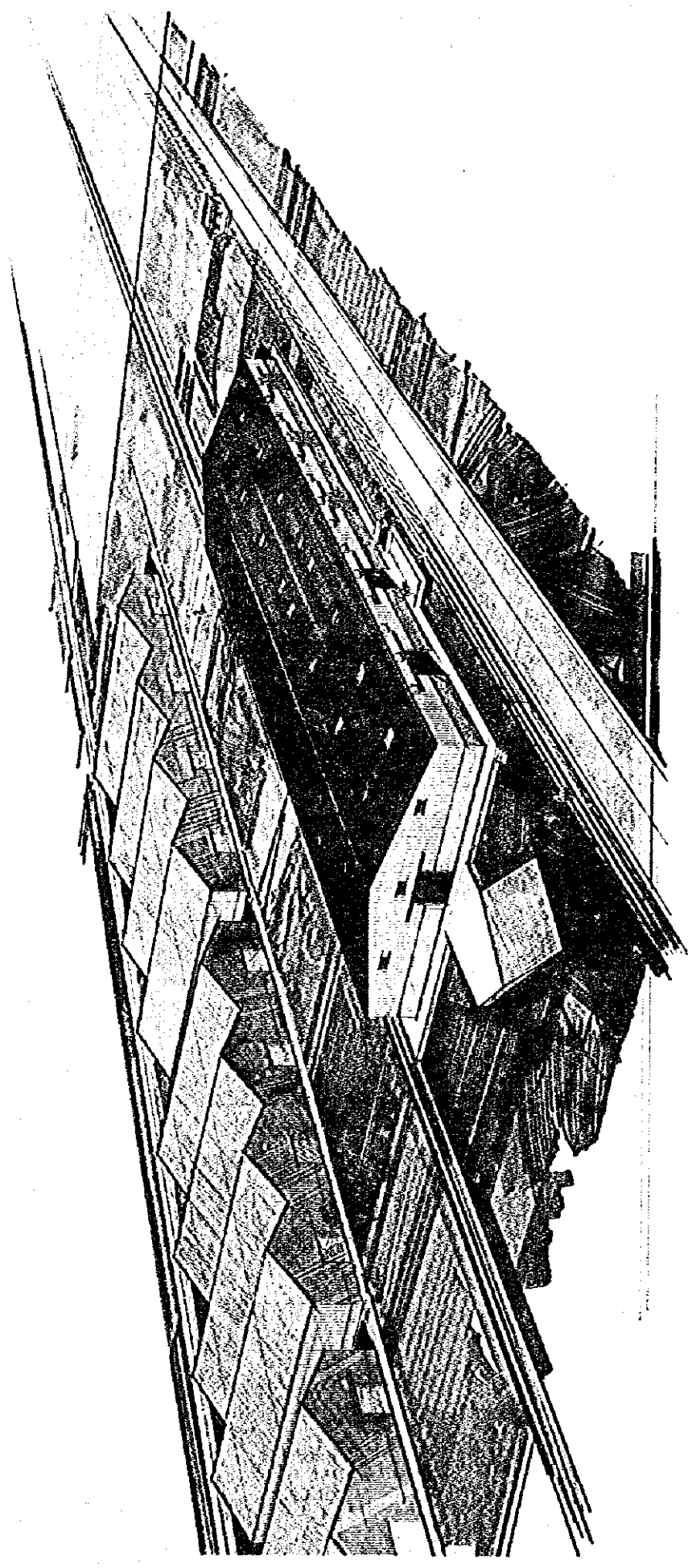
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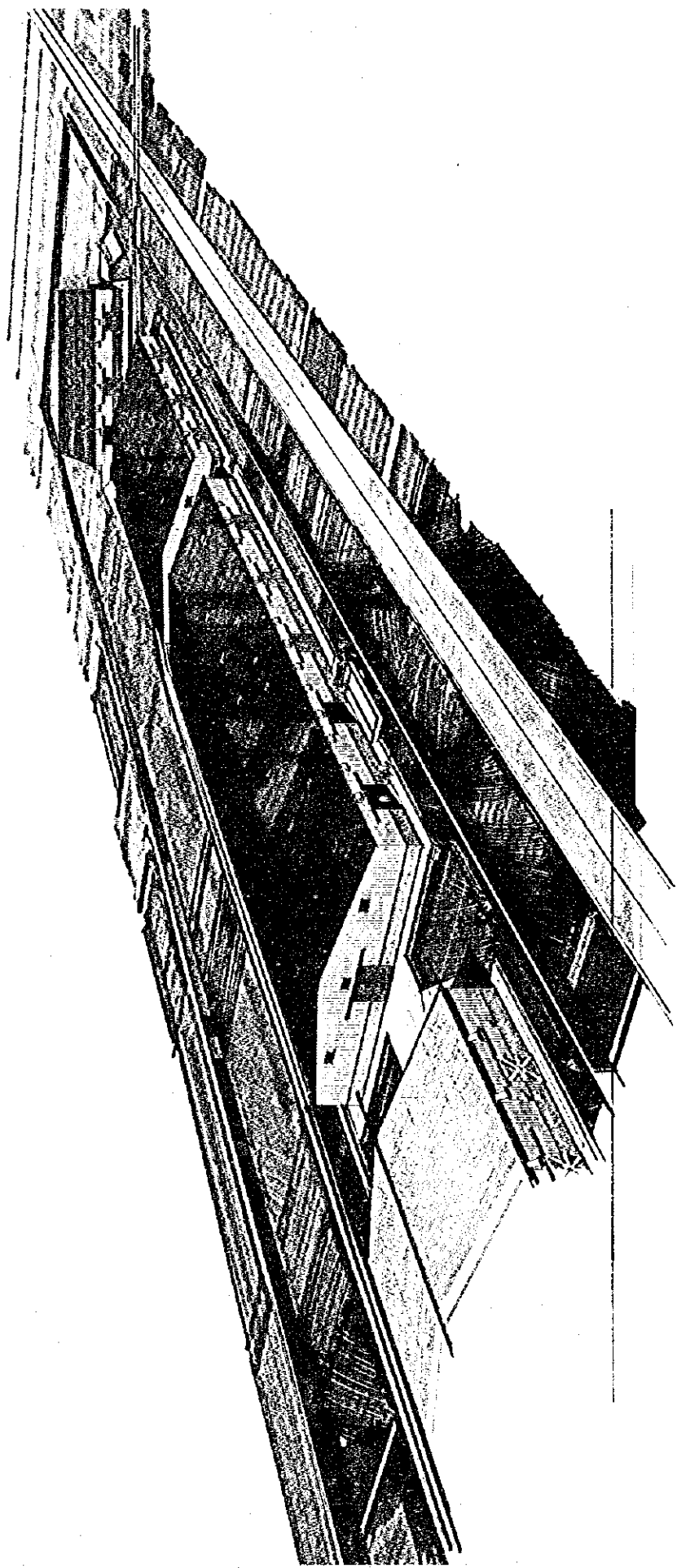
GENERAL MAP OF THE PROJECT





穀物倉庫完成予想図 (GEDAREF)

ARTIST'S CONCEPT OF THE GRAIN
WAREHOUSE IN GEDAREF



穀物倉庫完成予想図 (RABAK)

ARTIST'S CONCEPT OF THE GRAIN
WAREHOUSE IN RABAK

PREFACE

In response to the request of the Government of the Republic of the Sudan, the Government of Japan has decided to conduct a basic design study on the Project for Construction of Food Grain Warehouses and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Sudan a study team headed by Mr. Jooji YAMAUCHI, Deputy Director, Research Division, Director General's Secretariat, Food Agency, Ministry of Agriculture, Forestry and Fisheries from 27 March to 30 April, 1986.

The team had discussions on the Project with the officials concerned of the Government of the Sudan and conducted a field survey in Kassala, White Nile and Blue Nile areas. After the team returned to Japan, further studies were made, a draft report was prepared and, for the explanation and discussion of it, a mission headed by Mr. Momoki TANEICHI, Official, Grant Aid Cooperation Division, Bureau of Economic Cooperation, Ministry of Foreign Affairs was sent to the Sudan from 21 July to 5 August, 1986. As a result, the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Sudan for their close cooperation extended to the team.

August, 1986



Keisuke Arita

President
Japan International Cooperation Agency

SUMMARY

The Sudan is the largest country in Africa with a total area of about 2.5 million km²; and it has a very important economic and political position in North Africa and Red Sea regions. It is bounded by 8 countries, namely, Egypt, Libya, Chad, Central Africa, Zaire, Uganda, Kenya and Ethiopia, and by Saudi Arabia over the Red Sea.

From 1969 until recently the Sudan had been under military rule, but since May, 1986, it has been transformed into a democratic country and is now in the process of consolidation of democracy. The economy of the Sudan is greatly dependent on agriculture having 76% of the population in agriculture, and obtaining 30% of GDP from the agricultural sector.

Rainfed agriculture suffered from three continuous droughts since 1982 together with the lack of transport facilities, roads, food reserves, and the serious financial condition of the Government has resulted in starvation of several hundred thousand people. Even though the Sudan experienced record grain production of 4.6 million tons in 1985, people in country side have still been starving as a cause of chronic food shortage due to the poor market system, such as insufficient roads and the shortage of grain storage capacity. The on-going 3-year development plan (1984/85 - 1986/87) gives highest priority to rehabilitation and development of agricultural production. Planned economic development rate is 3.1% per year.

The grain storage project has the highest priority in the agricultural development plan based on the bitter experience of the starvation from 1982 to 1984. This project is to construct flat warehouses of 320,000 tons in total capacity in grain production areas and consumption areas. The objectives and background of the project can be summarized as follows:

- (1) To minimize the serious post harvest grain losses, which are estimated to be as high as 25% of total production

Losses are mainly due to open space storage caused by shortage of storage space, to the poor condition of existing warehouses (bare soil floor, crevices in the walls), insufficiency of fumigation, etc. Modernized warehouses aim to save storage losses, to market more grain, to prevent starvation and to save foreign exchange.

- (2) Stabilization of grain prices

It is noted that the sharp fluctuation of the market prices of sorghum, the staple food of the nation, during the drought year 1984 - 85 (prices rose to as high as 4.7 times the prices before drought at Gedaref) tends to cause low prices of products for farmers and, on the contrary, high prices for consumers. This discourages the farmers from working. On the other hand, in terms of appropriate allotment of resources, this gives excessive profits to the traders.

For the steady economic development, buffer stock for price control reserved by the Government, which is only 20,000 to 30,000 tons at present, has to be increased to 70,000 - 140,000 tons equivalent to 10 to 20% of the marketed volume of sorghum. The modernized warehouses are also necessary to keep safely the crop collateral for agricultural credit, which can guard farmers from extortionate creditors, so as to encourage farmers to produce crops.

- (3) To maintain minimum food reserves for stabilizing food situation in regions

The starvation and economic breakdown, triggered by extraordinary drought, are likely to happen again due to weakening of the national economy. Therefore, the storage capacity needs to be increased to conserve sorghum produced in bumper years for steady supply of sorghum to consumers and for export.

(4) To preserve good quality of food during distribution

Open storage and poor quality warehouses as commonly found in the Sudan cause deterioration in the quality of grain by changes in chemical composition as well as by direct damage by fungi and grain pests.

Quality degradation affects taste and decreases the export value in the international market, resulting in loss of foreign exchange earnings. Grain warehouses can thus save losses and strengthen the economy.

The Sudan has had account deficits in most recent years and is totally dependent on foreign aid for the foreign currency portion necessary for the development. The Sudan has great difficulty in financing the construction of the grain warehouses by itself.

In these circumstances, the Government of the Sudan has requested the Government of Japan for grant aid for construction of some of grain warehouses.

Requested construction sites and their capacities are:

Kosti	:	Sorghum warehouses of 10,000 tons
Wad-Medani	:	Sorghum warehouses of 10,000 tons
<hr/>		
capacity; total 20,000 tons		
Sennar	:	Sorghum warehouses of 25,000 tons
Gedaref	:	Sorghum warehouses of 25,000 tons
<hr/>		
capacity; total 50,000 tons		

In response to this request, the Government of Japan decided to execute a basic design study through JICA and 6 experts were despatched to the Sudan from March 27 to April 30, 1986.

The study team made a field survey of the construction sites, confirmed the request through discussions with the Agricultural Bank of Sudan (ABS), the executing agency for the Project, assessed the feasibility of the request, collected data for the basic design and made a semi-detailed design in Japan.

The results of study and analysis conducted in the field and in Japan are briefed in the subsequent paragraphs.

Basic plan

Sorghum is a reasonable choice as the objective grain for assistance by the Government of Japan because sorghum is one of the most important grains economically and socially, being the main crop occupying 52% of the total planted area, and being 66% of the grain consumed by the country.

The survey areas, Kassala, Blue Nile, White Nile and Gezira provinces are the major production areas of sorghum, but these areas are confronted with accumulation of stocks in the field due to shortage of transportation facilities. It is judged, therefore, that construction of grain warehouses in these areas would be preferable to meet urgent need and would be more appropriate than the locations in consumption areas.

Additional storage space required

Additional storage space required was estimated based on the data collected in the present survey period. The storage space required was obtained by dividing the marketable surplus by a turnover of warehouse (1.4). The marketable surplus is the product after deducting farm consumption, seed stock, animal feed, storage and transportation losses. The additional storage required is obtained deducting the existing storage space and planned storage space from the storage space required. It was estimated that the additional storage space requirement would be 50,000 tons in Kassala Province and 100,000 tons in the Central Region such as Blue Nile, White Nile and Gezira Provinces. Since it is too ambitious to construct all the necessary storages at one stroke, it is proposed to take up at first the additional storage space required by ABS, the largest owner of the storage space, which shares about 20% of the whole grain storage space in the Sudan.

Results of the estimate are summarized as follows:

<u>Province Deficient in Storage Space</u>	<u>Additional Space Required</u>
Kassala province	10,000 tons
Central region (Blue Nile, White Nile and Gezira Provinces)	20,000 tons

Construction Sites

The construction sites were selected base upon the following criteria: 1) ease of access to national roads and railway, 2) central position in relation to the sorghum production area, 3) existence of an ABS branch office for storage management, and 4) availability of construction sites.

Taking into account the above, Gedaref and Rabak were selected for the construction sites. The former is located in Kassala Province and the latter is located in the Central Region. Rabak is the assembly point of sorghum to be distributed to Darfur and Kordofan regions which are the large sorghum deficient areas. These sites are proposed by the Government and have favourable conditions meeting the above-mentioned criteria.

Type of Warehouse

Flat type warehouses are appropriate to present conditions in which sorghum is marketed in jute bags in the Sudan.

Executing Agency

ABS is designated by the Government as the executing agency of the Project. ABS is the largest holder of storage space in the Sudan and has an adequate number of well-experienced staff for handling warehouses from construction to management. In addition, it is provided with sound financial background and with the monopolistic authority to handle the buffer stock of sorghum for market control. Taking these conditions into account, it is considered that ABS is the appropriate agency for implementation of the Project.

The area of the warehouses planned in this report is 40,000 m² for Rabak site and 13,000 m² for Gedaref site. Warehouses in Rabak and Gedaref sites will be controlled by ABS Kosti and Gedaref branches, respectively. Both sites are provided with sufficient infrastructures.

An outline of the project is given below:

i) Facilities

a. Gedaref		
Flat sorghum warehouse	:	4,000 m ² (storage space: 10,000 tons)
Guard house	:	30 m ²
b. Rabak		
Flat sorghum warehouse	:	8,000 m ² (storage space: 20,000 tons)
<hr/>		
Total	:	12,030 m ² (storage space: 30,000 tons)

ii) Major equipment

Slat-conveyor		
- Gedaref	:	2 units
- Rabak	:	2 units
Fumigation sheet (17 x 17 m)		
- Gedaref	:	6 pieces
- Rabak	:	12 pieces
Gas masks	:	13 units
Gas testers	:	4 units
Wireless sets	:	3 units

The implementation schedule of the project after an exchange of notes between the countries will be six (6) months for contract negotiation, detailed design and tendering, and twelve (12) months for construction.

As for sharing of the construction works, the Government of the Sudan will do 1) level the sites, 2) provide facilities for distribution of electricity, water supply, power supply and 3) construct fences, and the Government of Japan will provide funds for the construction of main buildings including piping and wiring, and for the procurement of construction machinery. The Sudanese Government has already agreed to this sharing. Costs for the undertakings to be borne by the Government of the Sudan will be LS74,000.

The project benefits consist of direct benefits such as i) saving of sorghum storage losses, ii) efficient handling of sorghum, iii) stabilization of sorghum prices, and indirect benefits, iv) prevention of starvation, v) import substitution of sorghum and vi) encouragement of sorghum production. The benefit of saving storage losses will be measurable and the largest benefit. It will be additional supply of sorghum produced by alleviation of storage losses, which was estimated at 4,200 tons per year assuming that the turnover of warehouse is 1.4, average storage period 3.8 months and the rate of losses 10%.

Taking the high economic return, high priority in the national development plan, and urgency for early implementation into account, it can be concluded that the present project is suitable for Grant Aid by the Government of Japan.

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ABBREVIATIONS

ABS	- Agricultural Bank of Sudan
ARC	- Agricultural Research Corporation
ASP	- Agricultural Service Project
CINMYT	- Centro Internacional de Mejoramiento de Maiz y Trigo (International Center for Improvement of Maize and Wheat)
DANIDA	- Danish International Development Agency
FAO	- Food and Agriculture Organization
GOS	- The Government of the Sudan
GOJ	- The Government of Japan
IBRD	- International Bank for Reconstruction and Development
ICARA II	- The Second International Conference on Assistance to Refugees in Africa
ICARDA	- International Center for Agricultural Research in the Dry Areas
ICB	- International Competitive Bidding
ICRISAT	- International Crop Research Institute for Semi-Arid Tropics
IDA	- International Development Association
IMF	- International Monetary Fund
IFAD	- International Fund for Agricultural Development
JICA	- Japan International Cooperation Agency
NOANR	- Ministry of Agriculture and National Resources
NAPC	- Northern Agricultural Production Corporation
ODA	- Overseas Development Administration, U.K.
PPC	- Program Procurement Committee
PY	- Project Year
SPD	- Seed Propagation Department of MOAI
T&V	- Training and Visit (Extension System)
USDA	- United States Department of Agriculture
VEW	- Village Extension Worker

GLOSSARY

Abbreviations of measures and weights used in this report are listed below:

1. Length and Height

mm : millimeter
 cm : centimeter
 m : meter
 km : kilometer
 MSL : mean sea level
 EL : elevation above MSL

6. Electric Measures

kV : kilovolt
 kW : kilowatt
 kWh : kilowatt-hour
 MW : megawatt
 MWh : megawatt-hour
 GWh : gigawatt-hour

2. Area

cm² : square centimeter
 m² : square meter
 km² : square kilometer
 ha : hectare
 fd : Feddan (0.42 ha)
 MSM : million square meter

7. Other Measures

% : percent
 PS : horse power
 °C : degree centigrade
 m³/sec, m³/s : cubic meter per second
 lit/sec/ha, lit/s/ha : liter per second per hectare
 cm/sec, cm/s : centimeter per second
 t/ha : ton per hectare
 ppm : part per million
 No(s), no(s) : number(s)
 SPT : Standard penetration test

3. Volume

lit, l : liter (=1,000 cm³)
 m³ : cubic meter
 MCM : million cubic meter

4. Weight

mg : milligram
 g : gram
 kg : kilogram
 t : ton (= 1,000 kg)

8. Currency

US\$: US Dollar
 M\$: million US Dollars
 LS : Sudanese Pound

5. Time

Sec : second
 min : minute
 hr : hour
 yr : year

	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>
Official Exchange Rate					
1\$ = LS	0.71	1.30	1.30	2.5	2.5
Parallel Market Rate					
1\$ = LS	1.42	1.91	2.20	3.0	4.0

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The Government of the Sudan has been trying to increase food production since independence in 1956 mainly by expansion of the irrigated area, putting highest priority on agriculture. As a result, production of grains increased by about 60,000 tons/year or increase of 0.5%/year/capita during the 1970s. But in the 1980s, the production decreased by about 20,000 tons/year or decrease of 4.4%/year/capita because of the bad weather, shortages in irrigation water and fuel for agricultural machinery, leveling-off in the amounts of fertilizers applied, shortage in infrastructure such as roads. The per capita dietary energy supply in the Sudan was 99% of the requirement in the late 1970s. The situation must be even worse than this at the present time. In 1984, the Sudan experienced heavy damage from abnormal drought resulting in a decrease in food production to 1.4 million tons, which was far short of the food requirement of 3.4 million tons for the total population of 20,630,000 (1983). As a consequence, a critical food deficit occurred in various places (except southern areas) and 8.4 million people needed assistance, of whom 1.5 million people migrated in search of food. Starvation was worst in Kordofan region. This situation was aggravated by the shortages of food reserves, means of transportation and fuel for transportation, and by the existence of about 1.0 million refugees from neighboring countries.

According to the 3-year development plan (1984/85 - 1986/87), great quantities of harvested grains are lost because of inadequate post-harvest facilities and inadequate transportation means, and it has been reported that 25% of production has been lost every year. On the other hand, FAO has reported that the Sudan needed about 1.55 million tons of food assistance in 1984.

In the emergency referred to above, the Government of the Sudan requested the Government of Japan for grant aid for sorghum storage facilities in the crop production areas with purposes of saving of the post-harvest losses, stabilization of the prices, food reserves and preservation of sorghum quality.

The prospective sites chosen and their storage capacity are:

Kosti, Damazin and Wad-Medani	: 10,000 tons each, 30,000 tons in total
Sennar and Gedaref	: 25,000 tons each, 50,000 tons in total
Rahad	: 12,500 tons

In response to the request, the Government of Japan dispatched a study team, headed by Mr. Jooji Yamauchi, Assistant Director of Research Division, Food Agency, Ministry of Agriculture, Forestry and Fisheries for the basic design to the Sudan from March 27, 1986 to April 30, 1986.

The surveys and investigation were carried out in the Sudan in close cooperation with ABS, which is the proposed executing agency of the Project. The outline of these surveys and investigations is summarized as follows:

- Conferences with ABS with regard to formulation and implementation of the Project
- Market surveys and studies in connection with sorghum storage from socio-economic viewpoint
- Engineering and architectural surveys and studies with regard to construction of warehouses
- Preparation of a field report

The minutes of discussions with ABS and the governmental staff concerned are annexed hereto together with the daily field activity reports and a list of the persons contacted in the Sudan.

After coming back to Japan, the study team reviewed and compiled data and information collected in the field and formulated the optimum plan for construction of the sorghum storage warehouses, based on the results of comparative study of a number of alternatives.

CHAPTER 2 BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Economic Development Programs

There have been two development plans in the Sudan, a five year development plan (1970 - 75) and a six year development plan (1977/78 - 1982/83). The six year development plan was divided into two. The first half was called the first three year public investment plan (1977/78 - 1979/80) and the latter, the second three year public investment plan (1980/81 - 1982/83). The economy of the Sudan, however, remained sluggish during this period and raising of the necessary funds became difficult. Since the development plans could not be realized, the six year development plan was extended by two years, and the third three year development plan (1982/83 - 1984/85) was prepared. This third three year public investment plan was also amended in 1982, and it was executed as a fourth public investment plan. The current three year development plan is the third comprehensive economic development plan which succeeded the above-mentioned two long-term development plans and includes the fifth three year public investment plan (1984/85 - 1986/87).

The economic development plans during the 1970s have been characterized by nationalization of private enterprises, high public investment in projects and strong reliance on external resources for financing the development. These plans were subject to revision in several times mainly due to slow development of the public corporations which suffered from managerial weakness, exodus of qualified staff to neighboring countries, and overstaffing at lower levels.

The total fund for the present three year development plan, which aims at reconstruction and growth of the economy, amounts to LS 2,700 million, out of which LS 1,420 million corresponding to 53% is expected to be financed by foreign countries by means of loans and/or grants. Since the foreign portion, LS 1,420 million, of this development plan was calculated on an exchange rate of US\$1.00 = LS 1.30, it corresponds to US\$1,090 million at the time of estimate (October 1984). By using the present exchange rate, US\$1.00 = LS 2.50 = Yen 170, the fund

required for this development plan becomes LS 4,010 million equivalent, and hence foreign portion becomes LS 2,730 million which occupies 68% of the total fund.

The objectives and criteria of budget allocation in the present three year investment plan are as follows:

- to increase GDP to LS 17.29 billion in 1986/87 with the average annual economic growth of 3.1% in real terms,
- to decrease the annual inflation rate to 15% until 1986/87,
- to re-activate and to increase productivity in the production sector (agriculture and manufacturing industry),
- to promote exports and to decrease imports,
- to raise the efficiency of public services and to decrease financial expenditure,
- to implement rehabilitation projects having high investment efficiency,
- to facilitate infrastructures necessary for efficient production, and
- to solve various problems caused by the drought in 1983 - 84.

As shown in Table 2.1, LS 839 billion or 31.1% of the total budget (equivalent to LS 1,330 billion in terms of present exchange) of this project is allocated to the agricultural sector, the largest industry in the Sudan. This is equivalent to US\$530 million or approx. Yen 90 billion.

Table 2.1 Fifth Public Investment Plan
(Fiscal Year 1984/85 - 1986/87)

(Unit: LS million)

Sector	Domestic Currency	Foreign Currency	Total	Ratio (%)
Agriculture	312	527	839	31.1
Manufacturing industry	65	195	260	9.6
Transportation and communication	217	261	479	17.7
Energy and mining	74	234	308	11.4
Waterworks	33	36	69	2.6
Services	145	159	303	11.2
Regional development	314	8	322	11.9
Reserve	120	-	120	4.5
Total	1,280	1,420	2,700	100.0
Ratio (%)	47.4	52.6	100.0	

Table 2.2 shows the breakdown of the Budget for agricultural sector which will be allocated mainly to: (1) rehabilitation projects, (2) on-going projects, (3) new projects, and (4) other small scale projects. The construction project for food grain warehouses is included in the category of new projects.

Table 2.2 Investment Plan for Agricultural Sector
(Fiscal Year 1984/85 - 1986/87)

(Unit: million Sudanese Pounds)

Sector	Domestic Currency	Foreign Currency	Total	Ratio (%)
Rehabilitation projects	111.5	251.4	362.9	43.3
On-going projects	97.2	164.2	261.4	31.2
New projects	43.2	72.6	115.8	13.8
Small scale projects	60.2	38.7	98.9	11.7
Total	312.1	526.9	839.0	100.0

In relation to the problems caused by the drought in 1983 - 84, high priority has been given to the construction project for food grain warehouse in the framework of the public investment plan for the

agricultural sector. In emergency, it is necessary to transport large quantities of foodstuffs, and in this regard food grain warehouses would be indispensable. The construction project for food grain warehouses, which was formulated in the fifth three year development plan, aims at construction of flat warehouses with total storage capacity of 320,000 tons in and around the production and consumption areas. Four high priority sites proposed for the above are Wad-Medani, Kosti, Sennar and Gedaref. According to the three year development plan, objectives of the construction of the warehouses are:

- to minimize the losses of foodstuffs after harvest that are as much as 25%,
- to stabilize the prices of foodstuffs,
- to reserve minimum supplies of foodstuffs for the purpose to stabilize the demand supply conditions in local areas, and
- to protect from quality deterioration during the marketing process.

The three year development plan says that for the installation of food grain warehouse, flat warehouses are preferable to silos because in flat warehouses.

- Investment costs are less,
- A variety of foodstuffs can be stored, and
- No sophisticated management technique are required.

2.2 Agriculture and Food Production in the Sudan

Agricultural Production

Agricultural population of the Sudan is 15.6 million (1983) which represented 76% of the total population. The share of agriculture in

GDP is approximately 30%, occupying the largest portion among all sectors, and a major part of the exports are agricultural products such as sorghum, cotton, (see Table 2.3).

Table 2.3 Economic Status of Agriculture in the Sudan

Item	Agriculture	Total
Population (1983, million)	1,560 (75.6%)	2,063 (100%)
GDP (1983/84, LS million)	2,664 (29.6%)	8,996 (100%)
Export (1981/82-83/84 average US\$million)	460 (79.6%)	579 (100%)
GDP/population (LS)	171 (39.3%)	435 (100%)

Source: Statistics of the Sudan, World Bank

Main crops in the Sudan are sorghum, millet, groundnuts, sesame, etc., and planted acreage of crops reaches 7.17 million ha on an average in 1981/82 to 1983/84. Sorghum is the most dominant crop occupying 52% of the planted acreage and 66% of the whole grain consumption in the Sudan (see Tables 2.4 and 2.5). It is the main staple foodstuff of the Sudanese and is one of the most economically important crops. Annual average production of sorghum during 1981/82 - 1983/84 is 2.36 million tons and the per ha yield is 0.63 ton (see Table 2.4).

The agriculture in the Sudan can be classified into the three types, i.e., (i) irrigated farming, (ii) mechanized rainfed farming, and (iii) traditional rainfed farming. The irrigated farming is practised mainly by the Government, whereas the rainfed farming is practised by the private enterprises and farmers. Traditional rainfed farming is the extensive farming type using little chemicals and fertilizers. Traditional rainfed farming, as seen in Table 2.4, is practised in about 51% of the total cropping area and groundnuts and sesame are planted mainly occupying 85% of the traditional rainfed area, respectively. Sorghum is mostly cultivated under the mechanized rainfed and traditional rainfed farming methods accounting for 93% in terms of total cropping area and 88% in terms of whole production. It is noted that traditional rainfed farming shows relatively low productivity, compared

with irrigated and mechanized farming and that there is still room for future improvement.

The proportion of each crop to the total cropped area is: 52.2% for sorghum, 16.3% for millet, 11.8% for groundnuts, 10.5% for sesame and 5.7% for cotton. Sorghum shows the high percentage because it is the staple food in the Sudan.

Table 2.4 Crop Production by Each Farming Method
(1981/82 - 1983/84 average)

Crop and Farming Method	Cropping Area (10 ³ ha)	Production (10 ³ ton)	Production (ton/ha)
<u>Sorghum (52.2%)</u>	<u>3,738.7 (100%)</u>	<u>2,358.2 (100%)</u>	<u>0.63</u>
Irrigated Rainfed	252.4 (6.7%)	276.0(11.7%)	1.09
Mechanized Rainfed	2,272.5(60.8%)	1,496.3(63.5%)	0.66
Traditional Rainfed	1,213.8(32.5%)	585.9(24.8%)	0.48
<u>Cotton (5.7%)</u>	<u>410.8</u>	<u>558.5</u>	<u>1.36</u>
<u>Groundnut (11.8%)</u>	<u>545.3 (100%)</u>	<u>545.5 (100%)</u>	<u>0.65</u>
Irrigated Rainfed	123.6(14.6%)	216.8(39.7%)	1.75
Traditional Rainfed	721.7(85.4%)	328.7(60.3%)	0.46
<u>Sesame (10.5%)</u>	<u>750.7 (100%)</u>	<u>195.7 (100%)</u>	<u>0.26</u>
Mechanized Rainfed	256.9(34.2%)	72.7(37.1%)	0.28
Traditional Rainfed	493.8(65.8%)	123.0(62.9%)	0.25
<u>Millet (16.3%)</u>	<u>1,171.2</u>	<u>408.7</u>	<u>0.35</u>
<u>Others (3.5%)</u>	<u>249.6</u>	=	=
<u>Total (100%)</u>	<u>7,166.3 (100%)</u>		
Irrigated Rainfed	978.3(13.7%)		
Mechanized Rainfed	2,529.5(35.3%)		
Traditional Rainfed	3,658.5(51.0%)		

Demand and Supply of Food

Table 2.5 shows the demand and supply of major agricultural products in the Sudan. Among the grains, self-sufficiencies of rice and wheat are as low as 31.8% and 46.9% respectively, and their shortage was made up by import. Millet and maize are sufficient for local consumption and 246,000 tons of sorghum were exported annually on an

average between 1979 and 1981. Among other products, sugar shows high dependency on importation showing the self-sufficiency of 57%.

Table 2.5 Demand and Supply of Food
(Average, 1979 - 81)

(Unit: 1,000 tons, %)

Item	Domestic Production	Import (net)	Stock change	Domestic Consumption	Self-sufficiency Rate (%)
	(A)	(B)	(C)	(D=A+B-C)	(A/D)
Wheat	206	233	-	439	46.9
Maize	47	-	-	47	10.0
Rice	7	15	-	22	31.8
Sorghum	2,611	-246	327	2,038	128.1
Millet	538	-1	17	520	103.5
Groundnut	890	-83	60	747	119.1
Sesame	224	-47	-3	180	124.4
Sugar	362	244	-31	637	56.8
Beef	231	-14	-	217	106.5
Mutton	100	-2	-	98	102.0
Goat (meat)	53	-	-	53	100.0
Camel (meat)	23	-	-	23	100.0
Chicken	21	-	-	21	100.0
Egg	33	-	-	33	100.0

Source: FAO Demand and Supply of Food in Major Countries
FAO Annual Report of Export and Import

High self sufficiency of food had been maintained until 1983 and the surplus had been exported. The drought in 1982-1984 caused food shortage and in 1985, 730,000 tons of wheat, 550,000 tons of sorghum and 39,000 tons of rice were imported. In 1985/86, favourable rainfall brought a record production of food. In spite of the record production, there is still famine in the remote areas due to problems in transportation and storage.

2.3 Administrative Organization for Agriculture

The present government organization is as shown in Fig. 2.1.

Economic cooperation by foreign countries which was under the responsibility of the Ministry of National Planning (MNP) is now taken

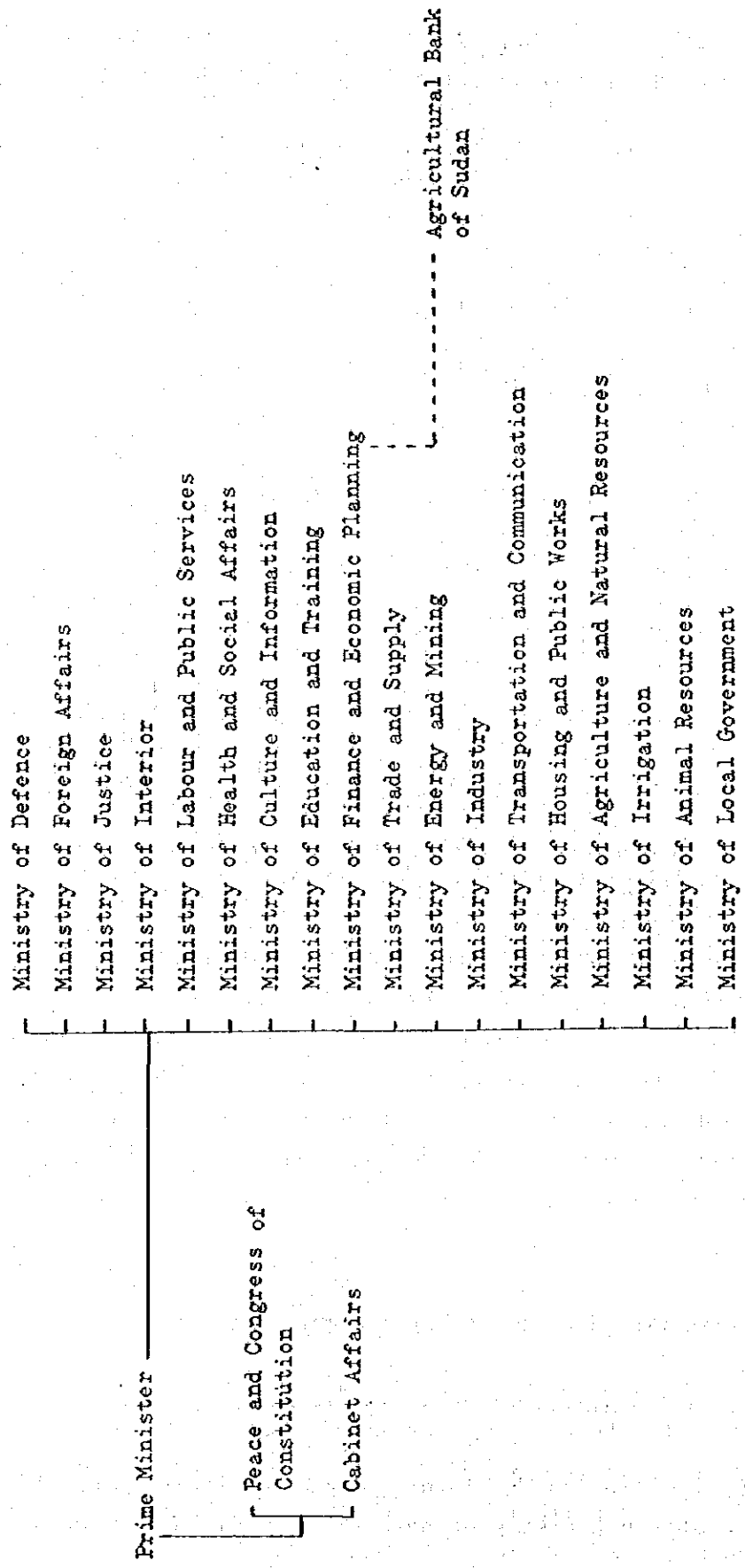


Fig.-2.1 Government Organization (May, 1986)

charge by the Ministry of Finance and Economic Planning (MFEP), which is formed as an integrated organization of MNP and the Ministry of Finance and National Economy. The present project will be managed by the Agricultural Bank of Sudan (ABS), which is an agency under MFEP. ABS was established in 1957 as a sole national agricultural bank and is not only essential for realization of the policy to promote agriculture, but also plays an important role in food marketing being monopolistic body to manage buffer stock of sorghum.

The other ministries dealing with agricultural development are: The Ministry of Irrigation (MI), which is responsible for farm land consolidation and maintenance of irrigation facilities; the Ministry of Agriculture and Natural Resources (MANR), responsible for agricultural research and reconstruction activities, and protection of natural resources; and the Ministry of Animal Resources (MAR), which was separated from MANR.

2.4 Economic Cooperation by Foreign Countries

The economic cooperation extended to the Sudan by foreign countries amounted to \$1,019.4 millions in 1983. Bilateral aid accounted for \$794.3 millions (77%), multilateral for \$166 millions (17%) and private sector for \$59.1 millions (6%). The most important financing country in bilateral aids was the United States of America, which supplied 15.5% of the total amounts. The amount of aid by the Government of Japan was \$17 millions, all of which was in grant.

Table 2.6 Foreign economic Cooperation for the Sudan

(Unit: Million US dollars)

	1980	1981	1982	1983
Bi-lateral	428.0	458.2	522.9	794.3
Biggest supplier (West Germany) (Netherlands)	(62.4)	(34.8)	(USA) (131.0)	(USA) (158.0)
Japan	(2.84)	(0.08)	(-3.56)	(17.05)
Multi-lateral	192.2	222.5	217.3	166.0
Biggest supplier (ECC 56.3)	(ECC 56.3)	(IDA 64.8)	(IDA 84.9)	(IDA 55.0)
Private	85.6	40.4	69.6	59.1
Total	705.8	721.1	809.8	1,019.4

Source: Handbook of Economic Co-operation, 1986
International Development Journal Co., Ltd.

The Sudan's finance is in a state of severe deficit and the majority of the fund for development is covered by foreign financing. According to the 3-year development plan (fiscal year 1984/85 - 1986/87), 47% of the total development fund or LS422 millions in 1982/83 and 43% or LS501 millions in 1983/84 were covered by foreign source. It is expected that all the foreign currency portion (equivalent to LS1,420 millions) of the development fund (LS2,700 million) needed during fiscal year 1984/85 - 1986/87 will be covered by foreign fund. The development plan gives higher priority to rehabilitation of the Gejira scheme and rehabilitation of sugar industry. The former will rehabilitate irrigation facilities and agricultural machinery, whereas the latter will rehabilitate 4 sugar mills including sugarcane production.

The grain storing facilities constructed or to be constructed under the post-harvest project by the foreign aid are as follows:

Table 2.7 ABS Grain Storage Facilities Assisted by Foreign Aids

Location (Province)	Capacity (tons)			Source of Planned Finance	Type
	Existing-	Under Con- struction			
Port Sudan (Red Sea)	50,000	-	-	USSR	Silo
Gadaref (Kassala)	100,000	-	-	USSR	Silo
Mad-Medani (Gezira)	12,000	-	-	UK	Warehouse
Renk (Upper Nile)	16,000	-	-	KUWAIT FAO	Warehouse
Dongola (Northern)	2,600	-	-	UK	Warehouse
Khartoum North	12,000	-	-	UK	Warehouse
Shendi (Nile)	2,600	-	-	UK	Warehouse
Damazin (Blue Nile)	12,000	-	-	UK	Warehouse
New Falfa (Kassala)	12,000	-	-	UK	Warehouse
Kassala (Kassala)	-	3,000	-	IDA	Warehouse
Karima (Northern)	-	3,000	-	IFAD	Warehouse
Um Ruwabe (Northern Kordofan)	-	10,000	-	IDA	Warehouse
Abu Hamad (Nile)	-	3,000	-	IDA	Warehouse
Dilling (Southern Kordofan)	-	6,000	-	IDA	Warehouse
Dilling (Southern Kordofan)	-	-	3,000	USA	Warehouse
Abu-Gubeiha (Southern Kordofan)	-	-	3,000	USA	Warehouse
Talodi (Southern Kordofan)	-	-	3,000	USA	Warehouse
Obeid (Northern Kordofan)	-	-	16,000	USA	Warehouse
Buram (Southern Darfur)	-	-	8,200	Italy	Silo
Foro Burunga (Southern Darfur)	-	-	6,500	Italy	Silo
Kubbum (Southern Darfur)	-	-	4,500	Italy	Silo
Umm Dafog (Southern Darfur)	-	-	5,100	Italy	Silo
Dar Ein (Southern Darfur)	-	-	7,000	Italy	Silo
Total	219,200	25,000	56,300		

As seen in the above table, facilities with a total capacity of about 220,00 tons were constructed, 25,000 tons are under construction, and 56,300 tons are planned. Most of the facilities under construction or to be constructed are located in Kordofan and Darfur regions, where people suffered most from the famine in 1983 - 84. The silos to be constructed by Italy grant aid will be of small size of 26 tons/silo, and will be designed to keep security food in the remote areas as a result of the present famine. These silos will

be made of prefabricated glassfiber which is suitable for quick transportation, easy construction, and storage of grains for a long period of time.

2.5 Background and Details of the Request

Background of the Request

Since the country's independence in 1956, the Government of the Sudan has given the highest priority to agricultural development of the country and has been making efforts to promote food production through irrigation development and expansion of the arable land. In spite of these efforts, a huge amount of food in the Sudan has been lost due to shortage of transportation means and storage space.

With a view to improving the marketing of staple food through resolving the above problems from a long-term viewpoint, the Government of the Sudan made a request to the Government of Japan for a grant aid to construct warehouses for grains (sorghum) in or near the producing areas, and small warehouses for relief food (wheat) from foreign countries through ICARA II. The latter are planned to be constructed near the camps of refugees.

Details of the Request

The details of the preliminary request made by the Government of the Sudan are shown below:

1. Warehouses for sorghum:
 - A. Kosti, Wad-Medani, Damazin 10,000 tons at each site
 - B. Sennar, Gedaref 25,000 tons at each site
 - C. Rahad 12,500 tons
 - Total 92,500 tons

 2. Warehouse for relief food:
 - A. Port Sudan, Yei, Juba 25,000 tons at each site
 - B. Showak, Gedaref, Hawata, Maridi 15,000 tons at each site
 - Relief food-total (7 places) 135,000 tons

 3. Equipment: Truck scale and other related facilities and equipment
-

On the above-mentioned details of the request, the Government of Japan made studies mainly from the viewpoints of budget and construction requirements, and requested the Government of the Sudan to reconsider the details of the request. The two Governments mutually agreed on the following as the final request.

Requested Warehouses and Equipment	Construction Site	Storage Capacity (tons)
1. Warehouses for sorghum		
Flat warehouse	Rabak (Kosti)	10,000
Flat warehouse	Wed-Medani	10,000
Flat warehouse	Sennar	25,000
Flat warehouse	Gedaref	25,000
Total	(4 places)	70,000
2. Facilities and Equipment		
Truck scale, fumigation equipment and stackers.		

The warehouses planned in the project have the following four usages as contemplated by ABS:

- Storage of Sorghum Buffer Stock owned by the Government of the Sudan

The Government of the Sudan decided in November, 1985 to purchase a sorghum buffer stock of 450,000 tons which far exceeds the present storage capacity of ABS, i.e. 320,000 tons. The planned warehouses could be used fully for storing the balance of the above.

- Storage of Stratetic Food Reserve

The Government of the Sudan decided to reserve 250,000 tons of sorghum for Darfur region and 260,000 tons for the southern regions, as a security food reserve (Newspaper, May 26, 1986). The existing total storage capacity in these regions, i.e. 81,000 tons, is far below this requirement. The planned warehouses can be used for

storage of the food security reserves provisionally till necessary storage space is provided in these regions.

- Storage of Crop Collaterals

Small owner cultivators or tenants who do not have such collaterals as land or houses can borrow soft loans from ABS with crop collaterals. This system can motivate the farmers giving them a free hand from extortionate creditors. The warehouses contemplated in this project could be used for that purpose.

- Storage of General Goods

ABS can lend storage space for goods other than grains at the same rate as grains (LS 0.1/month/sack).

**CHAPTER 3 PRESENT CONDITION AND PROBLEMS IN PRODUCTION
AND MARKETING OF SORGHUM**

CHAPTER 3 PRESENT CONDITION AND PROBLEMS ON PRODUCTION AND MARKETING OF SORGHUM

3.1 Sorghum Production

(1) Cropping Pattern and Farming Practices

Sorghum is the main foodstuff in the Sudan. As shown in Table 3.1, it is planted under three conditions, i.e., (i) irrigated, (ii) mechanized rainfed and (iii) traditional rainfed methods. The irrigated farming of sorghum is practiced by tenant farmers with the irrigation facilities controlled by the Government. The mechanized farming under rainfed condition is practised by private enterprises, whereas the traditional rainfed farming is carried out by small farmers. According to agricultural statistics covering the past five years, the planting acreage of sorghum is 3.93 million ha in annual average of which 60% is cultivated by the mechanized rainfed farming method producing 60% of the total sorghum production in the Sudan. On the other hand, the irrigated farming occupies only 6% of the planted area; however, its production is as high as 17% of the total production.

The cropping pattern of sorghum varies according to the seasonal and regional rainfall conditions. In general, seeding is carried out from April to August in coincidence with the onset of the rainy season, whereas harvesting is done in the dry season from August to January next year.

The regional rainfall pattern is illustrated in Fig. 3.1. As shown in Table 3.2, since the rainfalls are concentrated in the rainy season from April to October, other crops than sorghum such as millet, maize, groundnuts are also planted in accordance with almost the same cropping pattern as that of sorghum.

Table 3.1 Planted Area, Unit Yield and Production of Sorghum by Cultivation Method
(1981/82 - 1985/86)

Year	Irrigation Farming		Mechanized Rain-fed farming		Traditional Rain-fed Farming		Total
	*1 Yield	*2 Production	*1 Yield	*2 Production	*1 Yield	*2 Production	
1981/82	243	271	2,324	2,150	1,310	851	3,877
1982/83	243	233	1,808	1,185	1,126	520	3,177
1983/84	310	359	2,197	1,084	1,182	363	3,689
1984/85	322	436	1,904	389	1,129	272	3,355
1985/86	472	658	3,585	2,328	1,468	609	5,525
Total	1,590	1,957	11,818	7,136	6,215	2,615	19,623
Average	318	391	2,364	1,427	1,243	523	3,925
Proportional Extent (Area)	8.1	-	60.2	-	31.7	-	100.0
(Production)	-	16.7	-	61.0	-	22.3	-
	-	-	-	-	-	-	100.0

Note: *1 Planted Area
*2 Yield = Production ÷ Area

Source: 1981/82: Current Agricultural Statistics, Cas Vol I, No.4, Ministry of Agriculture.
1982/83: Ministry of Agriculture and Natural Resources.
1983/84 - 1985/86: Agricultural Situation & Outlook, Vol II, No.2, Ministry of Agriculture and Natural Resources.

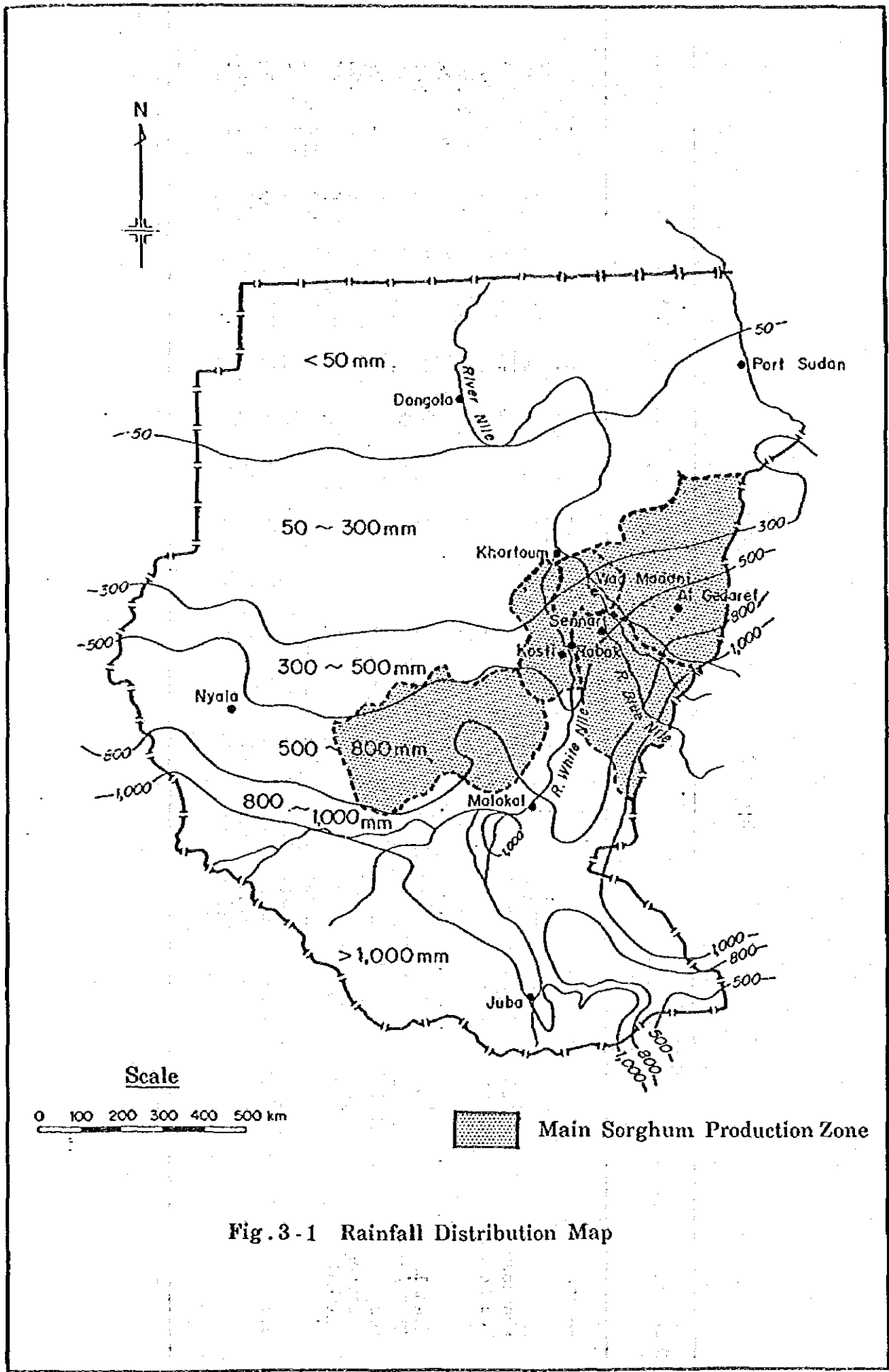


Fig.3-1 Rainfall Distribution Map

Table 3.2 Climate of The Sudan

Observation Station	Location		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
	Longitude	Latitude													
Karima	32°	18°33'	164	184	254	264	290	273	265	257	243	230	183	158	2,765
			20	22	26	30	33	35	34	34	34	32	26	22	29
Khartoum	32°33'	15°36'	-	-	-	1	5	2	48	72	27	4	-	-	164
Wed Medani	33°48'	14°23'	-	-	-	1	15	29	116	133	48	19	1	0	362
			174	204	242	250	272	267	242	214	210	202	190	183	2,650
			24	25	28	31	33	32	29	28	29	30	27	24	28
Kassala	36°37'	18°40'	-	-	2	5	14	27	100	124	60	7	2	-	341
El Faasher	25°20'	13°37'	-	-	-	1	10	13	89	133	36	5	-	-	217
Kosti	32°20'	13°15'	-	-	-	4	8	47	111	143	60	22	2	-	407
Roseires	34°33'	11°55'	-	-	-	15	60	125	183	218	153	30	6	-	790
Malekal	31°39'	9°33'	-	-	7	21	102	109	149	167	144	82	6	-	787
			208	218	230	225	208	177	167	170	170	180	180	208	2,340
			27	28	31	31	30	28	26	26	27	28	27	27	28
Juba	31°50'	4°52'	4	8	51	95	156	112	136	150	114	115	38	9	990
			150	146	183	156	177	162	143	155	165	161	156	161	1,915
			28	29	30	29	28	27	26	26	26	27	28	28	27

The varieties of sorghum cultivated in the Sudan include both traditional local varieties and imported varieties. Among the local varieties, Feterita is the most prevailing variety and the others are Safra, Mayo and Mugud, etc.

The imported varieties are introduced mainly from India and the USA as suitable varieties for mechanized farming, especially for harvesting by combines.

The introduction and improvement of varieties in the Sudan are mainly based on varieties having short stem, high yielding and high quality, however it is said that the imported varieties are not suited to the taste of farmers and their market price is about 10% lower than that of the local varieties.

As for general cultivation method, ploughing, harrowing and ridging are made by machine and seeding is done by hand or by drilling seeder in case of irrigated farming. Irrigation is made 5 - 6 times per cropping season. In case of mechanized rainfed farming, plowing, harrowing and seeding are made by machine. The ploughing depth is commonly as shallow as 4 - 6 cm. Seeding is made by a broadcaster or a drilling seeder. Weeding in irrigated farming or mechanized rainfed farming is made only 1 - 2 times by hand depending on the volume of grass and labour availability. Harvesting and threshing in these farming methods are normally made by hand, but sometimes by stable type thresher as well as combine harvester.

As for the traditional rainfed farming, all farming practices from seeding to harvesting/threshing are done by hand. Usually, ploughing and harrowing are not practised. After cutting and burning of remained stems of former crops, seeding holes are dug at intervals of about 60 cm and 5 - 6 seeds are sown in each hole.

Main insects are stem borers and pyralid moths and damage by large crowd of quelea is also serious. However, protection against insects and diseases is not practised in general.

(2) Unit Yield Level and Production

The unit yield of sorghum is shown in Table 3.3. It is 1.2 tons/ha in case of irrigated farming, 0.6 ton/ha in mechanized rainfed farming and 0.4 ton/ha in traditional rainfed farming respectively, on the basis of the past 10 years average from 1976/77 to 1985/86 as shown in Table 3.1.

Table 3.3 Sorghum Production in the Sudan

Year	Planted Area (1,000 ha)	Unit Yield (Ton/ha)	Production (1,000 ton)
1976/77	2,815	0.64	1,791
1977/78	2,888	0.71	2,062
1978/79	2,900	0.76	2,190
1979/80	2,357	0.62	1,463
1980/81	2,922	0.71	2,068
1981/82	3,877	0.84	3,272
1982/83	3,177	0.61	1,938
1983/84	3,689	0.49	1,806
1984/85	3,355	0.33	1,097
1985/86	5,525	0.65	3,595
(Total)	(33,505)	(6.36)	(21,282)
Average	3,351	0.64	2,128

Source: - Current Agricultural Statistics, Cas Vol I, No.4, Ministry of Agriculture.
- Ministry of Agriculture and Natural Resources.
- Agricultural Situation & Outlook, Vol II, No.2, Ministry of Agriculture and Natural Resources.

Grains of sorghum after harvesting/threshing are left in the field until they are sold to middle men and/or ABS in the mechanized rainfed farming (enterprising management). In case of irrigated farming (cultivation by small farmers) and traditional rainfed farming, harvested grains are mostly stored under the eaves of the farmhouses and/or in the field.

The grain losses at producer level during this period are rather high as shown next, based on the Grain Storage Study Sudan conducted by the government of the Federal Republic of Germany.^{/1}

- Transportation loss between field to farm house : 1 - 2%
- Storage loss : 8 - 10%

On the other hand, according to the Three Year Development Plan of the Government, the total post-harvest loss is estimated at 25% of the production. The loss at producer level is caused mainly by rats and insects.

Table 3.3 shows the production of sorghum in the Sudan in the past 10 years (1976/77 - 1985/86). The average planted area was about 3.35 million ha, occupying more than 50% of the whole planted area of grains. The average annual production for the past 10 years reaches about 2.1 million tons.

The main production areas of sorghum in the Sudan are the Provinces of Gezira, Blue Nile, White Nile, Kassala and Southern Kordofan, and the production these five (5) provinces occupies about 80% of the total national production as shown in Fig. 3.2 and Table 3.4.

The sorghum production in the Sudan is mainly depending on rainfall pattern. The main production areas are located in zones with rather small rainfall of about 300 mm - 800 mm per year as shown in Fig. 3.1 and most of the planted area (92%) is located in the rainfed cultivation area. Because of these conditions, the sorghum production largely fluctuates year by year as shown in Fig. 3.3. Being affected by abnormal drought the production in 1984/85 remarkably decreased to 1,100,000 tons which was about 50% of the ten-year average production. However, the production in the following year, 1985/86, reached up to 3,600,000 tons which was the highest production in the past and got exceeded the annual national demand of about 2,100,000 tons. Hence, the Government exported some surplus production amount of sorghum, but some of the grain traders were obliged to keep the surplus grains in the fields or underground pits because of shortage of storage facilities.

/1: Grain Storage Study the Sudan, Federal Republic of Germany, December 1982

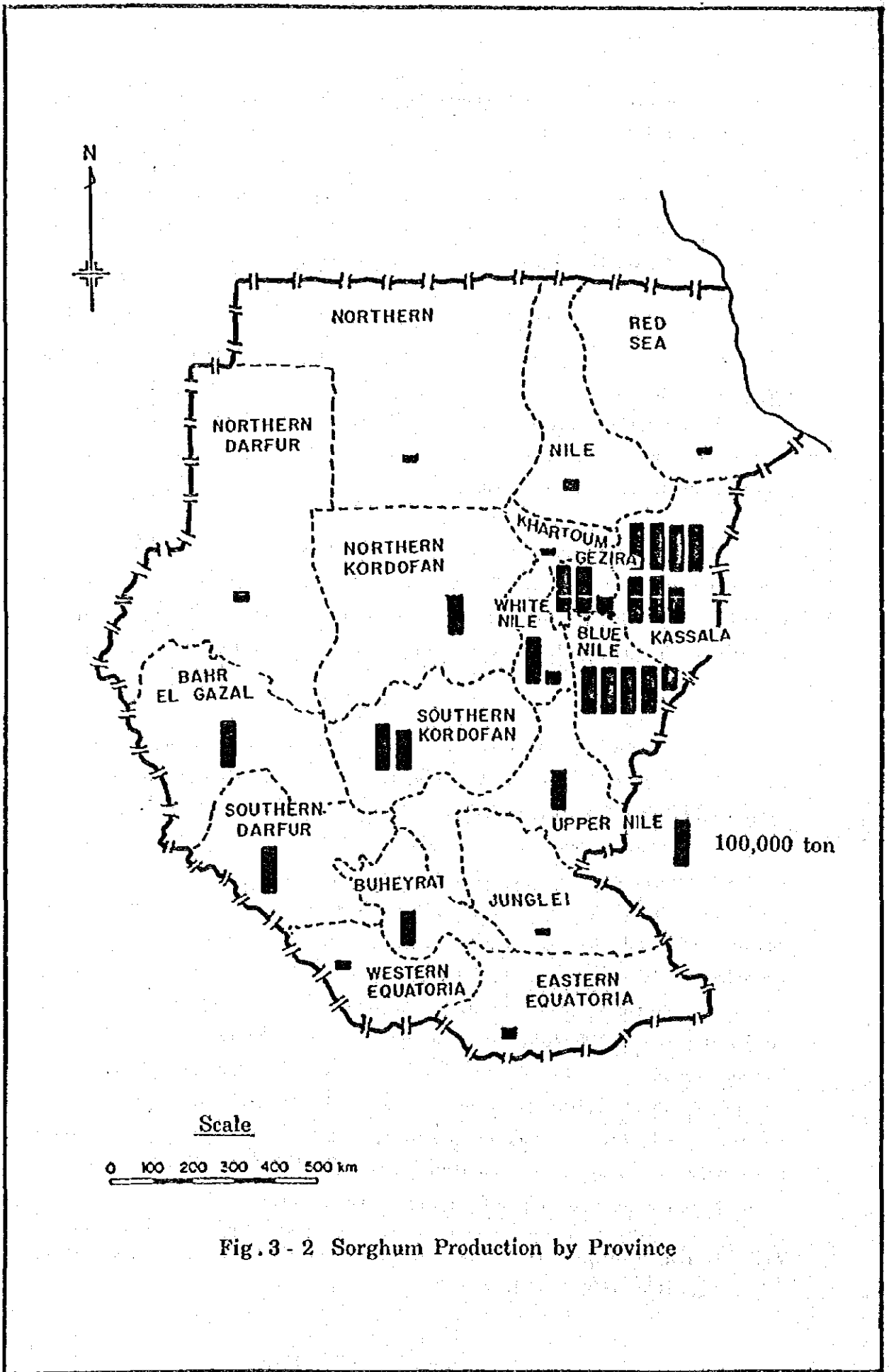


Table 3.4 Sorghum Production by Province
(Average of 10 years during 1976/77 - 1985/86)

Province	Planted Area (1,000ha)	Unit Yield (t/ha)	Production (1,000t)	
Northern Nile	6	1.0	6	0.3
Nile	9	1.1	10	0.5
Khartoum	4	0.5	2	0.1
Gezira	226	1.0	225	10.6
Blue Nile	710	0.7	475	22.3
White Nile	229	0.5	116	5.5
Kassala	1,016	0.7	676	31.8
Red Sea	11	1.0	11	0.5
Northern Kordofan	193	0.4	78	3.7
Southern Kordofan	312	0.6	189	8.9
Nothern Darfur	23	0.3	7	0.3
Southern Darfur	155	0.6	94	4.4
Upper Nile	137	0.6	83	3.9
Junglei	2	0.5	1	-
Bahr El Gazal	} 319	} 0.5	} 155	} 7.2
Buheyra				
Western Equatoria				
Eastern Equatoria				
Total	3,351	0.6	2,128	100.0

Source: - Current Agricultural Statistics, Cas Vol I, No.4, Ministry of Agriculture.
 - Ministry of Agriculture and Natural Resources.
 - Agricultural Situation & Outlook, Vol II, No.2, Ministry of Agriculture and Natural Resources.

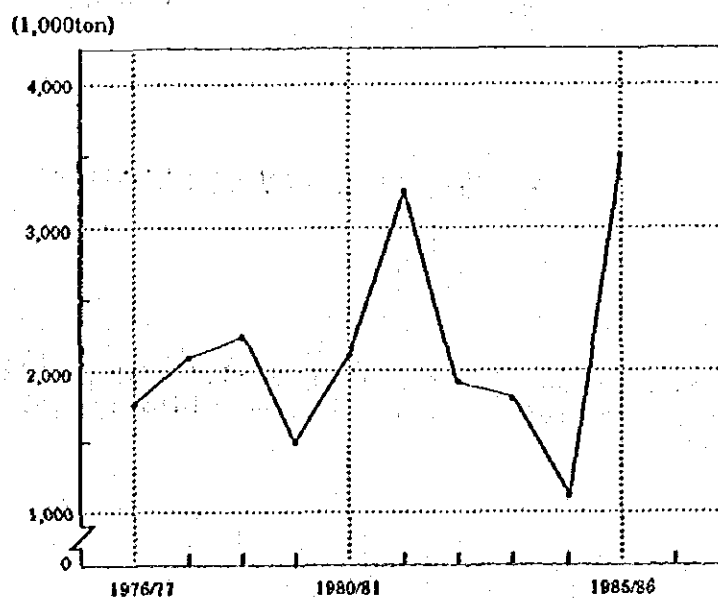


Fig. 3.3 Sorghum Production Trend by Year

3.2 Sorghm Marketing

(1) Marketing Channels

There are three marketing channels of sorghum from producers to consumers, through namely traders, auction markets and ABS as illustrated below.

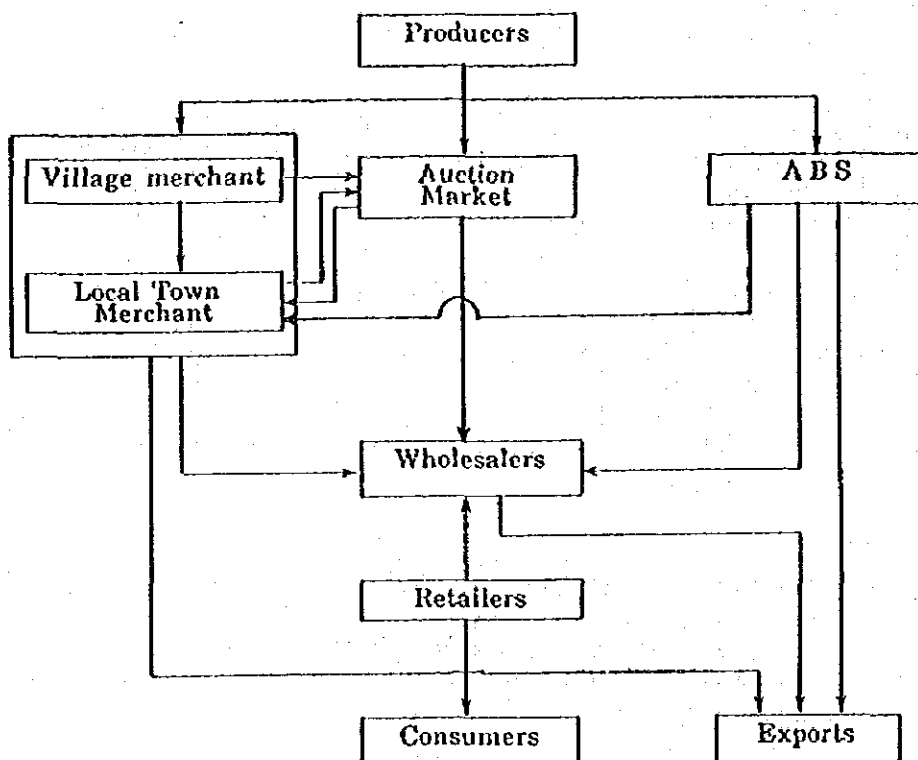


Fig. 3.4 Marketing Channels of Sorghum

Source: Production and Marketing of Food Grain in the Sudan with Particular Reference to Sorghum, Ministry of Agriculture, 1982.

In the traders' channel, traders often provide loans to farmers on a contractual basis and the latter have to sell the product to the traders. Traders then sell the product to wholesalers in consuming areas directly or through agents.

The auction market channel is opened only to the farmers who have sufficient capital and transportation means. It is hard for the farmers without fund and means of transportation to utilize this channel. The product is auctioned at public markets, where the farmers can sell them at the price higher than that to traders.

In case of the ABS channel, farmers can get production loan from ABS, however they have to bond their fixed properties or their product as collateral security. They can later choose either to receive their bonded product after repaying the loan, or to let ABS sell their bonded product. In the latter case, farmers receive the balance of sale amount after deduction of the loan amount, management cost and storing charge of their product. ABS sells sorghum from farmers to local town merchants or wholesalers to control proces.

If the volume of carry over is large and their quality is good, they are sometimes exported. As to the grain flow between regions, since actual data on volumes handled by both private sector and public corporation are not available, it was estimated as shown in the following table based on the actual handling volume of ABS in 1983/84, which is shown in Table 3.5.

<u>Assembly Points</u>	<u>Consumption Area</u>
Renk	Southern and Central Regions
Rabak/Kosti	Darfur Regions
Sennar	Darfur, Central Regions
Port Sudan	Eastern, Central and Khartoum Regions
Cedaref	Eastern, Khardofan, Darfur Regions

Table 3.5 Grain Flow of Sorghum Handled by ABS (1983/84)

Consumption Area Distribution Area	Consumption Area							Total	
	Northern	Eastern	Khartoum	Central	Kordof	Darfur	Southern		Others
Reank	-	-	-	50	-	-	41	9	100
Rabak	-	-	-	5	-	71	-	24	100
Kosti	-	-	-	-	-	99	-	1	100
Sennar	-	-	-	13	-	86	-	1	100
Port Sudan (Sile)	19	74	-	6	-	-	-	1	100
Port Sudan (Warehouse)	-	-	21	79	-	-	-	-	100
Gedaref	8	30	-	8	21	33	-	-	100

Note: Figure of Gadaref is of 1984/85

Source: ABS, 1986

The surplus quantity of sorghum produced in the three (3) provinces of Kassala, Blue Nile and White Nile, which are main sorghum production areas, are collected and transported to such main assembly points as Gedaref, Sennar and Rabak/Kosti. Sorghum produced in Blue Nile and southern part of White Nile is distributed to Renk and that produced in northern part of Kassala to Port Sudan, although the surplus in these areas is small.

According to the actual handling flow by ABS as shown in Table 3.5, the sorghum grains collected at Rabak/Kosti are distributed mainly to Darfur region (Northern Darfur and Southern Darfur Provinces). The grains handled by private traders are distributed not only to Darfur region but also to Southern areas, i.e. Junglei, Buheyrat, Bahr El Gezal, Western Equatoria and Eastern Equatoria. The Rabak/Kosti assembly point is located at the intermediate transit of railway/road from the capital city of Khartoum and the trading harbor of Port Sudan to southern and western parts of the Sudan. Then, most of the sorghum grains produced in the aforementioned three (3) provinces, main producing areas, are collected at Rabak/Kosti and supplied to each province in western and southern areas which are the great sorghum deficient areas in the country.

(2) Price of Sorghum

The price of sorghum varies by year and by region. In recent years, especially, the price variation was widened by the famine caused by abnormal continuous droughts. Namely, the sorghum price increased by 4.7 times the lowest price at Gedaref/Obeid during the period from January 1984 to February 1986.

There was a price difference of about LS 18 between Gedaref and Obeid in 1985 i.e, LS 87/bag (90 kg) and LS 106/bag, respectively. This was considered to be caused by the insufficiency in all weathered roads, storage space, and communication facilities as referred to in Table 3.6.

The large price fluctuation could be controlled to some extent by purchasing and distributing buffer stock. This measure would

improve the living condition of farmers and consumers, and may contribute to smooth economic development of the country. For this purpose, the construction of grain storage facilities would be essential.

Table 3.6 Monthly Average Wholesale Price of Sorghum at Gedaref and Obeid

(unit: SLD/bag(90kg))

Month	1984		1985		1986	
	Gedaref,	Obeid	Gedaref,	Obeid	Gedaref,	Obeid
January	24.65	29.50	99.42	112.27	33.00	37.10
February	24.45	29.50	103.60	127.67	33.42	30.00
March	26.35	36.88	111.07	116.18		
April	30.02	37.50	114.17	123.63		
May	30.18	37.88	106.63	113.85		
June	29.63	43.75	114.66	126.28		
July	34.63	52.13	108.90	138.19		
August	47.83	70.69	92.49	123.18		
September	78.00	102.50	75.97	114.76		
October	93.40	125.06	58.48	94.45		
November	94.67	117.02	33.73	44.85		
December	89.41	97.25	30.30	34.55		
(Total)	(603.22)	(779.66)	(1049.42)	(1269.86)		
Average	50.27	64.97	87.45	105.82		

Source: Agricultural Situation & Outlook, Vol II No.2, 1986

(3) Transportation of Sorghum

Main transport means in the Sudan are railways, roads, rivers and airline. The transport network except airlines is illustrated in Fig. 3.5 and the traffic volume by transport means is shown in the following Table 3.7.

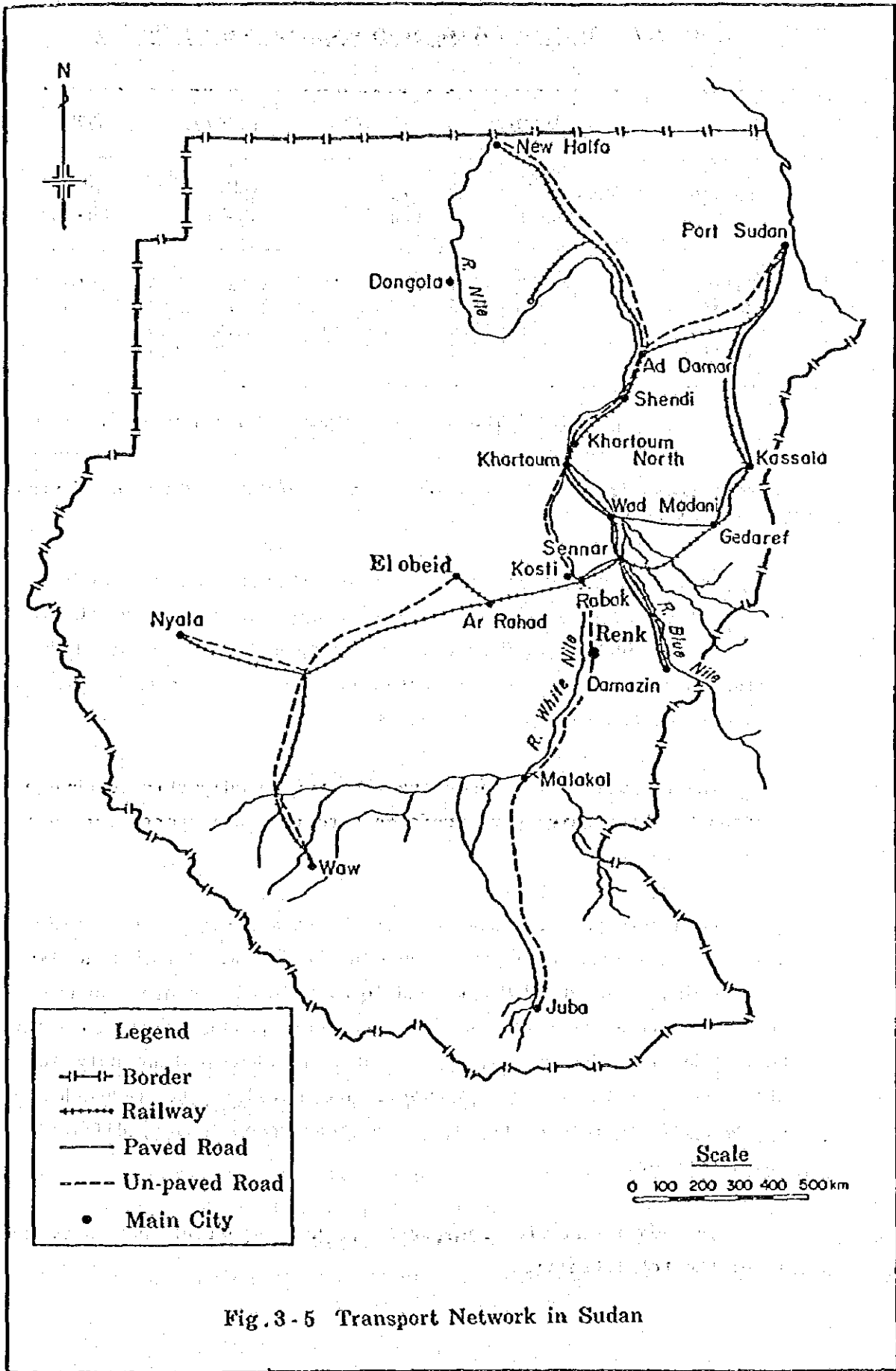


Fig.3-5 Transport Network in Sudan

Table 3.7 Traffic Volume by Transport Means (1979/80)

Year	1969/70		1974/75		1976/77		1979/80	
Transport Means	10 ⁶ ton-Km	%	10 ⁶ ton-Km	%	10 ⁶ ton-Km	%	10 ⁶ ton-Km	%
Railways	2,700	72.7	2,170	45.0	2,420	44.1	1,910	34.3
Roads	920	24.8	2,560	53.1	2,970	54.1	3,570	64.2
Rivers	88	2.4	82	1.7	94	1.7	71	1.3
Airline	6	0.1	8	0.2	8	0.1	10	0.2
Total	3,714	100.0	4,820	100.0	5,492	100.0	5,561	100.0

Source: Transport Statistical Bulletin 1979/80, Ministry of National Planning

The railway connects the capital city of Khartoum with local main cities. Railway traffic volume occupied about 73% of the total traffic in 1969/70. However, it decreased to 35% in 1979/80. Railway facilities are deteriorated due to insufficient repair and maintenance, and lack of spare parts, etc.

The railway traffic decrease was attributed partly to change in transport policy which gave preference to road transport over railway transport in the 1970s.

Road transport occupied 65% of the total traffic in 1979/80 and now it is the main transport means in the Sudan. Total road length is extended to about 22,000 km and local main cities are connected by roads as well as by railways. However, only road sections connecting Port Sudan and Khartoum, Kosti and Damazin representing only 10% of the total length of road network, are paved. The remainder are unpaved and, therefore, transport on these roads is very difficult in rainy seasons.

The river and air transports are not important and share only 1% of the total traffic.

Usually, transport of sorghum is made by trucks from production areas to distribution areas, and mainly by trains from distribution areas to consuming areas. According to the actual transport data of ABS in 1983/84 as shown in Table 3.8, 100% of sorghum grains were transported by trucks from production area to the warehouses of ABS, and 80% of the grains were sent by trains from ABS to consuming areas. The loading capacities of trucks (including a trailer) are classified into three categories: 600 bags (54 tons), 350 bags (31.5 tons) and 150 bags (13.5 tons). The 350-bag capacity is the most common one among these. Usually, the loading capacity of a railway wagon is 300 bags (27 tons).

Table 3.8 Sorghum Transport Means of ABS (1983/84)

Assembly Points	Receiving		Dispatching	
	Railway	Truck	Railway	Truck
	(%)	(%)	(%)	(%)
Kosti	-	100	99	1
Rabak	-	100	71	29
Renk	-	100	74	26
Gedaref	-	100	95	5
Port Sudan (Silo)	-	100	25	75
Port Sudan (Warehouse)	-	100	100	-
Sennar	-	100	87	13
Average	-	100	82	21

Source: ABS, 1986

(4) Storage Facilities of Agricultural Products

There are many kinds of storage facilities in the Sudan. Those of traditional type are underground pits, simple muddy or brick warehouses, jute bag or can storage, whereas those of modern type are concrete silos, metal silos, and flat warehouses. The types of storage facilities vary from region to region. In the northern region, warehouses are usually made of stone masonry, whereas in the central region the underground pits are dominant, and the elevated-

floor type warehouses, which are commonly used in tropical humid zone, are prevailing in the southern region.

The modern silos and flat warehouses play an important role in the marketing of grains. From a viewpoint of ownership, they are categorized into public, private and millers' facilities. Furthermore, they are categorized into facilities for cereals, oil milling and flour milling mainly of wheat. The public owners include ABS, agricultural production corporations, mechanized farming corporations, etc., while private owners and millers comprise merchants, flour milling factories, oil milling factories, etc. Total storage capacity of these facilities amounted to 1.66 million tons as of 1982, of which 317,000 tons or 19.1% are owned by ABS. Regional distribution of these facilities is shown in Table 3.9 and more details are given in Appendix 7.

Table 3.9 Total Capacity of Grain Storage Facilities in the Sudan

(Unit: 1,000 tons)

Province	For Grains		For milling ^{/1} of flour and oil		Total Storage Capacity
	Public (ABS)	Private	(Public+Private)		
Northern	2.5	(2.5)	4.3	-	6.8
Nile	2.5	(-)	10.1	6.7	19.3
Red Sea	75.0	(75.0)	301.8	396.1	772.9
Kassala	230.8	(116.0)	15.3	15.1	261.2
Khartoum	10.7	(10.7)	24.0	32.2	66.9
Blue Nile	111.4	(43.6)	11.7	28.3	151.4
White Nile	52.8	(38.0)	8.9	26.4	88.1
Gezira	62.1	(12.0)	15.8	41.2	119.1
Northern Kordofan	-	(-)	9.4	18.2	27.6
Southern Kordofan	32.0	(-)	7.5	0.2	39.7
Northern Darfur	-	(-)	8.2	0.4	8.6
Southern Darfur	0.6	(-)	8.2	8.2	17.0
Bahr El Gazal	4.2	(-)	5.5	0.8	10.5
Buheyral	-	(-)	3.1	0.6	3.7
Upper Nile	44.8	(19.3)	11.0	0.5	56.3
Junglei	-	(-)	-	-	-
Western Equatoria	-	(-)	3.2	0.6	3.8
Eastern Equatoria	3.7	(-)	5.7	0.6	10.0
Total	633.1	(317.1)	453.7	576.1	1,662.8
Percent (%)	(38.1)	(19.1)	(27.3)	(34.6)	(100.0)

Remark ^{/1}: Materials for milling of flour and oil

Source: Grain Storage Study Sudan, Federal Republic of Germany, December 1982.

The greater part of the above storage facilities are flat warehouses. Silos are found in Port Sudan in the Red Sea province and in Gedaref in Kassala province, having capacities of 50,000 tons and 100,000 tons, respectively.

Main features of existing warehouses in Wad-Medani, Kosti, Rabak Gedaref and Sernar visited by the survey team are as follows:

- Storage space is relatively large as compared with Japanese ones, ranging from approximately 8,000 to 13,000 tons of sorghum per warehouse.

- Warehouses are utilized for many purposes. Stored goods include grain (mainly sorghum), jute bags, fertilizers, and agricultural materials such as agricultural chemicals.
- Daily management and operation of warehouses is performed by one or two storekeepers and several guards under the control of an ABS branch manager.
- No modern facilities such as truck scale, belt conveyers, electric ventilators and lighting equipment are provided.
- As for infrastructure for the existing warehouses, roads and electric power supply are facilitated but water supply and a communication systems have not yet constructed.
- Skylights are provided as lighting facility.
- Warehouses have gable roof framed structures with corrugated steel sheets on their roofs and walls. No reinforced concrete structures were observed.
- There are two types of ventilation: one has simple gate (60 cm x 100 cm) controlled by cords, and the other has a hood (without louver) under which air is taken. Neither type is provided with devices of prevention of entry of sand. The cord-controlled ventilator can be closed.
- Steel frame has a long span (40 m x 100 m)
- The warehouses have large sliding doors (5 m x 4 m) provided at intervals of 20 m in the walls. Doors are simple in structure, i.e. drawn doors.
- The warehouses are not provided with equipment for quality control of grains, and have no ventilation openings for this purpose. Air temperature inside warehouses seems to be high,

but it does not cause deterioration of grain quality because of the low moisture content of grains.

- Airtightness is insufficient to ensure fumigation of the entire warehouse. Usually, partial fumigation is performed under a vinyl sheet.
- The warehouses are mainly used by government agencies, farmers and merchants, and labourers required for the handling of bags are hired by the users at their own costs. ABS is in charge only of storage management and checking of the number of bags received. These activities are usually done by store keepers of ABS branch offices. Store keepers do not stay in warehouses except when checking the number of bags. Only guards stay in warehouses. No office room nor lavatory are provided in warehouses.

Inventory record of ABS' branch office at Gedaref shown in Table 3.11 and Fig. 3.6 show the monthly fluctuation of storage condition of sorghum. Monthly movement of sorghum at Gedaref is shown in Table 3.11. Since the Kassala Province, where Gedaref is located, is the major production area of sorghum in the Sudan sharing about 32% of the whole production, the record is considered to represent the general tendency of sorghum inventory conditions in the Sudan.

The receipt amounted to about 11,400 tons in annual average from November 1983 to October 1985 and the receiving were concentrated in periods from December to February. The annual average weight of sorghum dispatched was 11,400 tons. Dispatching was made mainly from February to May. The storage volume reached the maximum in February and the stock was almost exhausted in October or November. The turn-over of a warehouse, which is obtained by dividing the annual dispatched weight by the storage capacity, was estimated at 1.4.

Table 3.10 Inventory Record of Sorghum at ABS Gedaref Storage

(Unit: %)

Month	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Received	1.6	31.2	36.4	16.0	5.4	1.5	3.1	1.0	3.5	0.3	0	0
Dispatched	0	1.5	3.4	8.5	22.9	24.8	24.1	2.0	8.1	2.1	1.4	1.2
End-Stock	1.6	31.3	64.3	71.8	54.3	31.0	10.0	9.0	4.4	2.6	1.2	0

Remarks: Figures show percents of a total handled weight.

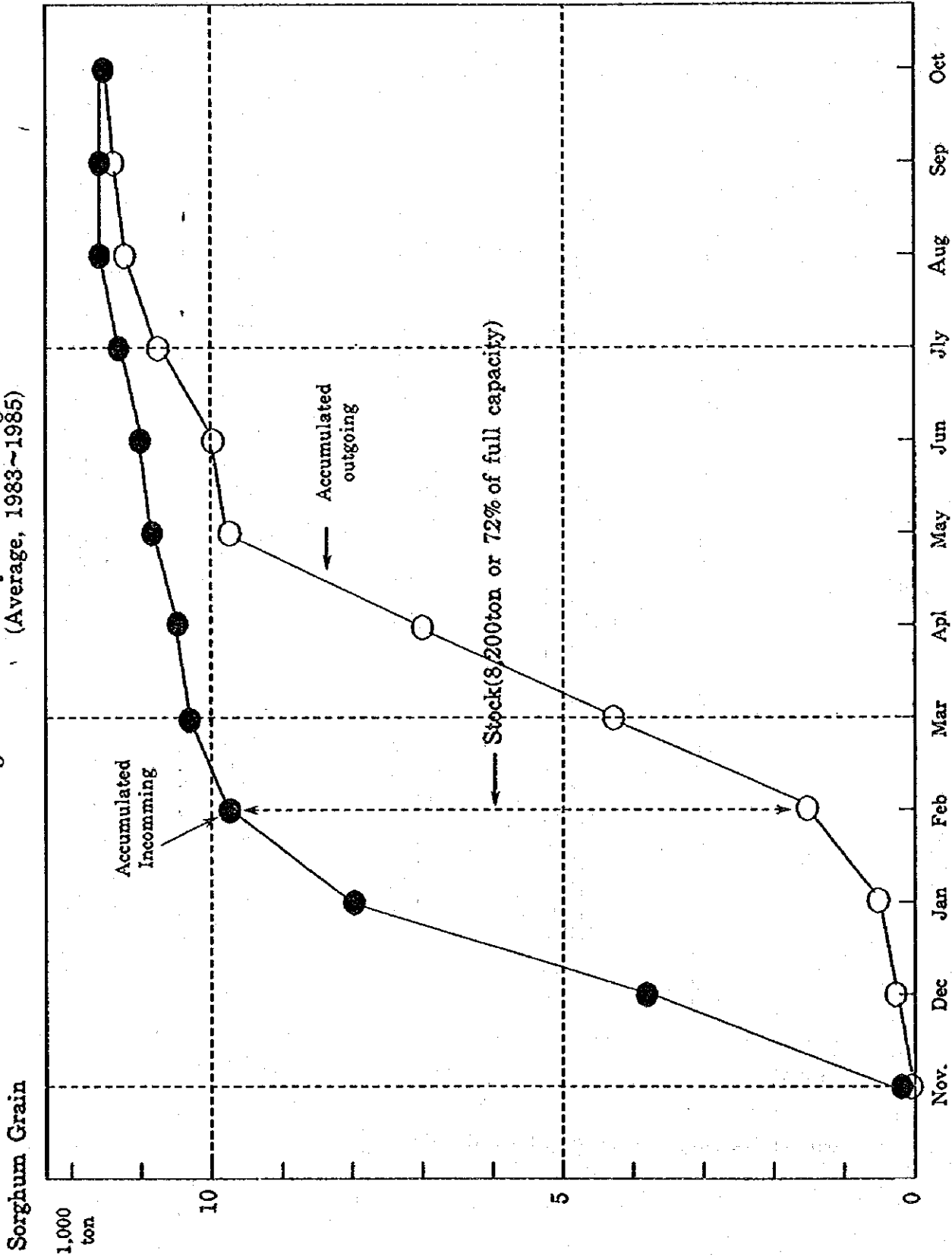
Table 3.11 Monthly Fluctuation of Storage Condition at Gedaref

(Unit: ton)

Year	Month	Initial	Incoming	Outgoing	End Stock
1983	11	5	0	0	5
	12	5	2,530	0	2,535
	1	2,535	4,381	0	6,916
	2	6,916	2,650	635	8,931
	3	8,931	530	2,232	7,229
1984	4	7,229	50	4,631	2,648
	5	2,648	493	2,361	780
	6	780	0	139	641
	7	641	0	180	461
	8	461	0	389	72
	9	72	0	67	5
	10	5	0	0	5
	11	5	363	0	368
	12	368	4,583	341	4,610
	1	4,610	3,938	776	7,772
1985	2	7,772	1,008	1,296	7,484
	3	7,484	711	2,992	5,203
	4	5,203	277	1,022	4,458
	5	4,458	217	3,143	1,532
	6	1,532	233	324	1,441
	7	1,441	808	1,679	570
	8	570	65	88	547
	9	547	0	262	285
	10	285	0	262	23
	11	5	182	0	187
12	187	3,557	171	3,573	
1	3,573	4,160	388	7,345	
2	7,345	1,829	966	8,208	
3	8,208	621	2,612	6,217	
Average	4	6,217	164	2,827	3,554
	5	3,554	355	2,752	1,157
	6	1,157	117	232	1,047
	7	1,042	404	930	516
	8	516	33	239	310
	9	310	0	165	145
	10	145	0	131	7
Total			11,422	11,413	

Source: Monthly Report of ABS Gedaref

Fig.-3.6 Monthly Stock of Sorghum in Gedaref
(Average, 1983~1985)



Source : A.P.S. Gedaref Branch file (Nov. '83-Oct. '85)

(5) Storage Loss

Storage loss in grain storage facilities was surveyed in 1973/74 by Abdul Azin Rodwan of Khartoum University based on samples taken from 110 flat warehouses and one silo at Port Sudan. The survey reported that the storage loss reached 20% of the annual throughput.

Same kinds of surveys were performed in Gedaref by FAO and Khartoum University under joint operation and in Kordofan regions by the Plant Protection Department of the Government. The survey of FAO and Khartoum University was made in 1981 on three kinds of warehouses of thatch-roofed type, brick type and galvanized iron plate-roofed type. The results are summarized below.

Table 3.12 Storage Loss of Sorghum at Gedaref (Feterita Variety)

(Unit: %)

	Thatch-roofed with earth floor		Brick house with gravel floor		Galvanized iron-roofed earth floor	
Storage period (Months)	6	12	6	12	6	12
Loss	6.4	7.1	1.3	3.8	1.2	4.3

Source: E. Khidir, 1981, A Study of Sack Storage in Different Types of Stores in Geraref Area

In the surveyed area, the loss reaches 7.1% a year in the case of thatch-roofed type, 3.8% in the case of brick type and 4.3% in the case of galvanized iron plate-roofed type respectively.

On the other hand, the Plant Protection Department of a local Government in Obedi made a loss survey on a large sized sorghum warehouse in 1983 in Kordofan region. The loss reached 45.9% a year.

Table 3.13 Storage Loss of Sorghum at Large Flat Warehouse at Kordofan

Storage Period	1 - 3 Months	3 - 6 Months	6 - 9 Months	12 Months
Storage Loss	5.5%	12.5%	21.5%	45.9%

Source: Kordofan Region Agricultural Marketing and Transport Study, USAID, 1983.

The above-mentioned surveys showed that the greater part of the storage loss was caused by insects and rats. Main insects are *Trogoderma granarium*, *Rhizopertha dominica*, *Sitophilus oryzae*, etc. Such high loss rates is attributed to the occurrence of crevices, openings in walls and doors, unpaved floor, inadequate fumigation, high infection rate of pest and disease during open space storage etc.

(6) Program of Increasing Buffer Stock of Sorghum

Through severe famine experiences in the past three years from 1982/83 to 1984/85 and with the recent bumper harvest of sorghum in 1985/86, the Government has decided to increase the buffer stock of sorghum from the previous weight of 23,300 tons to about 450,000 tons. The purposes of the increase are: (i) stabilization of the market price, (ii) encouragement of sorghum production, (iii) steady supply of staple food, and (iv) preserving grain quality and (v) saving of storage loss.

ABS is entrusted by the Government to act as a monopolistic agency to deal with the storage of the buffer stock of sorghum, and it has prepared the storage program as shown in Table 3.15. It shows that shortage of the storage capacity would reach 2,816,000 bags (253,440 tons).

Table 3.14 Shortage of Storage Space for Buffer Stock of Sorghum

Location (Province)	Required Space		Present Space		Shortage	
	1,000bags 10 ⁴ ton	18.0	1,000bags 10 ⁴ tons	19.7	1,000bags 10 ⁴ tons	25.3
Gedaref (Kassala)	2,000	18.0	1,000	9.0	1,000	9.0
Sennar (Blue Nile)	900	8.1	220	2.0	680	6.1
Damazini (")	500	4.5	133	1.2	367	3.3
Dalling (Southern Kordofan)	150	1.3	-	-	150	1.3
Renk (Upper Nile)	500	4.5	177	1.6	323	2.9
Obeid (Northern Kordofan)	100	0.9	-	-	100	0.9
Kasti/Rabak (White Nile)	500	4.5	388	3.5	112	1.0
New Halfa (Kassala)	50	0.5	133	1.2	- 83 -	0.7 ^{/1}
Wad-Medani (Gezira)	200	1.8	133	1.2	67	0.6
Atbara (Nile)	100	0.9	-	-	100	0.9
Total	5,000	45.0	2,184	19.7	2,816	25.3

^{/1} Minus figure means excess capacity
(Source: ABS, 1986)

To cope with the situation, ABS made a plan to store about 90,000 tons in underground pits and the remaining 163,000 tons in warehouses rented from local governments or private merchants. However, the underground pits have the following defects.

- High probability of damage by insects and moisture.
- Rather high handling cost caused by transformation from bag to bulk and bulk to bag handlings.
- Fumigation is quite difficult or hardly possible.
- Storage site is limited only to high land which is provided with good drainability.

Furthermore, except for a few warehouses which are located at Yei, Renk, Gedaref, Port Sudan, etc., the majority of the existing warehouses are poorly equipped against moisture and insects, and hence, they are considered unsuitable for storage in a long period of time.

(7) Problems in Marketing

The Government seldom intervenes on marketing of food grains such as sorghum. Marketing channel, price determination, and others are left to traditional markets such as village markets, local assembly markets and consumption markets in cities. The problem in these traditional markets is that most of marketing benefits are in the hands of traders because farmers are so often obliged to sell their product at a price extremely lower than the market price because they have no other means to pay back the pre-harvesting credit extended by traders or others for the reason of their poverty. Besides, marketing costs tend to be higher because the volume of transport of grains from each small farmer is very little and in many cases, farmers are living far from the markets. Thus, there is a big difference between retail price and farm gate price, and in some cases farm gate price may be less than 45% of retail price.

3.3 Marketing Organizations

(1) Marketing Organizations and their Functions

Broadly, agricultural products in the Sudan are marketed through the following three channels:

a) Governmental and quasi-governmental organizations

- Agricultural Bank of Sudan (ABS)
- Cotton Public Corporation (CPC)
- Sudan Oil Seed Company (SOSC)
- Gum Arabic Company (GAC)
- Public Corporation for Sugar Trade (PCST)

b) Private wholesalers, village and district level merchants

c) Cooperatives

Cotton and oil seeds are major export crops in the Sudan, and they are handled by CPC and SOSC, respectively. CPC is exclusively in charge of marketing of cotton from purchase to export, and it has the authority to set the cotton price annually. SOSC is a quasi-governmental organization for marketing of oil seeds and is provided with the same authority as the former with regard to the price control. Private wholesalers are obliged to deliver a certain amount of the oil seeds to SOSC at the price predetermined by SOSC. GAC and PCST are also provided with almost the same monopolistic power in marketing of Arabic gum and sugar. In case of wheat, domestic producer cost is kept at rather high level as compared with international price in order to increase food production with subsidies from the Government.

ABS deals mainly with provision of agricultural credits, handling of agricultural products, storage and sales services, storage of buffer stock of sorghum for market control, export of sesame, import of wheat, etc. ABS is also the executing agency of this Sorghum Storage Warehouse Construction Project. More details

about the organization and function of ABS are given in Section 3.3.(2)

Private wholesalers, as well as village and district level merchants, are acting as intermediary agents between consumers and the above-mentioned large scale organizations or dealers. Most of them own warehouses or storage facilities and deal with agricultural products. Major parts of sorghum marketed in the Sudan is handled by them.

Cooperatives are engaged in marketing of agricultural products at the level of producers. The following table shows the cooperative statistics in the Sudan as of 1975/76.

Table 3.15 Cooperative Statistics (1975/76)

Kind of Cooperative	Number of Cooperatives	Number of Members
Multi-purpose	1,533	268,650
Mechanized harvest	31	21,760
Credit & marketing	51	11,893
Agriculture	188	39,350
Machanized agriculture	141	6,120
Miller	402	72,410
Consumer	219	28,020
Others	55	12,762
Total	2,620	460,965

Source: Grain Storage Study Sudan, Federal Republic of Germany, May 1983

Among the above cooperatives, Credit & marketing cooperatives and Agriculture cooperatives are involved directly with marketing of agricultural products. However, they are not functioning well due mainly to shortage of working fund and to lack of motivation of their members.

Cooperatives in the Sudan are under the jurisdiction of the Ministry of Commerce, Cooperation and Supply, and organizationally,

they have a federated body at the provincial and central levels, respectively.

It can be said that the main marketing organizations for sorghum is private wholesalers, village and district level merchants and ABS.

(2) Agricultural Bank of Sudan (ABS)

ABS is a quasi-governmental organization which is totally financed by the Government. It was established in 1957 as a sole agricultural bank in the Sudan, and it is undertaking the following services:

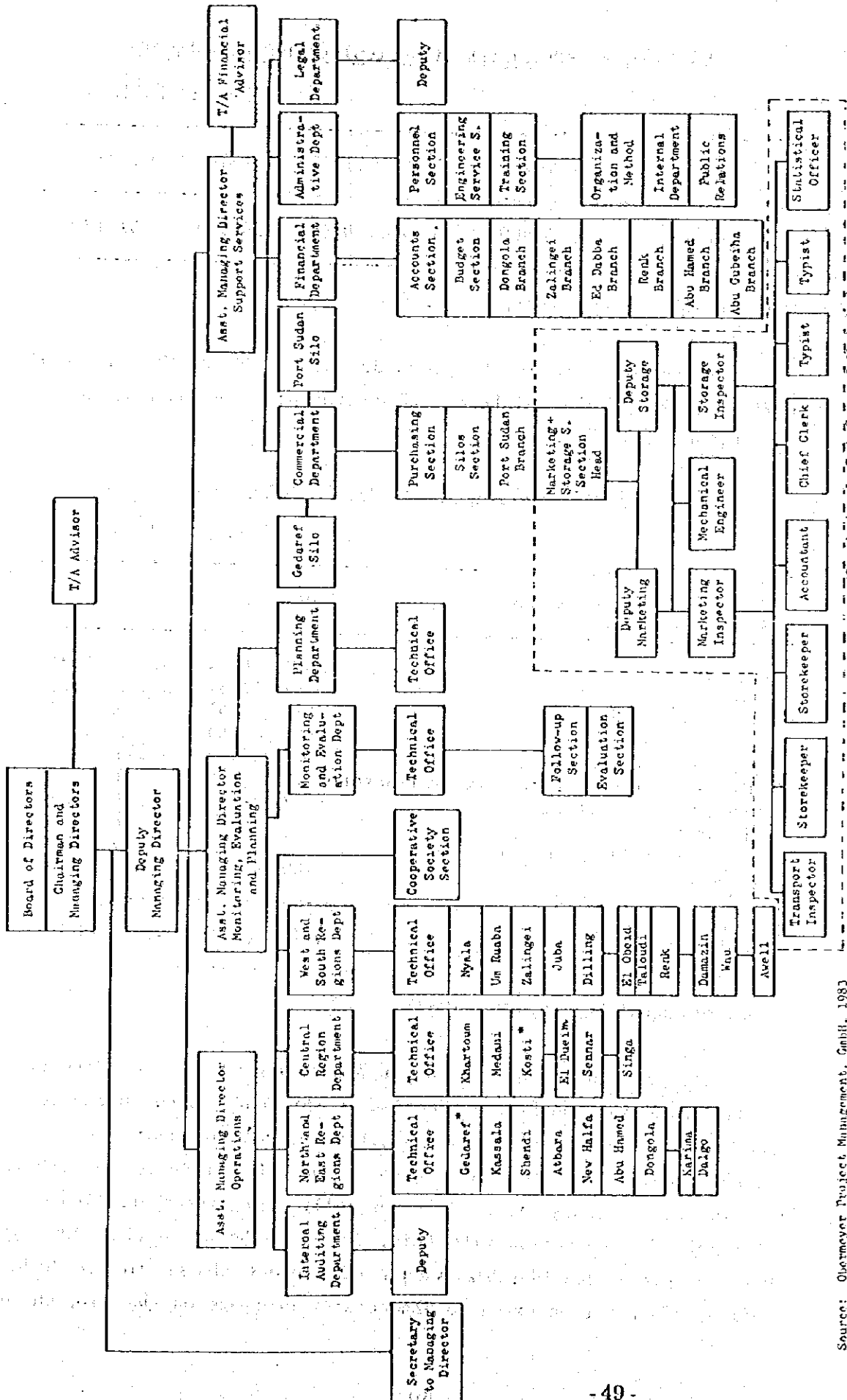
- Provision of agricultural credit and related services
- Purchase and sales of agricultural equipment and materials
- Purchase and sales of agricultural products
- General banking services such as receiving deposit and provision of credit
- Receiving loans and credit from other domestic and foreign lending agencies, issuance of own stock, holding of stocks of other enterprises
- Handling of agricultural products for the sake of farmers, provision of services for storage and marketing
- Storage of sorghum for the purpose of market control entrusted by the Government

ABS is under the jurisdiction of the Ministry of Finance and Economic Planning and has 27 branch offices throughout the country comprising 18 branches for agricultural credit services and 9 branches for general services other than agriculture. In addition, it holds 2 offices for silo management and a main office in Khartoum.

As of 1982, the Bank has a staff of about 600 persons, together with almost the same number of laborers. The Bank's organizational structure is illustrated in Fig. 3.7.

One of the major activities of ABS is provision of agricultural credit to farmers. Table 3.16 shows the performance of such credit services from 1978 to 1982. During these years, provision of the credit increased by 4.6 times.

FIG. -47 ORGANIZATION OF THE AGRICULTURAL BANK OF SUDAN WITH PARTICULAR REFERENCE TO STORAGE/MARKETING SECTION



Source: Obeidmeyer Project Management, Gmbh, 1983
Grain Storage Study Sudan

(* : Proposed ABS Regional Office for Operation and Maintenance of the Warehouses.)

(Organisations for Grain Storage & Marketing)

Table 3.16 Provision of Agricultural Credit by ABS

(Unit: LS 1,000)

Year	1978	1979	1980	1981	1982
Amount	6,800	8,970	8,480	16,530	31,120

(Source: ABS Annual Report, Dec. 1982)

On the other hand, the gross income of ABS reached about LS 9.75 millions in 1982, about 85% of which comes from trade and agricultural credit services.

Table 3.17 Annual Gross Income of ABS

(Unit: LS 1,000)

Income Source	1981 (%)	1982 (%)
Trade	1,003 (29)	5,124 (53)
Interests	1,480 (43)	3,152 (32)
Commission charges	132 (4)	126 (1)
Storage charges	135 (4)	359 (4)
Sorghum handling gains	400 (12)	544 (6)
Custom charge of ploughing by tractors	16 -	4 -
Silo handling charges	2 -	1 -
Insurance	- -	17 -
General banking services	8 -	123 (1)
Others	169 8	298 (3)
Total	3,445 (100)	9,748 (100)

(Source: Annual Report, Dec. 1982)

Storage control of sorghum in ABS is made under the direction of the Marketing and Storage Section of ABS head office in Khartoum. Because of poor means of communication between the head office and storage sites, the storage control cannot be conducted smoothly, causing unnecessary spending especially for transportation and storage. In connection with this, it is to be noted that ABS may have to pay a considerable amount of storage charge to the Sudan Railways Corporation owing to unnecessary stoppage on the way, which

is caused mainly by delay of shipment notice from the head office to the sites.

3.4 Present Condition of the Survey Areas

Grain warehouse schemes requested by the Government of the Sudan are located in the following 4 areas.

- | | |
|-----------------------|-------------|
| - White Nile Province | Kosti/Rabak |
| - Blue Nile Province | Sennar |
| - Kassala Province | Gedaref |
| - Gezira Province | Wad-Medani |

Rabak/Kosti scheme in the White Nile Province is located at the existing ABS's warehouse area of Rabak, and an ABS Branch office is located at Kosti about 3 km from Rabak. A railway siding for the existing warehouse at Rabak is connected with the main railway at Kosti for handling of sorghum.

Present conditions of the above-mentioned 4 sites such as climate, population, production of sorghum, marketing, existing warehouse for grains and traffic network are described below:

(1) Climate

Kosti, Sennar, Gedaref and Wad-Medani are located between latitudes 13°N to 15°N. Climate in these sites is of savanna climatological zone which covers about half of the Sudanese area and its characteristics are high temperature and low humidity and 2 seasons consisting of rainy season (May to November) and dry season (December to April). A summary of climatic conditions at the sites such as temperature, relative humidity, rainfall, evaporation, wind velocity and sunshine hour is given in Table 3.18.

Temperature at the 4 sites has a similar range and annual mean maximum temperature, annual mean minimum temperature and annual mean temperature are respectively 36°C, 21°C, 29°C. Annual daily difference of temperature is about 16°C. Monthly mean temperature rapidly increases from April to May and maximum daily temperature reaches over 40°C. However, the temperature from December to February is low and minimum daily temperature is less than 20°C.

Annual rainfall ranges from 340 mm to 590 mm and about 90% of the rainfall is concentrated in the 4 months from June to September and no rainfall is recorded for the months from December to April.

Annual mean relative humidity ranges from 39% to 46%. Seasonal change of monthly mean relative humidity is co-related to monthly rainfall and the humidity increases to about 70% in August which has maximum monthly rainfall.

Sorghum is harvested under the condition of high temperature and low humidity in the dry season, and water content of sorghum just after harvesting is less than 6%. Appropriate storage facility would preserve the quality of sorghum from damage by insects and fungi even at high temperatures.

Table 3.18 Climate of Project Area (Average of 1951 - 80)

Item	Wad-Medani	Kosti	Sennar	Gedaref
Annual mean temperature (°C)				
- Mean	28.3	27.7	28.5	28.7
- Maximum	36.7	36.0	36.7	36.2
- Minimum	20.0	21.3	20.3	21.2
Annual mean reactive humidity (%)	40	46	39	44
Annual mean precipitation (mm)	343	404	463	593
Annual mean evaporation (mm/day)	14.1	10.3	14.7	11.9
Wind velocity (mile/hour)	11.7	8.8	6.0	8.8
Annual mean sunshine hour (hours/day)	9.7	9.1	-	9.3

Source: Climatological Normals, 1951 - 1980, Sudan Meteorological Department, Ministry of Defence

(2) Population

Population at each site is shown in Table 3.19.

Population and number of families in the country-side occupy 68% to 84% and 69% to 85% respectively of those in each province concerned. Moreover, an average household size in each Province ranges from 5.6 persons/family to 6.1 persons/family and average household size in the country side is smaller than that in the city. The average household sizes in the cities of Sennar and Wad-Medani are respectively 8.6 persons/family and 7.1 persons/family, which are rather high, compared with those in other cities.

Table 3.19 Population, Household and Family Size of the Project Area and Province

	Population (1,000)			No. of household (1,000)			Family Size (persons/household)		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Average
White Nile	304	640	944	49	110	159	6.2	5.8	5.9
	(%) (32.2)	(67.8)	(100.0)	(30.8)	(69.2)	(100.0)			
- Kosti	92			14			6.6		
Kassala	371	1,141	1,512	61	207	268	6.1	5.5	5.6
	(%) (24.5)	(75.5)	(100.0)	(22.8)	(77.2)	(100.0)			
- Gedaref	119			20			6.0		
Blue Nile	209	847	1,056	32	143	175	6.5	5.9	6.0
	(%) (19.8)	(80.2)	(100.0)	(18.3)	(81.7)	(100.0)			
- Sennar	43			5			8.6		
Gezira	333	1,692	2,025	50	283	333	6.7	6.0	6.1
	(%) (16.4)	(83.6)	(100.0)	(15.0)	(85.0)	(100.0)			
- Wad-Medani	141			20			7.1		

Source: Third Population Census, 1983, Ministry of National Planning
edaniMedani

(3) Production, Marketing and Storage of Sorghum

Present conditions of production, marketing and storage of sorghum in the 4 provinces are summarized in Table 3.20.

Table 3.20 Production, Marketed Volume and Existing Storage Space of Sorghum

(Unit: 1,000 ton)

Province	Production ^{/1}		Surplus		Marketed Volume ^{/2}		Existing Storage Space	
		(%)		(%)		(%)		(%)
White Nile (Kosti)	116	(5.4)	14	(2.0)	62	(1.4)	88	(5.3)
Blue Nile (Sennar)	475	(22.3)	290	(40.8)	531	(12.3)	151	(9.1)
Kassala (Gedaref)	676	(31.8)	406	(57.2)	518	(12.0)	261	(15.7)
Gezira (Wad-Medani)	225	(10.6)	-32	-	517	(12.0)	119	(7.1)
Total	1,492	(70.1)	710	(100.0)	1,628	(37.7)	619	(37.2)
The Sudan	2,128	(100.0)	710	(100.0)	4,318	(100.0)	1,653	(100.0)

(Note): ^{/1}/₂ Average of 10 years during 1976/77 - 1985/86
 Marketed volume includes sorghum, millet, wheat and oil seeds such as peanuts, sesame and cotton seed.

Total sorghum surplus production and marketed volume of the 3 Provinces i.e, Kassala, White Nile and Blue Nile, cover respectively 100% and 38% of those of the whole country. These 3 Provinces play an important role in sorghum production and grain marketing in the Sudan. On the other hand, the Gezira Province being one of the main sorghum production provinces in the Sudan covers about 11% of the nation-wide production of sorghum. However, there is no surplus production in this province because of its large population. Total storage space of the 4 Provinces, namely White Nile, Kassala, Blue Nile and Gezira is about 620×10^3 tons and occupies about 37% of the whole country.

(4) Transportation

The four sites, namely Gedaref, Kosti, Sennar and Wad-Medani are located in the central area of sorghum production zone and have suitable and good traffic condition for transportation of grains.

Gedaref and Wad-Medani are located along the main highways and national railway connecting Port Sudan and Khartoum, the capital city of the Sudan via Kassala, as shown in Fig. 3.8. Furthermore, Sennar and Kosti are the key points of main highways and national railway extending to southern and western regions of the Sudan. Kosti has an important location to trade sorghum with the southern and western regions which have large marketing areas of sorghum. Sorghum produced in White Nile, Kassala and Blue Nile Provinces is assembled at Kosti and is transported to the southern and western regions.

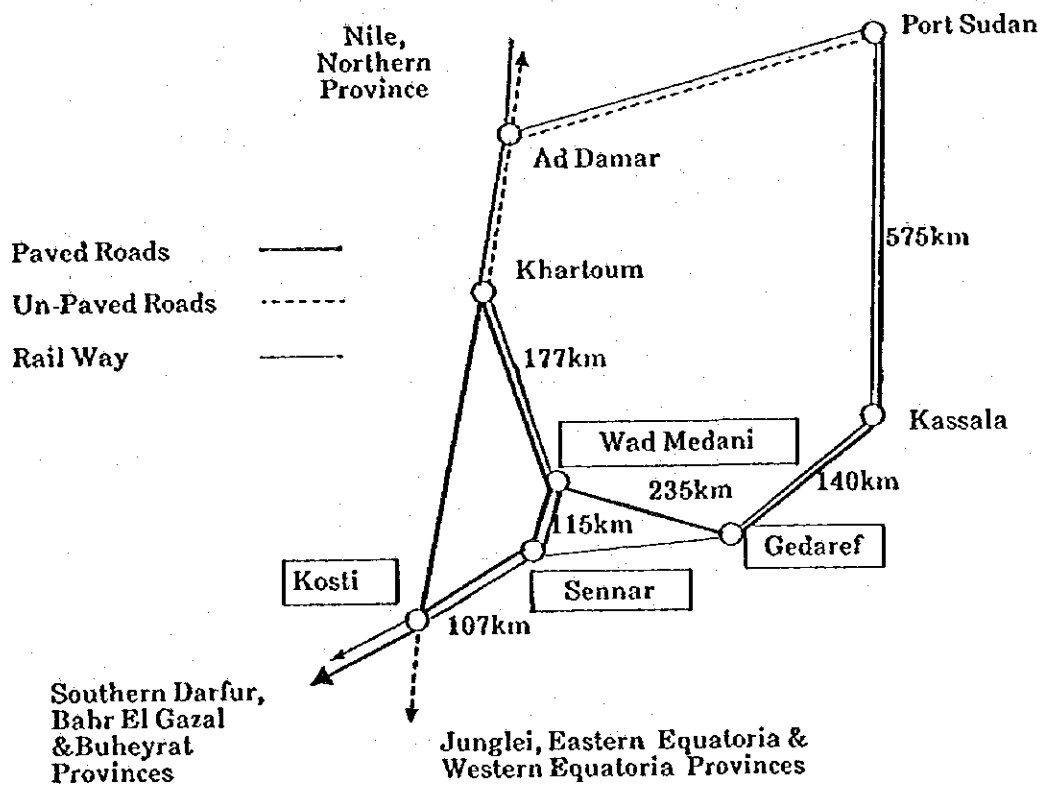


Fig.3.8 Transport Network

CHAPTER 4 PROJECT CONCEPT

CHAPTER 4 PROJECT CONCEPT

4.1 Objectives of the Project

The Government of the Sudan requested the Government of Japan for grant aid to construct grain warehouses with background of: (1) serious food shortages and starvation, (2) heavy grain storage losses, (3) sharp fluctuation in grain prices, (4) acute shortage in foreign currency, (5) severe account deficits (6) shortage of grain warehouses.

This project has the following objectives to solve these problems by providing appropriate grain warehouses as many as possible:

- saving of sorghum storage losses,
- stabilization of sorghum prices,
- steady supply of sorghum, and
- preservation of sorghum quality

4.2 Assessment of the Request

(1) Request by the Government of the Sudan

Warehouses

The construction sites and storage capacities requested by the Government of the Sudan are shown in the following table:

Site	Type of Store	Storage Capacity
		(tons)
Rabak (Kosti)	Flat warehouse	10,000
Wad-Medani	Flat warehouse	10,000
Sennar	Flat warehouse	25,000
Gedaref	Flat warehouse	25,000
Total	-	70,000

The sites for construction of warehouses as requested by the Government of the Sudan are located at four places, namely Rabak (Kosti), Wad-Medani, Sennar and Gedaref. The capacity of storage requested for each site is 10,000 tons for Rabak (Kosti) and Wad-Medani, 25,000 tons for Sennar and Gedaref, respectively. The type of storage requested is flat warehouse for all the sites. The grain to be stored in the requested warehouses is sorghum.

Facilities and Equipment

The Government of the Sudan also made a request to the Government of Japan for equipment and facilities for weighing, fumigation and handling of the sorghum at the warehouses. These include: 2 sets of truck-scale, 1 set of fumigation facility and an adequate number of stackers for each warehouse.

(2) Assessment of the Request

Grain to be stored

Sorghum is one of the main food crops in the Sudan occupying 52% of the total planted areas of all agricultural crops and 66% of grain consumption in the country. In spite of such economic and social importance of sorghum, huge losses of this crop were observed in the main producing provinces such as Kassala, White Nile, Blue Nile and Gezira, mainly because the grains are left in the open space due to shortage of warehouses. Considering the above background, it is appropriate for the Government of the Sudan to have chosen sorghum for the Project.

Capacity of Warehouse to be Constructed

The storage capacity of warehouses to be constructed under the Project was estimated independently from the capacity requested by the Government of the Sudan. The estimation was made for the four provinces of Kassala, White Nile, Blue Nile and Gezira. Firstly, the total storage space required for all main crops in these areas, such as

wheat, millet, oil seeds (groundnuts, sesame, cotton seed) was estimated because these crops can share storage space. From the result the additional storage space of warehouses to be implemented under the Project for sorghum storage was calculated.

The basis for this estimation is the flow shown in the subsequent Figure (Fig. 4.1). The storage capacity required was obtained dividing the annual marketable surplus by a turnover of warehouse. The annual marketable surplus is the product after subtracting farm self-consumption, seed stock, feed stock, storage losses and transportation losses from the total production. Storage space required for grains in the consumption areas have not been calculated at this stage because the construction of grain warehouse in production area is recongnized to be more urgent. Turnover of grain warehouses was estimated at 1.4 (see Table 3.12) based on the inventory records (1983/84 and 1984/85) of ABS Gedaref warehouses. The average of 10 years (1976/77 - 1985/86) was taken as the annual production because of great variation and little increase in grain production.

Parameters

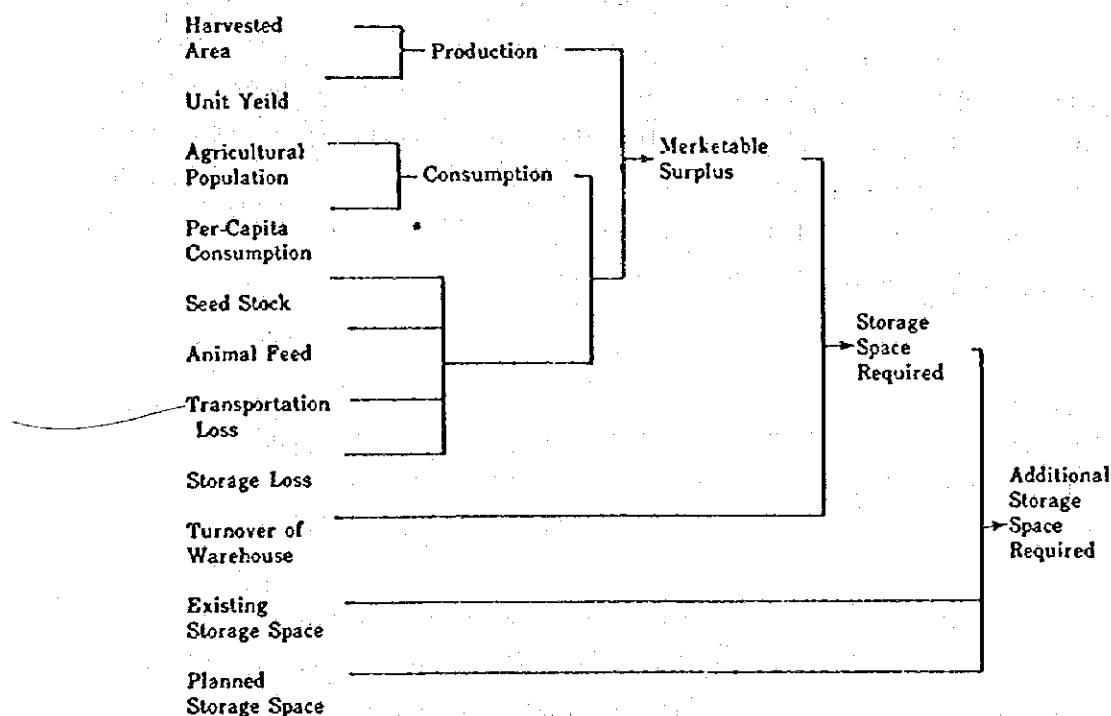


Fig. 4.1 Flow of Calculation of the Additional Storage Space for ABS Grains

Self-consumption by farmers was obtained multiplying agricultural population by per capita consumption. Estimated per capita consumption of respective grains (average of the country) and its references are shown in the following table:

Estimated per Capita Consumption of Grains

Per capita consumption		Reference
Sorghum	108 kg	IBRD Agricultural Sector Survey, 1975
Millet	26 kg	"
Wheat	31 kg	"
Oil seeds	45 kg	FAO Food Balance Sheet 1979-81

Per capita grain consumption by the agricultural population is assumed to be 120% of the average national per capita consumption because agricultural population consumes more grains than urban population and keeps some amounts of grains for their relatives living in urban areas. Seed stock, feed stock, storage losses and transportation loss were respectively estimated at 2, 2, 10, 2% of the production (see Grain Storage Study Sudan Vol. 4, pp.74). Existing storage space was estimated from the survey results in Grain Storage Study Sudan (Attached Table 7). Additional storage space required for sorghum was calculated by multiplying the total additional space required by the share of storage space for sorghum in the storage space for the total grains (Attached Table 8). The results are given in the following table.

Additional Storage Space Required for Sorghum

(Unit: 1,000 tons)

Province	Marketable Surplus Grain	Required Storage Space	Existing Storage Space	Additional Storage Space Required	
				All Grain	Sorghum
Kassala	447	320	264	- 56	- 50
White Nile	40	29	83	54	19
Blue Nile	483	345	151	- 194	- 116
Gezira	433	309	119	- 190	0

The above table shows that Kassala and Blue Nile provinces require additional storage capacity of 50,000 and 116,000 tons, respectively. The total additional storage space required (166,000 tons) corresponds to 50% of the existing storage space controlled by ABS. This figure is thought to be too large for the present ABS management capacity. The increase in storage space in proportion to the ABS share (20%) in storage space is realistic for meeting the immediate urgent need. The ABS managed additional storage space for Kassala and Blue Nile provinces is accordingly calculated at (50,000 tons x 0.2) 10,000 tons and (116,000 tons x 0.2) 23,000 tons, respectively. On the other hand, it is noted that there is a surplus in storage capacity of (19,000 tons x 0.2) 3,800 tons in White Nile province. In this regard, it seems reasonable to make a plan for establishing storage facilities in the central region (Blue Nile, White Nile, and Gezira provinces) which is to be considered as one economic unit.

The capacity of the warehouses to be constructed in Blue Nile province was estimated to be 20,000 tons [(116,000 tons - 19,000 tons) x 0.2 = 20,000 tons].

Besides the above, an additional storage capacity of about 120,000 tons should be provided by the Government of the Sudan through promotion of private sector investment, etc. to cover all the sorghum storage requirement in the area.

Sites for Warehouse Construction

The sites proposed by the Government of the Sudan for the warehouse construction are Rabak (Kosti) in White Nile province, Gedaref in Kassara province, Sennar in Blue Nile province and Wad-Medani in Gezira province. Among these areas, Kassala province and Central Region consisting of Blue Nile, White Nile and Gezira provinces were defined as the objective areas.

The proposed sites for warehouse construction under the Project were decided mainly from the following criteria: 1) ease of access to national roads and highways, 2) central position in relation to the sorghum production area, 3) existence of an ABS branch office for storage management, and 4) availability of construction sites. Taking into account these conditions, Gedaref and Rabak were selected as the construction sites. The former is located in Kassala province and the latter in White Nile province in Central Region. The selected sites are among the proposed construction sites by ABS, which shows that the sites, i.e. Rabak and Gedaref, chosen by ABS are appropriate.

The production areas of sorghum, storage space needed and their sites are summarized below:

Sorghum Production Areas	Storage Space Needed	Construction Sites
Kassala province	10,000 tons	Gedaref
Central region (White Nile, Blue Nile and Gezira provinces)	20,000 tons	Rabak
Total	30,000 tons	-

Type of the Requested Warehouses

Flat warehouse has been requested by the Government of the Sudan. Considering the fact that sorghum is handled in bags at present, the requested flat warehouse was assessed to be quite appropriate for the Project.

Executing Body

The Government of the Sudan designated ABS as an executing body of the Project. ABS is considered as appropriate for this purpose mainly for the following reasons:

- ABS is the largest warehouse owner in the Sudan, and it has practical experience and sufficient staff in construction and management of grain warehouses,
- The ABS's financial condition is quite sound,
- ABS has been entrusted with the monopolistic management of buffer stock of sorghum in the Sudan.

Facilities and Equipment

Introduction of truck scale was not recommended mainly due to the reasons mentioned below:

- (a) At present, sorghum is marketed on a volume base, not weight base. Therefore it is rather difficult to establish a marketing system based on weight only by ABS. When a bag of sorghum has not enough weight, it is rather difficult for ABS to negotiate with sellers who purchased the sorghum on volume base, and trade is expected to be cancelled.
- (b) A truck scale is made of highly accurate parts and is not produced in the country. When it becomes out of order, acquisition of spare parts seems to be difficult because of limited foreign currency in the country.

Fumigation for the warehouses except silos is usually conducted by Plant Protection Department of Ministry of Agriculture and Natural Resources. The following equipment will be provided for emergency use when fumigation will not be performed by the Department.

- fumigation vinyl sheet: 6 sheets for Gedaref, 12 sheets for Rabak to cover volume of 3 days receivings. Spares are included.
- gas mask: 13 sets for one fumigation team
- gas tester: 4 sets, 2 for each warehouse site

Slat-Conveyers

Slat-conveyers are the appropriate equipment to stack bags up to an economic height of 24 bags in a safe way. Electric motors should be used for power of the slat-conveyers because of their easy maintenance. Jute bags in warehouses are handled by manual at present and the labour cost of the work is rather expensive, LS 0.5/bag. Therefore, mechanization in stacking of bags will bring about cost reduction and will lessen the danger of stack collapse.

The number of conveyors to be introduced was estimated at 2 for each site based on the following calculation

- 1 conveyor is required for receiving and despatching operations, respectively,
- The maximum daily handling volume expected in each warehouse is 196 tons,
- The capacity of 1 conveyor is 55 tons/hour (7-hour operation).

4.3 Project Concept

(1) Project Execution Organization

Construction, operation and maintenance of the Project will be under the control of ABS and the primary responsibility will rest on its Managing Director. Supervision and management of project implementation will be undertaken by the Department of Inspection and Evaluation with the collaboration of engineers from the Engineering Section, Department of Administration. There are 3 civil engineers, 1 typist and one clerk in the Engineering Section.

Operation and management of the warehouses after their completion will be taken in charge by the Market and Store Department in the Head Office of ABS. Actual sorghum receiving and despatching operations will be directed by managers of branch offices. The warehouses of Rabak and Gedaref will be operated and managed under the control of Kostu and Gedaref Branch Offices, respectively. The present staff of the existing warehouses in Rabak and Gedaref are as follows:

Designation	Gedaref	Rabak
Branch Office Manager	1	1
Accountant	7	5
Clerk	3	3
Store Keeper	3	3
Guard	18	3
Total	32	15

The present staff at Rabak manage 1 existing warehouse, while the staff at Gedaref manage 1 rented warehouse and sorghum stored in the open space.

Taking into account the existing number of staff, number of existing warehouses to be operated and managed and capacities of

warehouses to be increased under the Project at each place, it would not be necessary to increase the staff for operation and management of the new warehouses.

(2) Facilities and Equipment

The facilities and equipment to be constructed and supplied under the Project are summarized as follows:

Facilities and Equipment	Sites	Quantity	
A. Warehouses	Gedaref	1 building of 4,000 m ² in area and 10,000 tons in storage capacity	
	Rabak	3 buildings of 8,000 m ² in area and 20,000 tons in total storage capacity	
B. Guardhouse	Gedaref	1 building of 30 m ² in area	
C. Equipment	- Slat conveyor (55 ton/hour)	Gedaref	2 sets
		Rabak	2 sets
	- Fumigation sheet (17 m x 17 m)	Gedaref	6 sheets
		Rabak	12 sheets
	- Gas mask		13 sets
	- Gas tester	Gedaref	2 set
		Rabak	2 set
	- Motorcycle (125 cc)	Gedaref	1 unit
		Rabak	1 unit
	- Off road 4-wheel driven vehicle	Gedaref	1 unit
Rabak		1 unit	
- Wireless set		3 sets	

(3) Condition of Project Sites

a) Site Condition

Rabak (Kosti)

The proposed construction site is a part of the yard for the existing warehouse owned by ABS. It is around 2 km to the west of Rabak town, which is located almost in the center of White Nile Province. The site has an area of almost 40,000 m² (100 x 400 m). The yard is flat and fenced by brick walls about 2 m high. A flat warehouse with 4,000 m² (40 m x 100 m) floor area lies to the southeast of the site. To the north of the warehouse, there remains vacant land. To the west of the yard a railway siding runs from north to south and bends to east at the northern part of the yard. An unpaved road in front of the yard (10 m wide) joins the paved trunk road which connects with Kosti and Sennar. There are factories such as of cement, spinning in the vicinity.

Gedaref

The proposed construction site is near the Gedaref grain silo (capacity 100,000 tons) owned by ABS, around 2.5 km to the southwest of Gedaref town, in the south of Kassala province. At present the site is used as a yard for storing bagged sorghum. It is a flat strip with total area of 13,000 m² (55 m x 240 m). To the north of the site there is an unpaved road, and to the south there is a railway siding.

b) Geological Features and Bearing Capacity of Ground

In the proposed sites the ground, not only topsoil but also subsoil, is composed of hard clayey soil. The bearing capacity of the ground is expected to be over 10 tons/m² because existing warehouses and brick buildings have been constructed without any pile foundations. There will be no problem as far as flat warehouses or buildings are concerned.

c) Meteorology

The proposed sites, Kabak (Kosti) and Gedaref are located between 13° and 15° north latitude. They lie within the Central Savanna Belt, which covers almost the half the Sudan, and has high temperature, low humidity. The average temperature is almost constant throughout the year, and is around 29°C. Monthly average temperature is highest in May, around 33°C and lowest in January, around 26°C. Relative humidity ranges between 39% and 46%. Rainfall reaches from 350 mm to 600 mm although hardly any rainfall is recorded in dry season, from October to May. The maximum wind velocity is around 32 m/sec.

d) Earthquakes

No earthquakes have been observed in the area. Therefore, seismic design is not required

e) Traffic Condition

A flat steel structure warehouse and an additional flat brick building are the main construction structures in the Project. Steel materials, finishing materials and a part of additional equipment is not available in the domestic market and will therefore have to be imported from Japan. Concerning the transportation of the above mentioned equipment and materials, there will be no problem because of good accessibility of the proposed site at Gedaref which is located along a paved twolane national road from Port Sudan, a port of delivery, to Khartoum. Rabak also has no transportation problem as it has another paved twolane national road from Wad-Medani via Sennar to Khartoum. These roads are rather important because of their large traffic volume. They are well maintained and have good traffic conditions. They have bridges over the Blue and White Niles respectively. Railway traffic connecting with the proposed site is also available but there will be little possibility of using it for construction work as its capacity is very small. Table 4.1 shows distance among these towns.

Table 4.1 Distances between Towns

Names of Towns	Distance (km)
Port Sudan - Gedaref	715
Gedaref - Wad-Medani	235
Wad-Medani - Khartoum	177
Wad-Medani - Sennar	115
Sennar - Rabak	102

f) Electric Power

Rabak (Kosti)

No electrical facilities has been provided in the existing warehouse although a service cable can be provided to the proposed warehouse with commercial electric power.

Gedaref

Electric power can be supplied from the existing Gedaref grain silo to the west of the proposed site.

g) Water Supply and Drainage

Rabak (Kosti)

There are no plumbing system and lavatory in the existing warehouses, but it is possible to supply water from the existing water main near the proposed site. Rain water from the roof will be drained to nearby bare soils..

Gedaref

Water will be supplied from the existing ABS silo which is close to the proposed site, and there will be no problems for temporary plumbing work. Rain water from the roof is drained to nearby bare soils.