PRELIMINARY SURVEY REPORT

ON

RICE CUITIVATION ALONG WHITE NILE, SUDAN

Mar, 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOREWORD

Upon request of the Democratic Republic of the Sudan for technical cooperation on the rice cultivation development along the White Nile River, the Japan International Cooperation Agency (JICA), the sole technical co-operation organization of the Government of Japan, dispatched a preliminary survey team to the country, consisting of six experts headed by Mr. J. Kitamura, Head of Development Planning Division for Agriculture & Forestry, JICA, for about three weeks from November 5, 1976, in order to perform the following works;

1) To verify the detailed contents of the request for the technical cooperation,

2) To grasp the existing condition of the agricultural development in the Sudan,

3) To explain the Japanese governmental technical cooperation system,

4) To find out immediately applicable means under the current Japanese technical cooperation system, and

5) To select the appropriate site for irrigated paddy cultivation under the existing conditions.

Submitted herewith, is a report based on the results of the above-mentioned survey including the corrections made thereto in accordance with the examination of comments by the Sudanese authorities.

I firmly believe that this report will contribute to the preparation of subsequent feasibility study to be carried out soon, and also to study of the construction and operation of a pilot farm which are already requested by the Sudanese Government.

The Sudan is considered to be a food production base for the entire Arab world and technical cooperation to this country as Arabic food production base will be highly significant in the current world situation of food shortage.

Availing myself of this opportunity, I would like to express my hearty gratitude to the officials of the authorities concerned of the Sudanese Government for their whole-hearted support and assistance extended to the team, and sincerely wish that our efforts for cooperation will serve to strengthen the

closer relationship between the Democratic Republic of the Sudan and Japan.

February, 1977

Shinsaku HOGEN
President
Japan International Cooperation
Agency

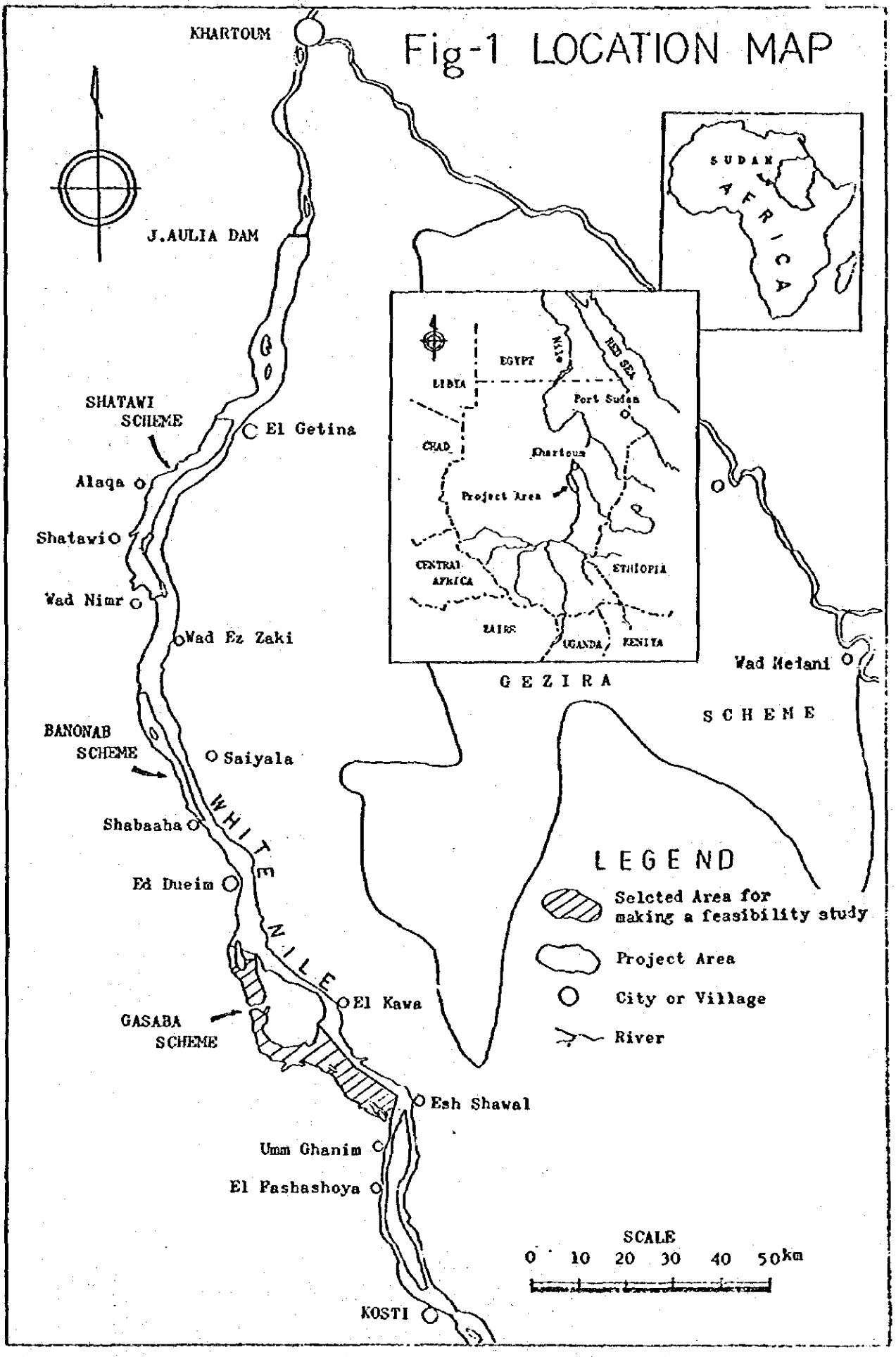


Fig-1 LOCATION MAP
KHARTOUM
J.AULIA DAM
SHATAWI SCHEME
El Getina
Alaqa
Shatawi
Wad Nimr
Wad Ez Zaki
BANONAB SCHEME
Saiyala
Shabaaha
Ed Dueim
WHITE NILE
El Kawa
GASABA SCHEME
Esh Shawal
Umm Ghanim
El Pashashoya
KOSTI
Wad Medani
GEZIRA SCHEME
SUDAN
AFRICA
EGYPT
LIBYA
CHAD
CENTRAL AFRICA
ZAIRE
UGANDA
KENYA
ETHIOPIA
Port Sudan
Khartoum
Project Area
RED SEA
LEGEND
Selcted Area for making a feasibility study
Project Area
City or Village
River
SCALE
0 10 20 30 40 50km

CONTENTS

1. INTRODUCTION

1.1 Objectives of the Survey

At the request of the Sudanese Government for cooperation in the agricultural development in Sudan, preliminary survey was conducted over the object area along the White Nile which was the arable land located at about 100 km to 250 km south of the capital Khartoum, and the area of the rice cultivation carried out in the Gezira area famous for the largest output of cotton in the country.

The survey was intended to grasp the current situation of the agricultural development in Sudan and any problems involved in the development and, at the same time, to look into the status of technical cooperation extended from the third countries for rice cultivation and to select an appropriate site conforming to the objectives contained in the request.

It was also intended to confirm the details of the request for technical cooperation of the Sudanese Government through exchange of views with the Sudanese officials, explain the system of technical cooperation of the Japanese Government to the Sudanese Government, and thus find a practicable method of cooperation within the system and formulate a plan for prospected feasibility survey.

For the technical as well as financial cooperation requested by the Sudanese Government for construction and operation of a pilot farm in the area of irrigated rice cultivation project, it was planned to grasp in detail the request of the Sudanese Government and report the same to the Japanese Government.

1.2 Background of the Survey

The Democratic Republic of the Sudan is dependent, for its greater part of economy, on agriculture. The country has a land area of 250×10^6 hectares including an arable land of 84×10^6 hectares, but only 8.5 percent of such arable land is used presently. The agricultural products such as cotton, oil seeds, etc. constitute a greater part of the export, while wheat, sugar and rice are dependent on the import. In its five year plan now in progress from 1970 (two years extended), the Government of the Sudan is exerting every effort for achievement of the self-support of the agricultural products and expansion of the production for promotion of the export. Particularly, with

respect to rice, self-support in and after 1977 is contemplated, and it is planned to assign the produce in this project area for export.

Under the foregoing background situation, the Sudanese Government requested the Japanese Government distinguished in the technology of rice cultivation for technical cooperation for the present project of rice cultivation through development of the vast and fertile arable land in use of the abundant water of the White Nile.

The request included a feasibility survey for construction of irrigation and drainage facilities, paddy field opening and building of ring levees (Arab fund being sought for such works) specified in the project and a necessary survey and financial as well as technical cooperation for construction and operation of a pilot farm to be built in the project area.

The Sudanese Government regarded the pilot farm as a test farm for feasibility survey with an area of minimum 500 feddans allocated for the scale and location, while the Japanese Government held that the cooperation for survey, construction and operation of the pilot farm was possible in the area of 200 feddans and would not be effective before the effects of the infrastructure construction works were confirmed by the feasibility survey. Thus, there was a great difference in the basic attitude between the respective governments.

1.3 Composition of the Survey Mission

Mr. JUNICHI KITAMURA	(Leader)	Head of Development Planning Div., for Agriculture and Forestry, JICA.
Mr. SHINICHI YANO	(Drainage)	Director of Agricultural Water Utilization, NIPPON KOEI Co., Ltd.
Mr. GORO YAMADA	(Irrigation)	Deputy of Water Utilization Div., Tohoku Region Agricultural Administration Bureau, MAF.
Mr. TAKESHI KUROSAWA	(Agronomy)	Chief Research Officer, Tohoku National Agricultural Experiment Station, MAF.
Mr. YASUMI YAMAGUCHI	(Technical Cooperation Programing)	Overseas Technical Cooperation Officer, International Affairs Div., MAF.

Mr. ISAO TAKAHASHI	(Coordination)	Officer of Development Planning Div., for Agriculture and Forestry, JICA.
Mr. ISMAIL MUSTAFA	(Counterpart)	Department of Agricultural Engineering, Ministry of Agriculture, Food and Natural Resources.

(Note) JICA: Japan International Cooperation Agency
MAF: Ministry of Agriculture & Forestry

1.4 Activities of the Survey Mission

NOV. 5, 1976 (Friday) Left Tokyo for Khartoum via Cairo.

NOV. 6, 1976 (Saturday) Arrived in Khartoum and made a courtesy call at Embassy of Japan there.

NOV. 7, 1976 (Sunday) Visited the Ministry of Agriculture, Food and Natural Resources to meet the Under Secretary and the Director General of Engineering Affairs, and had discussion about surveying schedule and solving the problem on the pilot farm implementation between the Governments.
Made courtesy call on the Political Supervisor H.E. Mr. Ahmed Abdel Halim at the S.S.U. At the same meeting Mr. Mohamed El Sayed El Shaar, the Commissioner of the White Nile Province.

NOV. 8, 1976 (Monday) Made a courtesy call on the State Minister of Agriculture, explained the Japanese Technical Cooperation system and the simultaneous pilot farm implementation with making feasibility study of the irrigation project area in a practical way was suggested. The renewed request letter will, therefore, be submitted to the Embassy of Japan soon.
Visited the Manager of Planning, Ministry of Irrigation to ask questions of the relation with the Ministry of Agriculture and so on, and to be given the information of the third countries' cooperation for the irrigation projects in the Sudan.

NOV. 9, 1976 (Tuesday) Paid a visit to the Ministry of Finance, Planning and National

	Economy, to meet the Chief of Project Preparation Unit, the Under Secretary and the Assistant Under Secretary individually, and explained the project to get the future cooperation. Left Khartoum for Wad Medani in the evening and stayed there.
NOV. 10, 1976 (Wednesday)	Were given the informations of the outline of the Gezira Scheme by the Deputy Manager of Agriculture. Then the rice cultivation in the scheme was given by rice physiologist. The irrigation on-going projects in the scheme was given by the Director of Irrigation, Services. For the organization Structure of the Agricultural Research Corporation, this was given by the Deputy Director of the Corporation. Received the result of the soil survey of the area along the White Nile from the Soil Survey Department.
NOV. 10, 1976 (Wednesday) (continued)	Visited a typical irrigation project area (with Marhaba Weir and canals) and rice cultivation area in cooperation with the Chinese.
NOV. 11, 1976 (Thuesday)	Left Wad Medani for Ed Dueim. Had a meeting with the Assistant Commissioner of the White Nile Province and his staff members about the schedule for the site survey.
NOV. 12, 1976 (Friday)	Had a meeting again in the morning. Made surveys of Ureik Pump Irrigation Project Area, and the proposed areas, Salaga (Banonab) Area, and Shatawi Area. The technical members returned from Shatawi to Ed Dueim and the adminstrative members returned from Shatawi to Khartoum.
NOV. 13, 1976 (Saturday)	(The technical members) Visited the Agriculture Office to see their experimental rice plots. Made a courtesy call on the Commissioner of the White Nile Province. Inspected the proposed Gasaba Area and rice fields under traditional cultivation by Nigerian transmigrants.

	(The administrative members) Reported the survey result temporarily to the Ambassador of Japan. Visited the Manager of Planning, Ministry of Irrigation again to get more detailed information.
NOV. 14, 1976 (Sunday)	(The technical members) Visited offices concerned in Ed Dueim to obtain more data and information about Agriculture, Irrigation, Pasture, Forestry, Social Study, Statistics, Survey, Meteorology, and Agricultural Corporation. (The administrative members) Saw the Director General of Engineering Affairs, Ministry of Agriculture again to have a discussion about A1 form which is provided for experts' dispatch for pilot farm planning.
NOV. 15, 1976 (Monday)	(The technical members) Reported the result of the site survey to the Commissioner. Left Ed Dueim for Khartoum by taking the way on the left bank by way of Jabel Aulia Dam on the White Nile. (The administrative members) Visited the Deputy Director of Planning, Ministry of Agriculture to ask how responsible the Department of Planning is to provide A1 form for requesting experts' dispatch.
NOV. 16, 1976 (Tuesday)	Reported the result of the site survey to the Director General of Engineering Affairs, Ministry of Agriculture, and asked to make appointments with the personnel to obtain further data and information. Were given the publication list by the Director General of Statistics Department, in order to select the necessary publications. Visited Prof, A.H. El Nadi, Khartoum University, specialized in Plant and Water Relationship to obtain the information about rice cultivation along the White Nile.
NOV. 17, 1976 (Wednesday)	Visited the Survey Department, the Ministry of Defence, to obtain the Necessary topographical maps of the areas concerned, to inspect the triangulation points near the areas and to purchase available maps in the map sale section.

NOV.18, 1976 (Thursday)	Made an interim report
NOV.19, 1976 (Friday)	Made an interim report
NOV.20, 1976 (Saturday)	Continued to make the interim report.
NOV.21, 1976 (Sunday)	Reported the result of the site survey to the Embassy of Japan.
NOV.22, 1976 (Monday)	Reported and discussed with the personnel concerned of the Government of the Sudan about the result of the site survey made by the Mission. Left Khartoum for Tokyo via Cairo in the evening.
NOV.23, 1976 (Tuesday)	Kitamura and Yano departed Khartoum early in the morning to Rome. In Rome, visited Messrs. Tsutsui and Matsuo at FAO Headquarter where they were introduced to Mr. Khalid T. Ali (FAO officer), Leader of the Sudan Agricultural Development Survey Mission, Arab Fund for Economic and Social Development and had a talk with him. The other members departed Cairo in the afternoon to Tokyo.
NOV.24, 976 (Wednesday)	Kitamura and Yano visited FAO Headquarter again and sought opinions of Dr. Doorenbos and Mr. Buycx who were concerned with the agricultural development in Sudan. Purchased necessary materials at the books service center of FAO. The other members arrived Tokyo.
NOV.25, 1976 (Thursday)	Kitamura departed Rome to Lagos (Nigeria Agricultural Development Project). Yano departed Rome to Tokyo.
NOV.26, 1976 (Friday)	Yano arrived Tokyo.

1.5 List of the Personnel Concerned

1) Sudanese Government

NOV.7 Mr. Gaafer El Hassan
Under Secretary, Ministry of Agriculture, Food & Natural Resources.

NOV.7 Dr. Abdin Hassan Abdoun
Director-General, Engineering Affairs.

Mr. Salah El Din Hassan Ahmed,
Deputy Director-General, Foreign Relations Administration.

Mr. El Tahir Harby,
from Engineering Affairs.

Mr. Mohamed El Sayed El Shaar,
Commissioner, White Nile Province.

Mr. Obeid Abdel Halim
Supervisor, White Nile Province.

NOV.8 H.E. Mr. Abdel Rahim Mekki,
State Minister of Agriculture.

Mr. Isam Mustafa
Director of Planning, Ministry of Irrigation and Hydro Electric Power.

NOV.9 Dr. Abdel Rahman Abdel Wahab
Under Secretary for Planning, Ministry of Finance, Planning and National Economy.

Dr. B.A. El Datrouti
Assistant Under Secretary for Planning,
Ministry of Finance, Planning and National Economy.
(in charge of Agriculture)

Dr. Abdus Sattar
Agricultural Advisor, World Bank Planning Team.

Mr. Riazuddin Ahmed
Leader, World Bank Planning Team.

NOV.10 Mr. Hassan Abdalla Hashim
Managing Director of the Sudan Gezira Board, Barakat.

Mr. Mohamed Mufti
Deputy Agricultural Manager,
Sudan Gezira Board, Barakat.

Mr. Abdin Abdel Rahman
Senior Officer, Public Relations & Services,
Sudan Gezira Board, Barakat.

Mr. El Tayeb Tag Eldin
Director of Irrigation Services for Gezira Board.

Mr. Mohamed Abdalla Ali
Soil Survey Adminstration Director,Sudan Gezira Board.

Mr. Kamal Mohamed Abodou
Deputy Director of Irrigation Service, Sudan Gezira Board.

Dr. El Hadi El Nur
Deputy Director, General Agricultural
Research Corporation, Wad Medani.

NOV.10 Dr. George I. Ghobrial
Senior Rice Physiologist,
Agricultural Research Corporation, Wad Medani.

NOV.11 Mr. Abdel Rahman Rudwan
Assistant Commissioner for Irrigation, Ed Dueim.
Assistant Secretary for S.S.U. White Nile Province.

Mr. Burai El Sahib
Inspector of White Province, H.Q.

Mr. Abdel Wahab Fadlalla Ali
Chief Engineer, Ministry of Irrigation, Ed Dueim Div.

Mr. Ahmed Khalid Shouk
Agricultural Inspector, Ed Dueim.

NOV.12 Mr. Ahmed Maana
Executive Director, Ministry of Irrigation, Ed Dueim Div.

Mr. El Zubair Mohamed Ali
Forestry Inspector, Ed Dueim.

Mr. Nabeel Ahmed
Pasture Inspector, Ed Dueim.

Mr. Abu Bakir
Official from White Nile Agricultural Corporation, Ed Dueim.

NOV.13 Mr. Younis Mohamed Ali (official trip to Ed Dueim)
Cadastral Survey, Department of Survey, Khartoum.

NOV.14 Mr. Achmed Musa
Assistant Manager,
Ed Dueim Agricultural Corporation, Ed Dueim.

Mr. Mohamed Zaki Khalifa
Inspector of Social Affairs, Ed Dueim.

Mr. Hamid Mohamed Mustafa
1st Meteorologist, Meteorological Office, Ed Dueim.

Mr. Rahmtalla Sadabi
Head of Statistical Office, Ed Dueim.

Mr. Abdel Rahman Bashari
Assistant Inspector of Agriculture, Ed Dueim.

NOV.15 Dr. Mohamed Ibrahim
Deputy Director for Planning, Ministry of Agriculture, Khartoum.

NOV.16 Mr. Omer Ahmed Eltay
Director-General, Department of Statistics,
Ministry of Defence, KHARTOUM.

Prof. Abdel Mohsin Hassan El Nadi
Head, Agronomy Department, Faculty of Agriculture,
Shambat-Khartoum North.

NOV. 17 Mr. Awad Bagdadi Amir
Director, Cadastral Adminstration,
Survey Department, Ministry of Defence, KHARTOUM.

Mr. Yousif Ahmed Shalanani
Head, Checking & Computing Section,
Survey Department, Ministry of Defence, Khartoum.

2) Japanese Embassy

H.E. Ambassador Arimoto

Mr. Shono, First Secretary

Mr. Ebina, Second Secretary

Mr. Hosomoto, Second Secretary

3) Miscellaneous

Mr. Fukumitsu, Chief of the Khartoum Office of Marubeni Corporation.

4) FAO (Rome Headquarter)

Mr. Tsutsui (Water resources)

Mr. Matsuo (Agronomy)

Mr. Khalid T. Ali (Arab Fund for Economic and Social Development) (C346)

Dr. Doorenbos (Agriculture) (4030)

Mr. Buycx (Irrigation) (3551)

2. SUMMARY

2.1 Agriculture and Agroeconomy

(1) Agriculture

Current status: The arable land in the whole land area of Sudan is estimated at about 84,000,000 hectares, but the cultivated land is only about 7,130,000 hectares. Mean planted areas of the main crops in the years of 1971 to 1973 showed about 5,000,000 hectares in total by ncreasing 2,000,000 hectares since ten years ago; or, in details, cotton at 500,000 hectares, sorghum at 1,850,000 hectares, millet at 1,020,000 hectares, wheat at 130,000 hectares, benne-seed at 950,000 hectares and peanut at 690,000 hectares. Except cotton, the yields are generally low. Other crops cultivated are maize, cassava, sweet potato, paddy rice, sugar cane, vegetables and gum arabic. The area of irrigation is reported to be 1,000,000 hectares of which 680,000

hectares is used for plantation with cotton accounting for 40 percent, sorghum for 27.2 percent, wheat for 12.1 percent and others for 20.1 percent.

In Gezira Province, a pilot farm of 8.4 hectares has been operated since 1973 on the support of China for trial rice cultivation. Separately from the foregoing, rice cultivation was also carried out by the farmers for the area of 6,300 hectares (or 1.13 hectares per farming household) in 1976. In the White Nile Province and southern provinces, some rice cultivation is made. The rice cultivation in the Gezira province is of direct sowing on dry field in use of several varieties of Indica Type. As a fertilizer, urea and triple superphosphate of lime are used. The yield is about 1.67 tons to 2.0 tons per hectare, in dry paddy, and a yield as high as 7.1 tons is reported in a test plot.

The development project area is a low land along the main stream of White Nile and forms the riverbed in the flooding season (August to next February) every year with weeds growing thick. The soil is a heavy clay containing 60 to 70 percent of clay and is slightly alkaline, but no deposit of poisonous salts is found.

Problems: From the climatic and soil conditions and the result of the trial in the Gezira Province, the rice cultivation in the project area is considered to be promising if appropriate cultivation technique is established. On the other hand, there are a number of problems to be solved such as the soil being of heave clay, rampant growth of weeds, underdeveloped cultivation technique, the farmers being unexperienced in rice cultivation, etc.

Direction of development: Thus, as a direction of development hereafter, it is urgently required to establish the appropriate techniques of cultivation and management and cultivate men of ability. Further, in order to provide a large area cultivation with a high yield, creation of paddy fields where irrigation and drainage are operated freely and systematic study of rice cultivation technique with mechanized agriculture taken into consideration will be required.

(2) Agricultural economy

Current status: A new five year economic development plan (1970/71 - 74/75) with emphasis placed on the agricultural sector was formulated by the present government and was enforced from 1970/71. In 1974,

the period was extended for two more years. The total investment of the project is set at 386,000,000 Sudan pounds, and it is intended to improve the G.D.P. at 725,000,000 Sudan pounds in 1970 to 816,000,000 Sudan pounds in the final year of the plan.

The polulation is 17,300,000 according to the statistics in 1974, and the agricultural population constitutes 92 percent of the total population, with 40 percent of the agricultural populace occupied by the nomads. According to the statistics in 1969/70, the labor force in Sudan is about 6,440,000 with 80 percent engaged in agriculture.

The agricultural sector accounts for about 40 percent of G.D.P., and in 1972/73, G.D.P. stood at 809,300,000 Sudan pounds or 47.9 Sudan pounds corresponding to 137 U.S. dollars per capita. The gross export in 1975 was 147,600,000 Sudan pounds, agricultural products such as cotton, peanuts, gum arabic, etc. accounting for 96 percent particularly, the export of cotton accounting for 60 percent of the total export. On the contrary, wheat, sugar, etc. are supplied through import.

The forms of agriculture are classified largely into mechanized agriculture and conventional extensive agriculture, and the projects where mechanized agriculture is exercised are operated, for a greater part, as national farms by the Agricultural Development Corporation, and the farmers engage in the agriculture as tenants and receive the dividends of the profit according to a predetermined profit-sharing basis. The projects where the mechanized agriculture is carried out are further classified into (1) gravity irrigation project, (2) pump irrigation project, (3) flood irrigation project and (4) rain-fed cultivation project. Mean areas of cultivation and mean annual incomes of the tenant farmers in the projects (1) and (2) are 15-12 feddans corresponding to 6.3 - 5.0 hectares and 110 - 75 Sudan pounds, and 6-4 feddans corresponding to 2.5 - 1.7 hectares and 53-40 Sudan pounds, respectively. On the other hand, the mean annual income of the farming households engaged in the conventional extensive agriculture is 17 Sudan pounds.

The domestic market of the agricultural products is held in the hands of the brokers who are also acting as money lenders. Thus, the commission fees are reportedly so high as to reduce the volition of the farmers for improvement of the production.

The activities for extension of the agriculture are undertaken by 13 service offices belonging to the Ministry of Agriculture, Food and Natural Resources. In some provinces, and regions, these are extension service advisory committees organized to give guidance and advice to the extension activities.

The agricultural cooperative associations are limited to the areas under control of said Corporation and are not present in the areas where the traditional agriculture is prevalent.

Problems:

- It is important to emerge from the cotton monocultural productive structure through production of cash crops succeeding cotton and thus diversify the export products.

- Notwithstanding an agricultural country, wheat and sugar, etc. are dependent on import. Self-supporting of the foodstuff leading to improvement of the trade balance has not yet been established.

- In order to correct various differences accruing from the dual structure of modern mechanized agriculture and conventional extensive agriculture, and thus improve the productivity and profitability; a policy based on a long ranging prospect is required.

- Correction of the distribution mechanism called "Sheil" and liberation of the farmers from "Sheil" will encourage the farmers for improvement of the production.

- Provision of the storing and processing facilities and improvement and expansion of the traffic means are requisite for maintenance of the quality as well as adequate prices and also for stable supply of the agricultural products.

Direction of development: The Six Year Development Plan to be implemented from June 1977 is designed for establishment of a food self-supporting system and formulates improvement of the irrigation and expansion of the irrigated area. The present rice crop development project is designed along said Six Year Development Plan and is of a great significance for the country with little experience in rice cultivation.

2.2 Irrigation and Drainage

Current status

The irrigation projects in the Sudan are developed generally along the Nile River. Particularly, the Gezira and other major projects are concentrated in the middle provinces. The area of irrigation along the Nile comprises: (1) 420,000 hectares under gravity irrigation; (2) 485,000 hectares under pump irrigation; and (3) 38,000 hectares under flood irrigation.

The Gasaba area chose as the object site of this development project is a part of the riverbed of the White Nile. It is located about 15 to 60 kilometers south of Ed Dueim, the capital of the White Nile Province, and comprises an area of about 20,000 hectares. The elevation of the area is 375 to 378 meters above sea level and is subject to the influence of flood control of the Jebel Aulia Dam and is thus waterlogged during seven months of from August to next February.

The flood control of the Jebel Aulia Dam is carried out as set forth in the following:

(1) The first water storage is started in mid-July and is continued until the water level reaches an elevation of 376.50 meters above sea level in mid-August;

(2) The second storage is started in mid-September and is continued until the water level reaches an elevation of 377.20 meters above sea level in mid-October; and

(3) Release of the stored water is started early in February, and the whole storage is released by the end of March. Thereafter, the river flow is allowed to run down.

For the consumptive use of water for upland crops, a standard is set forth for the respective areas. In the case of the pump irrigation projects in the White Nile Province, the maximum consumptive use per feddan of planted area is set at 30 cubic meters per day. This corresponds to 7.1 mm/day. The water conveyance loss is assumed to be 8 percent, and the water operation loss to be 5 percent. In case of rice cultivation, for the maximum consumptive use per feddan of planted area called crop factor, there are no data available.

In the vicinity of the object area, there are 18 national pump irrigation project areas covering an area of about 17,000 hectares in total.

In the Gezira project, the design standard for the drainage canal is determined according to each catchment area. For example, for the catchment

area of 1,000 feddans (420 ha), the runoff is 0.41 l/sec/ha, and for 10,000 feddans (4,200 ha), it is 0.20 l/sec/ha.

Problems

In order to establish the development plan, it is important to investigate any projects present in the vicinity of the object project area and any future projects contemplated and thus position the project area concerned properly.

- The necessary data for development plan are short.
- The project area is located on the river-bed of the White Nile and has thus a speciality of being waterlogged for seven months in the flood season of the river.
- Unsatisfactory road network for connection of the project area to the adjacent cities is available.

Direction of development

It is important to establish a stable rice crop development plan upon full understanding of the present situation of the project area being submerged over a long period under the influence of the changing water level of the White Nile. That is, it is required to formulate a development plan in which it is enabled to cut off the influence of the outside water level and control the inside water level thoroughly.

As seen from the labor situation in the vicinity of the project area, it is considered to be quite appropriate to introduce the mechanized agriculture. Accordingly, it is required to consider a facilities plan adapted for such mechanized agriculture.

Further, the development plan should comprise a consideration that it would cause no hazard to any existing facilities in and out the project area.

The report "Reconnaissance Report ED DUEIM RICE DEVELOPMENT PROJECT" submitted to the Sudanese Government from the Nippon Koei Co., Ltd. in January 1976 includes a sample study conducted of an area of 14,000 hectares among the area of 20,000 hectares in Gasaba Area chosen as a development site in the preliminary survey. According to said project, there are to be constructed a polder dike extending for about 57 kilometers around the irrigation area, six pump stations for irrigation, two pump stations for drainage, trunk supply water channels extending 59.4 kilometers, trunk drainage channels extending 33.0 kilometers, etc., and the expense required

for such construction is estimated at about 28,300,000 U.S. dollars. The yield is considered to be 6.0 tons per hectare (paddy) for the first crop and 3.0 tons per hectare (paddy) for the second crop, if possible.

3. PARTICULARS

3.1 Current Status and Problems

3.1.1 General Situation

(1) Natural conditions

The country of the Democratic Republic of the Sudan is situated at the north-eastern part of the African continent within 3°-23°N and 21°-39°E and is bounded on north-east by the Red Sea, on north by Egypt, on west by Libya, Tchad and Central Africa, on south by Zaire, Uganda and Kenya, and on east by Ethiopia. It has a land area of 2,505,813 square kilometers and is the largest belonging to the torrid and subtropical zones on the African continent.

The Sudan consists, for a greater part, of plains extending over the water system of the Nile River penetrating the country from south to north and the hilly eastern and southern parts with a peak of 3,089 meters. The Nile water system has one headstream originated from Lake Victoria, flows down through the valley in the southern hilly zone of the Sudan and enters the sudd region where it loses a voluminous amount of water through evapotranspiration, then flows north as the White Nile, joins the Blue Nile rising in Ethiopia, in the vicinity of the capital, Khartoum, then flows north as the Nile mainstream into Egypt and to the Mediterranean Sea.

The climate is typically tropic-continental with clear distinction of the dry and wet seasons. Except part along the Mediterranean, the wet season comes about in summer of May to September generally. Rain falls usually with tropical fronts going up north in March to June and down south in August to December. Thus, the duration of the wet season as well as the annual precipitation decreases from south to north (reference the following table), and the humidity shows a similar trend.

Average Monthly Precipitation in (mm)

Station	Approximate Location		J	F	M	A	M	J	J	A	S	O	N	D	Yearly Total
	Longi-tude	Lati-tude													
1. Wadi Halfa	31°E	22°N							2			1			3
2. Merowe	32°E	18°N						2	7	15	4	2			30
3. Khartoum	33°E	16°N				1	5	7	48	72	27	4			164
4. Kassala	37°E	16°N			2	5	14	27	100	124	60	7	2		341
5. Al Fasher	25°E	13°N				1	10	13	89	133	36	5			287
6. Kosti	32°E	13°N				4	18	47	111	143	60	22	2		407
7. Al Rosieres	35°E	12°N				15	60	125	183	218	153	30	5		789
8. Raga	26°E	8°N	1	1	15	56	150	165	223	254	192	78	10	1	1146
9. Yubo	28°E	6°N	5	23	63	102	187	220	169	212	234	170	51	15	1451

However, as the Sudan is a large country extending over 2,000 kilometers from south to north, the climate varies greatly, and the country is divided into three climatic zones. The northern arid or semi-arid zone with an annual precipitation of 0-400 mm reaches up to one-third of the whole area of the Sudan. The central savannah zone occupying one half of the Sudan is of an annual mean precipitation of 400-750 mm. This region is divided further into the central clay plain and the western Kordofan sands: Goz. The central clay plain is one of the most fertile regions in Africa but is of heavy clayish soil so that manual cultivation is difficult. The southern rainy zone has an annual mean precipitation of 750-1,500 mm, 90 percent of which occurs from April to October. This region consists of a low swampy area in the upstream of the Nile, hills and mountains lying south of the swampy area and a forest area stretching in the southernmost part.

North of 15°N, the temperature rises up to 41°C or higher in summer, while it is cold in winter, and it is not rare that a temperature below the freezing point is recorded. Further, in summer, there are dust storms generated. South of 15°N, the annual temperature difference is smaller than that in the north. In this region, the temperature changes not from summer to winter but from wet to dry season.

The yearly mean total discharge of the Nile is estimated at about 119,000,000,000 cubic meters of which 45,000,000,000 cubic meters is lost by evaporation from the rivers, swamps and Aswan High Dam so that the remaining 74,000,000,000 cubic meters is estimated to be the yearly mean flow. This flow is distributed to the Sudan and Egypt according to the agreement between both the countries in 1959, the allocation to the Sudan being 18,500,000,000 cubic meters about one half of which is presumed to be used as agricultural water. The yearly mean river discharge in 1/10 probable droughty year at Malakal about 450 kilometers south of Ed Dueim, upstream of the White Nile is estimated at about 22,000,000,000 to 26,700,000,000 cubic meters, and the monthly mean river discharges at the said point are as follows.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Flow	15	12	12	11	12	17	22	25	26	29	27	12	220

$1 \times 10^8 m^3$

The object areas of the preliminary survey are the following three located in 13°30' - 14°53'N on the left side of the White Nile in the vicinity of Ed Dueim, the capital of the White Nile Province, upstream of the Jebel Aulia Dam on the White Nile.

Name of Scheme	Gross Area (Fed.)	Location
Gasaba	47,430 (19,920)	15-60 km south of Ed Dueim
Banonab	8,500 (3,500)	17-47 km north of Ed Dueim
Shatawi	26,500 (34,620)	65-108 km north of Ed Dueim

In these areas, the yearly mean rainfall is 280 mm about 90 percent of which concentrates in four months of June to September. The relative humidity is generally low. Particularly, in February to May, its value at 12:00 hours is as low as 20 percent or less (Reference Table 3-1 (1)). The monthly mean atmospheric temperature ranges from 24.3°C (in January) to 32.7°C (in May), giving a relatively large annual difference as a tropical

climate. Monthly mean high and low temperatures are within the ranges of 32.1° - 41.1°C and 16.4° - 24.4°C respectively. During the past 30 years, a temperature as high as 46°C is recorded. On the other hand, in December to February, there are days with a low temperature below 10°C (Reference Table 3-1 (2)).

These object areas are the river-land of the White Nile and are thus, very flat topographically. They are located at an elevation of 375 to 378 meters above sea level and are submerged during the storing period (August to February) of the Jebel Aulia Dam and are dried up during the releasing period. The flooding depth is assumed to be about 0.2 to 2.0 meters.

(2) Political, economic and social conditions

The history of the Sudan are governed by two important factors throughout all ages, viz. (1) importance of the White Nile for the agriculture and economy and (2) cultural unbalance and religious difference between the northern and southern inhabitants. Great is the role of this country located on the boundary line of the "Arab Mohammedan world" and the "African world" in the Asia-African world.

Early in the 19th century, the country was controlled by Egypt and, subsequently from the end of the 19th century, was under colonial administration of Egypt and Great Britain jointly under the condominium agreement, but achieved independence in January 1956 as the Democratic Republic of the Sudan and was given a seat in the United Nations in November of the same year. In October 1971, the Chairman of the Revolutionary Council, Gaffar Mohamed Nemairi was elected as the first president of the Sudan and started a sole political party "Sudan Socialists Union" to date. Further, in February 1972, through mediation of the Emperor of Ethiopia, the dispute involving military strifes with the southern heathen power was settled successfully.

The administration is executed by 26 ministers including the president. For legislation, the People's Council having 207 seats is responsible. For local administration, the country is divided into nine provinces, and in the southern tribal area, autonomy by the headman of the tribe is carried out.

In the absence of an accurate national sensus, the population of the Sudan is given differently from material to material of statistics. But,

Table 3-1 (1) SUDAN METEOROLOGICAL DEPARTMENT

CLIMATOLOGICAL NORMALS

1941 - 1970

ED - DUEIM

ELEMENT	RELATIVE HUMIDITY % (29 YEARS)			CLOUD AMOUNT (0-8)			TOTAL	RAINFALL (MM) (30 YRS)					EVAPORATION PICHE (MM)	WIND	
								NO. OF DAYS			MAX. ONE DAY			PREVAILING DIRECTION (10 Years)	MEAN SCALAR SPEED (M.P.H)
MONTH	0600	1200	1800	0600	1200	1800		0.1	1.0	10.0	TOTAL	DATE			
JANUARY	38	25		1.7	1.8		0	0	0	0	0	-	14.0	NE	4
FEBRUARY	34	20		1.6	1.6		TR	0	0	0	0.7	11-1966	15.7	NE	6
MARCH	29	17		2.0	2.0		TR	0	0	0	TR	21-1965	18.2	NE	6
APRIL	26	16		2.1	2.1		4	0.2	0.2	0.1	57.0	27-1959	19.7	NE	6
MAY	32	20		2.6	2.8		8	1.1	1.0	0.2	47.6	1-1942	18.8	NE	6
JUNE	49	27		3.6	3.5		24	2.8	2.8	0.8	54.0	2-1964	16.0	SW	5
JULY	65	38		4.8	5.1		79	6.4	6.1	2.6	64.4	25-1943	10.9	SW	5
AUGUST	73	48		5.1	5.1		108	8.1	7.9	3.4	88.6	11-1942	7.7	SW	5
SEPTEMBER	67	41		3.8	3.9		47	4.3	4.2	1.6	78.0	10-1959	9.1	SW	3
OCTOBER	52	32		2.5	3.1		10	1.3	1.2	0.2	43.6	14-1946	12.5	NE	3
NOVEMBER	39	24		1.6	1.6		TR	0	0	0	5.3	3-1946	14.9	NW	4
DECEMBER	40	25		1.3	1.3		0	0	0	0	0	-	13.9	NE	4
YEAR	45	28		2.7	2.8		280	24.2	23.4	8.9	88.6	11-8-1942	14.3		

NOTES: (1) ALL TIMES ARE G.M.T. (SUDAN TIME MINUS 2 HOURS)

(2) TO OBTAIN: APROXIMATE EVAPORATION FROM AN OPEN WATER SURFACE PICHE FIGURES BY 0.5

Table 3-1 (2) SUDAN METEOROLOGICAL DEPARTMENT

(LAT 13°-59'N. LONG 32°-20' E. ALT380 M)

CLIMATOLOGICAL NORMALS 1941 - 1970

ED - DUEIM

ELEMENT	ATMOSPHERIC PRESSURE (MB)			AIR TEMPERATURE °C.									VAPOUR PRESSURE		
	STATION LEVEL (30 YEARS)			DRY BULB (30 YRS)			DAILY MAXIMUM (29 YRS)			DAILY MINIMUM (29 YRS)			(MB) (29 YRS)		
MONTH	0600	1200	1800	0600	1200	1800	MEAN	HIGHEST	DATE	MEAN	LOWEST	DATE	0600	1200	1800
JANUARY	969.0	965.8		20.3	31.2		32.1	40.0	12-1945	6.4	8.8	6-1949	9.3	11.3	
FEBRUARY	968.7	965.1		20.9	32.5		33.3	44.8	23-1956	17.1	6.0	10-1949	8.3	9.6	
MARCH	966.8	963.3		24.6	36.5		37.3	45.2	29-1953	19.8	11.2	7-1959	9.1	10.3	
APRIL	965.6	962.3		28.1	39.1		40.0	46.0	23-1944	21.7	18.1	8-1949	9.8	11.4	
MAY	965.3	962.2		30.3	40.1		41.1	45.7	23-1952	24.2	16.3	21-1949	13.7	14.8	
JUNE	966.3	963.4		29.7	38.4		39.6	45.4	3-1963	24.4	14.3	23-1956	20.1	18.1	
JULY	967.2	964.5		27.1	34.9		36.0	44.3	2-1962	23.4	14.2	7-1956	23.2	20.9	
AUGUST	967.4	964.9		26.1	32.8		34.0	43.6	11-1956	22.7	14.6	11-1952	24.6	23.2	
SEPTEMBER	967.0	964.0		27.3	34.7		35.9	41.4	21,29,1956	22.7	13.0	3-1956	24.0	22.6	
OCTOBER	966.3	963.2		26.5	36.7		37.9	41.6	27-1951	23.2	16.5	25-1948	20.3	19.4	
NOVEMBER	967.6	964.5		25.8	35.0		35.9	41.2	4-1957	20.7	10.7	29-1949	12.9	18.5	
DECEMBER	969.1	965.7		21.7	31.9		32.7	39.6	24-1943	17.2	5.4	24-1949	10.7	11.6	
YEAR	967.2	964.1		25.0	35.3		36.3	46.0	28-4-1944	21.1	5.4	24-1949	15.5	15.5	

according to the statistics in the 1974 World Almanac, it is about 17,300,000, about 8 percent being the urban population and the remaining 92 percent being the rural population which includes the nomads for about 40 percent reportedly. The growth rate of population is assumed to be 2.5 percent. According to the 1969/70 statistics, the labor force in the Sudan is about 6,440,000, 89 percent of which is engaged in the agricultural sector.

The population of the White Nile Province is 1,116,000 as of 1973 except the nomads, and about 93,000 people live in two cities of Ed Dueim and Kosti (as shown in the following table).

Perspective study of agricultural development for the Democratic Republic of the Sudan 1973

	Number of families	Male	Female	Total
Dueim Rural Area	16,576	330,691	318,359	649,050
Dueim Urban Area	4,662	14,102	12,727	26,829
Kosti Rural Area	71,383	192,751	191,292	384,043
Kosti Urban Area	12,153	36,808	29,761	66,569
Total	194,774	574,352	552,139	1,126,491

The capital of the province is Khartoum which forms, together with the other two cities of Khartoum North and Omudurman, a metropolis with a population of about 800,000. Two-thirds of the population speak the Arabic which is designated as an official language, but the remaining comprises a number of tribes living in the southern provinces and having their own languages.

The economy of the Sudan is dependent mainly on the agriculture, and more than 90 percent of the total export in 1975 (147,600,000 Sudan pounds) is occupied by the agricultural products such as cotton, peanuts and gum arabic, etc. Thus, the Sudan is an agricultural country, yet it is dependent on import for foodstuff such as wheat and sugar to an extent amounting to 30 percent of the total import.

In the following is illustrated the international balance of the Sudan as seen from the export and import as well as the reserve in foreign currencies.

Export and import

(Unit: 1,000,000 Sudan pounds)

	1970	1971	1972	1973	1974
Export	103.91	114.37	124.35	151.17	122.01
(Cotton)	63.67	69.91	72.84	84.31	43.26
Import	100.12	115.44	111.56	151.84	223.58
Trade balance	+ 3.79	- 1.07	+12.79	- 0.64	-101.57

Reserve in foreign currencies

(Unit: 1,000,000 US dollars)

Foreign currencies	21.6	27.9	30.3	44.9	97.9
SDR	0.1	-	5.3	16.4	26.4
Total	21.7	27.9	35.3	61.6	124.3

(Source: International Financial Statistics)

In 1974, the balance of the foreign trade was in the red in excess of 100,000,000 Sudan pounds, yet the reserve in foreign currencies showed no decrease. This may be accounted for by the loans and investment from the international organizations and foreign countries, and influx of the oil dollars from the Arab oil producing countries. The Arab oil producing countries envisage a "Sudan as a granary of the Arab countries" and are making investments positively for development of the agriculture and livestock raising.

Principal means of traffic in the Sudan are the road and railway. According to the statistics of 1973, the asphalted roads extend 449 kilometers, gravelled roads extend 1,694 kilometers, and unpaved roads extend 10,896 kilometers. The railway playing an important role as a means of transportation of the dry agricultural products such as cotton and peanuts extend up to 4,754 kilometers. There are two lines of railway departing from the capital, Khartoum. One goes north from Khartoum and is divided into two lines at Atbara, one leading to Wadi Halla near the Egyptian border, and the other to Port Sudan along the coast of the Red Sea. The other one is a line to Port Sudan via Wad Medani and Kassala. The main port is Port Sudan facing the Red Sea, and the trade cargos are put in and out through this port.

The medical service is the responsibility of the Ministry of

Health and Welfare, but the responsibility for operation of the local health centers and medical offices is shared with the local autonomies. Free medical service is offered by a number of hospital facilities. The employees of the national and private enterprises are granted social benefits equally. The physically handicapped and distressed persons are protected by the local autonomy concerned.

The currency is the Sudan pound, and 1 Sudan pound is 2.872 US dollars (since January 1959).

3.1.2 Agriculture and Agroeconomy

(1) Agriculture

1) Current status

Current status of land utilization and agriculture

Land utilization in the Sudan is illustrated in the table below. The arable land is estimated at 84,000,000 hectares including the cultivated land of 7,130,000 hectares.

Land Utilization in the Sudan

	Area (1,000 ha)	Percentage
Total area	250,581	100%
Land	237,600	
Rivers, lakes, etc.	12,981	
Farm land	84,000	35.35 (100.00)
Cultivated land	7,134	(8.49)
Arable land	76,866	(91.51)
Grassland	24,000	10.10
Forest	91,500	38.51
Miscellaneous	38,100	16.04

Source: Ministry of Agriculture 1976 (Quoted from the Report of Sudan-Egypt Import Promotion Survey Mission).

As shown in the following table, the mean area of plantation of the main crops in 1971 through 1973 is approximately 5,000,000 hectares comprising the irrigated field at 675,000 hectares (14 percent) and rain-fed field at 4,193,000 hectares (86 percent). Now seeing the use of the irrigated

fields, the largest is the area allocated for cotton at 40.6 percent, followed by sorghum at 27.2 percent and wheat at 12.1 percent, and these three crops occupy 80 percent of the irrigated field.

Total Area of Main Crops by Type of Irrigation

Crop Year	Area (1,000 ha)			
	Artificial	Rain-fed	Flood	Total
1965/ 66 - 1967/ 68	667.2	2823.3	54.3	3544.8
1968/ 69 - 1970/ 71	789.8	3202.3	61.4	4053.5
1971/ 72 - 1973/ 74	675.3	4157.2	35.8	4868.3
Percentage	13.87	85.39	0.74	100.0

Note: Mean value for three years each.

Source: Statistical Yearbook, 1973, Sudan.

In Table 3-2 are shown the areas of plantation and the produces of the main crops. As seen, the cotton which is the principal export crop is 500,000 hectares in the area of plantation and 626,000 tons in the produce, while the sorghum and millet which are the staple foods are 1,850,000 hectares and 1,723,000 tons, and 1,020,000 hectares and 349,000 tons, respectively, the areas of plantation of these crops, when totaled, constituting 56 percent of the whole. The benne-seeds are 950,000 hectares and 324,000 tons; peanuts, 690,000 hectares and 481,000 tons; wheat, 130,000 hectares and 193,000 tons; and maize, 17,000 hectares and 12,000 tons. In addition to the foregoing, there are cultivated legume, cassava, sweet potatoes, paddy rice, sugar cane, vegetables, fruits, gum arabic, etc.

Table 3-2 Areas of plantation and produces of main crops

Year	'62 - '64		'65 - '67		'68 - '70		'71 - '73	
	A	P	A	P	A	P	A	P
Cotton	446	409	470	504	480	688	500	626
Dura (Sorghum)	1,390	1,246	1,515	1,240	1,655	1,246	1,851	1,723
Dukhn (millet)	546	339	589	282	664	374	1,019	349
Peanuts	325	266	380	303	388	319	694	481
Benne	459	169	434	152	591	193	953	324
Wheat	34	41	80	86	123	134	132	193

Year	'62 - '64		'65 - '67		'68 - '70		'71 - '73	
	A	P	A	P	A	P	A	P
Maize	33	23	24	14	38	25	17	12
Total	3,233		3,492		3,939		5,166	

Note A: Area of plantation (in 1,000 ha)

P: Produce (in 1,000 tons)

Figure represents mean value for three years each.

Source: Statistical Yearbook 1973, Sudan.

Now looking the change in the area of plantation, there is an increase of about 2,000,000 hectares noted in ten years after 1962-1964 (average 3,230,000 hectares) as shown in Table 3-2. This increase is due mainly to the increasing areas of plantation of staple foods, that is, sorghum and millet, and other crops such as peanuts and benne which are cultivated on rain-fed fields. The wheat the consumption of which is increasing recently has an increase of only about 100,000 hectares in area, but the rate of increase is exceptionally high.

The yields per hectare of the main crops, as seen in mean values of 1971-1973, are: cotton, 1.34 tons; sorghum, 0.87 ton; millet, 0.46 ton; peanuts, 0.78 ton; benne, 0.35 ton; wheat, 1.27 tons; and maize, 0.69 ton. Except cotton, the crops are low in the yield per hectare. Further, with respect to the crops cultivated on rain-fed fields (such as sorghum, millet, peanuts and benne), a decreasing trend is observed in the yield per hectare except sorghum (Figure 3-1).

Now looking the cropping pattern, a rotational system is employed as shown in the following table, and while the land use rate varies from 50 to 100 percent, it is generally low.

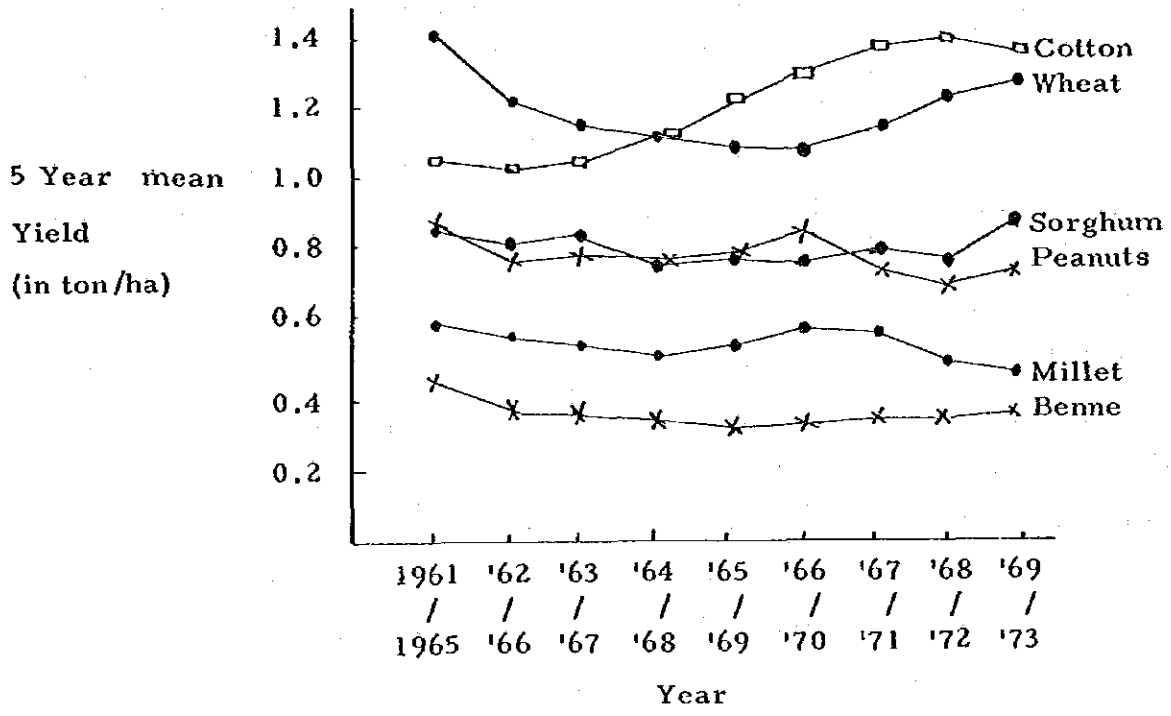
Rotational Cropping Pattern and Land Use Rate

Type	Rotational cropping pattern	Land use rate (%)
1	Cotton - Peanuts - Wheat - In fallow	75
2	Cotton - In fallow - Peanuts - In fallow - Wheat	50
3	Cotton - Sorghum - In fallow	67

Type	Rotational cropping pattern	Land use rate (%)
4	Cotton - Peanuts or Sorghum - Wheat - Cotton	100

(Note) Hearing survey.

Fig. 3-1 Trend of Mean Yields of Main Crops



(Note) The values are given in five year transitional mean.

Source: Statistical Yearbook, 1973, Sudan.

There are two forms of agriculture employed, namely, modern mechanized agriculture based on large tractors and traditional extensive agriculture, the former being carried out mainly on the irrigated fields. The tractors introduced in 1962-1972 number 7,253 (Table 3-3) 80 percent of which are large tractors with a horsepower of 60 or more (Table 3-4). Further, tractor machines and combines are also introduced (Tables 3-5, -6). On the other hand, the extensive agriculture is carried out, in almost all cases, on the rain-fed fields. It is not only low in labor productivity but unstable in yield being subject to the climatic conditions or, more particularly, rainfall.

Table 3-3 Number of tractors introduced

Manufacturers	Introduced by agents	Introduced by Government	Total
Massey-Ferguson	1,692	1,400	3,092
Beylarus	125	936	1,061
For	973	-	973
Nuffield	759	135	894
International Harvester	560	40	600
Zettor	100	450	550
John Deere	46	-	46
Universal	18	-	18
Allis Chalmer	-	9	9
Steyr	4	-	4
I.M.T.	4	-	4
ZT-3000	-	2	2
Total	4,281	2,972	7,253

Source: Quoted from the Report of the Sudan-Egypt Development Import Promotion Survey Mission.

Table 3-4 Proportion by horseower of tractors

Horsepower range	Proportion (%)
34 - 45 HP	4.3
50 - 55	15.2
62 - 67	63.8
70 - 75	16.7

Source: Quoted from the Report of the Sudan-Egypt Development Import Promotion Survey Mission.

Table 3-5 Numbers of operating machinery drawn by tractors

Disc plow (unit)	Ridger (unit)	Sowing machine (unit)	Multi purpose blad (unit)	Trencher (unit)	Offset disc harrow (unit)	Disc harrow with sowing machine (unit)	Ridging disc
1,006	3,347	220	324	287	175	3,321	31

Source: Quoted from the Report of the Sudan-Egypt Development Import Promotion Survey Mission.

Table 3-6 Number of combines introduced, 1962-1972

Manufacturer (Model)	Number
Massey Ferguson (400-389)	76
John Deere (530, 630, 360)	97
Class (Matader, Mercater)	269
Ramsomes (902, 1001)	21
ZMAJ (780)	50
Russian (CKM-4)	102
Arbos (780)	10
International (3-41)	4
Case-(600)	4
Miscellaneous	4
Total	637

Source: Quoted from the Report of the Sudan-Egypt Development Import Promotion Survey Mission.

Livestock raising is one of the important industries of the Sudan. The output of meat in 1971/72 is estimated at 480,000 tons. The number of the heads of domestic animals during the last five years is shown in the table below.

Heads of domestic animals

(Unit: 1,000 heads)

	1969/70	1970/71	1971/72	1972/73	1973/74
Cattle	12,300	12,600	12,900	13,100	13,400
Sheep	10,300	10,600	10,900	11,922	12,280
Goat	7,200	7,400	7,800	7,800	8,040
Camel	2,500	2,500	2,500	2,460	3,030
Donkey	630	640	-	-	-
Fowl	-	19,000	-	-	-

Current status of agriculture in the White Nile Province

The area of plantation of the main crops is about 282,000 hectares including the irrigated field of about 90,000 hectares (31.8%) and rain-fed field of 192,000 hectares (Table 3-7). The irrigated field is operated by the Agricultural Corporation for 94 percent so that the irrigated land cultivated by the individuals is only 6 percent.

The cotton is the largest among the crops planted in the irrigated field at 57,000 hectares, followed by sorghum. Further, wheat, peanuts, benne and vegetables are cultivated more or less. As the fertilizer, urea is used for only cotton and wheat.

The rain-fed field consists of 24,000 hectares of mechanized agriculture and 168,000 hectares of traditional extensive agriculture. In the rain-fed field, sorghum, peanuts, benne and millet are cultivated, but cotton and wheat are not.

Cropping seasons of the main crops are as shown in Table 3-8.

The heads by kinds of the domestic animals are illustrated in Table 3-9.

Table 3-7 Areas of plantation and yields of main crops.

(1) Irrigation (Crop year 1975/76)

Crops	ED DUEIM Area (ha)	ED DUEIM Produce (ton)	KOSTI Area (ha)	KOSTI Produce (ton)	Remarks
Cotton	35,700	-	18,523	-	Agricultural Corporation
Sorghum	7,308	8,700	19,495	23,208	65 HP tractors: 60 units (including crawler type, 3 units)
Peanuts	1,470	1,260	252	180	
Benne	147	63	-	-	
Wheat	733	873	441	525	Harvesters: 3-4 units (rented)
Vegetables	-	-	504	-	Planting rate: 83%
Total	45,358	-	39,215	-	
Cotton	1,264	-	1,680	-	Small Pump Scheme
Sorghum	532	507	25	24	
Peanuts	-	-	-	-	
Benne	-	-	-	-	
Wheat	204	243	260	310	Private
Vegetables	403	-	743	-	
Total	2,403	-	2,708	-	

(2) Rainfed (Crop year 1973/74)

Crops	Area (ha)	Produce (ton)	Remarks
Cotton	0	0	Mechanized Crop Production
Sorghum	-	20,965	
Peanuts	-	-	
Benne	-	721	
Wheat	0	0	
Vegetables	-	-	
Millet	-	-	
Total	24,515	-	
Cotton	0	0	Traditional Crop Production
Sorghum	-	37,084	
Peanuts	-	32,855	
Benne	-	98,422	

Crops	Area (ha)	Produce (ton)	Remarks
Wheat	0	0	
Vegetables	-	-	
Millet	-	10,190	
Total	168,000	-	

Source: For (1) and (2), hearing survey and the material furnished by Mr. Ahmed Khalid Shouk (Agricultural Inspector, ED DUEIM).

Table 3-8 Sowing and harvesting seasons of main crops

	White Nile Province*		Gezira Province **	
	Sowing	Harvesting	Sowing	Harvesting
Cotton	Aug. 1 - 25	Feb. - end of Mar.	Jul. 25 - Mid-Aug.	Feb. - Apr.
Sorghum	Aug. 1 - 25	Mid-Dec. - Mid.-Jan.	Jun. - Jul.	Oct. - Nov.
Peanuts	Jul. 1 - 20	Early Dec.	Jun. - Jul.	Oct. - Nov.
Wheat	Nov. 1 - 20	Mid-Mar.	Mid-Oct. - Mid-Nov.	Late in Mar. - Apr.
Egyptian bean	Nov. 1 - 20	Mar.	-	

(Note) * Hearing survey at the Agricultural Corporation, White Nile Province.

** The Gezira Scheme, Past and Present.

Table 3-9 Number of livestock raised in White Nile Province

Livestock	Number
Camel	60,239
Cattle	1,216,100
Donkey	7,567
Sheep	2,244,193
Goat	222,542

Source: Hearing survey(from Agricultural Inspector, ED DUEIM).

Current status of rice cultivation

In the Gezira Province, rice cultivation has been tried under the technical assistance fo China since 1973 in a pilot farm of 8.4 hectares (20 feddans). Apart from this, rice cultivation was carried out in 1976 in an rea of 6,300 hectares (or 1.13 hectares per farm household). The method of cultivation and farming work is of direct sowing on dry field, as shown in Table 3-10 and seral varieties of Indica type are planted. Water management is of intermittent irrigation every four to seven days. As the fertilizers, urea and triple super phosphate of lime are used in an amount of 380 kilograms per hectare (applied in four batches) respectively. The harvest time is 90 days (early maturing) to 140 days (late maturing) after sowing, and the yield in dry paddy is varying greatly from 1.67 to 7.14 tons per hectare. Now looking the relationship between the cultivation period and the yield, the largest yield is obtained by seeding in late June, and the yield is decreasing at earlier or later seeding time. For the plowing, harrowing and seeding works, 65 HP tractors are used, and for the harvesting work, harvesters for wheat are used.

Table 3-10 Rice cultivation and farming works in Gezira Province.

Main works	Means of work	Details of the work, etc.
Land preparation Plowing, Harrowing Levelling	Plow Disc harrow Steel rod for traction	9-12 inches plough; plowing depth, 30-35 cm; 1 to 2 times operation.
Fertilization and sowing	Drill seeder	Seeding in late June; seeds, 120-170 kg/ha; seeding depth, 3 cm. Fertilization: urea (effective component 46%) 43-49 kg/ha; triple super phosphate of lime (effective component 46%) 172-196 kg/ha.
Control		
Additional fertilization		10 days after germination, urea 43-49 kg/ha. 35 days after germination, urea 43-49 kg/ha. Young panicle growing period, urea 43-49 kg/ha.
Water control		Irrigation every 4 to 7 days, very shallow water (3-4 cm).

Main works	Means of work	Details of the work, etc.
		Irrigation stopped 15 days before harvesting.
Weed control	Aircraft Tractor	Weed killer used; herbicidal effect not enough.
Pest and insect control	Manpower	Manual weeding, 35 men/ha for the 1st weeding (to be performed 7 days after the seeding or later).
Harvesting	Harvester	Harvester for wheat used.
Drying		Harvested paddy is immediately placed in stock house. With harvesting delayed, excessive drying occurs.

(Note) Test varieties: C9, C11, C14, C15, C43, IR22, etc.
Main tractor: 65 HP.

Source: Hearing survey by Dr. George I. Ghobrial (Agricultural Research Corporation) and Prof. Abdel Mohsin Hassan El Nadi (Khartoum University).

Table 3-11 Soil analysis

Area	Depth (cm)	PH (1:5)	$CaCO_3$ (%)	E.C. on Satex mmho/cm	Mechanical Analysis				C.E.C. me/100g	Exchangeable Cations me/100g		Soluble Cations me/Litre Saturation Extract			Soluble Anions me/Litre Saturation Extract		Nitrogen (%)	Organic Carbon (%)	C/N
					Coarse Sand(%)	Fine Sand (%)	Silt (%)	Clay (%)		Na	K	Na	Ca	Mg	Cl	HCO_3			
Banonab (1)	0 - 30	8.4	1.0	0.38	1	7	26	66	37	2.2	2.2	1.0	1.4	0.3	3.6	1.9	0.030	0.38	13.0
	30 - 70	8.9	1.0	0.88	2	6	21	70	39	6.1	2.0	6.0	1.4	0.7	6.2	2.2	0.023	0.30	13.0
	70 - 120	8.5	1.0	2.60	1	5	23	70	41	3.5	1.3	18.0	3.2	1.5	17.7	1.5	0.023	0.28	12.0
	120 - 160	8.3	1.0	3.99	1	4	22	72	39	9.6	1.4	38.0	5.7	4.2	26.3	1.1	0.021	0.31	15.0
Banonab (2)	0 - 5	7.4	1.0	0.88	5	11	33	50	52	1.9	2.3	5.0	3.8	1.8	5.8	3.5	0.190	5.00	28.0
	5 - 40	8.0	1.0	0.46	3	12	23	61	55	1.6	1.5	2.5	1.8	0.6	3.5	2.0	0.090	0.67	7.0
	40 - 80	8.4	1.0	0.40	3	10	24	62	55	4.0	1.2	2.5	0.9	0.4	2.1	2.4	0.032	0.38	12.0
	80 - 120	8.7	1.0	0.46	3	9	25	63	56	6.9	1.1	3.0	0.9	0.4	2.4	2.7	0.041	0.28	7.0
	120 - 160	8.6	1.0	0.74	0.5	9	25	64	53	6.9	0.9	7.0	1.8	0.4	3.3	2.4		0.20	
Shatawi (3)	0 - 15	8.9	1.0	0.38	2	9	18	70	56	1.6	2.3	2.0	1.0	0.7	2.2	2.0	0.021	0.25	12.0
	15 - 40	9.1	1.0	0.40	2	7	17	73	57	2.6	2.2	2.5	0.6	0.6	2.3	2.1	0.016	0.23	14.5
	40 - 90	8.9	1.0	0.49	2	7	17	73	57	3.4	2.0	3.5	1.4	0.8	3.0	2.3	0.016	0.22	12.0
	90 - 150	9.0	1.0	0.52	2	7	16	74	61	6.0	1.8	2.0	0.9	0.6	2.4	2.7		0.22	
Shatawi (4)	0 - 5	7.6	1.0	0.80	2	7	27	63	62	1.8	2.6	4.5	2.3	1.2	6.4	2.9	0.177	3.59	20.0
	5 - 40	8.5	1.0	0.25	2	3	24	68	55	2.2	1.6	1.5	1.0	0.2	2.2	1.5	0.136	0.33	
	40 - 80	8.3	0.5	0.31	1	5	23	70	53	3.1	1.4	2.5	1.0	0.2	2.6	2.0	0.023	0.23	10.0
	80 - 130	8.3	0.5	0.46	1	5	23	70	54	3.6	1.2	3.0	1.0	0.6	2.8	2.0	0.012	0.23	19.0
	130 -	8.5	0.5	0.40	1	6	21	69	58	3.0	1.1	3.0	1.1	0.7	3.0	1.5		0.23	

Source: Reconnaissance Soil Survey, White Nile Pump Scheme, Soil Survey Department, Wad Medani, 1972.

In the White Nile Province, the rice is cultivated by the immigrants from Nigeria for some scores of ares in the vicinity of Ed Dueim. The method of cultivation is of direct seeding on dry field, but after seeding and germination, the field is flooded by the increased water of the White Nile. According to the observation at the site, establishment of the seedling was exceptionally bad, but the growth thereafter was good.

Rice is also cultivated in the sourthern provinces of the Sudan, but the data are not available.

Soil conditions of the object area of preliminary survey

According to the result of the approximate soil survey (Table 3-11) conducted in the Shatawi area and a part (3,600 hectares) of the Banonab area, the soils in this area are divided into two groups of Pellusterts and Udifluvents (by the 7th approximate method of U.S.D.A. System of the Soil Conservation Service). Either of them is of heavy clay fine particle structure containing clay in an amount of 60 to 70 percent and of very low permeability. The soils are slightly alkaline with a pH value of 7.4 to 8.9, but there is no accumulation of poisonous salts observed.

Soil Classification

Order	Sub-Order	Great Soil Group	Sub-Group
Vertisol	Ustert	Pellustert	Udorthentic Pellustert
Vertisol	Ustert	Pellustert	Entic Pellustert
Entisol	Fluvent	Udifluvent	Vertic Udifluvent

Source: Reconnaissance Soil Survey, White Nile Pump Scheme, Soil Survey Department, Wad Medani, 1972.

Further, the object area turns into a river bottom in the flood season (August to February) and is swampy with a variety of weeds growing there. The weeds so far as observed are:

Cyperus rotundes L. (Sedge),

Phragmites communis Trinius (Reed),

Echinochloa P. Beauv. (Reed mace),

Nymphacaseae, and

Eichhornia Kunth (Water hyacinth).

In these areas, sorghum, etc. had been cultivated reportedly under the rain-fed system before the Jebel Aulia Dam was constructed. Thus, the areas seem to be relatively fertile.

Agricultural test and research organization

The agricultural research stations comprise four regional stations and seven substations (Table 3-12). The administration and control of research activities of these stations are carried out at the Gezira Agricultural Research Station which is one of the regional stations, and the research activities are carried out in ten fields according to the speciality such as crop physiology, cotton breeding, etc. (Table 3-13).

The appropriation for research activities is said to be 2,800,000 Sudan pounds (¥2,100,000,000) from the general account and 250,000 Sudan pounds (¥187,500,000) from the research and development expense.

2) Problems

Main problems in the rice cultivation are given below:

- Little experience and technically unskilled in rice cultivation;
- Mechanized labor saving rice cultivation required to compensate labor shortage:
- Because of heavy clay soil, harrowing and levelling works be carried out with utmost care;
- Unstable germination and establishment of seedling; and
- Low yield with great variation.

There are some tests and researches carried out on rice cultivation, and the items of research relative to rice cultivation in 1976 include variety comparison, fertilization, weed control, etc., or total 12 items, but the summation of the results of researches up to the previous year is yet forthcoming (Table 3-14).

Table 3-12 Agricultural research organizations and locations

Organization		Location	Long.	Lat.
Regional Station				
1. Gezira Agric. Research Stn.		Wad Medani	33°29'E	14°24'N
2. Hudeiba	"	Ed-Dammer, Northern Province	33°56'E	17°34'N
3. Kenana	"	Abu Naama, Blue Nile Province	34°08'E	12°44'N
4. *Yambio	"	Yambio, Equatoria Province	28°24'E	4°34'N
Research Substation				
1. Khashm El Girba Research Substation		Khashm El Girba	35°44'E	15°08'N
2. Guneid	"	Guneid	33°19'E	14°48'N
3. Soba	"	Khartoum		
4. Shambat	"	Khartoum North	32°30'E	15°40'N
5. Kadugli	"	Kadugli, Kordofan Province	20°43'E	11°00'N
6. Maatug	"	Wad El Ghorashi	32°35'E	14°11'N
7. Sennar	"	Semar	33°37'E	13°33'N

(Note) * Yambio Agric. Research Stn. : No research programme conducted since 1964.

Source: List of Research Officers and Administrators, Ministry of Agriculture, Food and Natural Resources, Agricultural Research Corporation, Sudan, 1975.

Organization of Agricultural Research, Ministry of Agriculture, Food and Natural Resources, Agricultural Research Corporation, Sudan.

Table 3-13 Fields of research activities

Research field	Location
Agronomy and Crop Physiology Section	Wad Medani
Botany and Plant Pathology Section	"
Cotton Breeding Section	"
Entomology Section	"
Horticultural Research Section	"
Soil Science Section	"
Statistics and Agric. Economics Section	"
Silvicultural Section	"
Plant Breeding Section	"
Forest Research Section	Khartoum

Source: List of Research Officers and Administrators, Ministry of Agriculture, Food and Natural Resources, Agricultural Research Corporation, Sudan, 1975

(In addition to the foregoing, researches on food processing, rubber, wild animals and fishery are also performed.)

Table 3-14 Test items relative to rice cultivation (1976)

1.	Rice Variety Trial
2.	Time of Nitrogen Application in Rice
3.	Zinc Application in Rice
4.	Spacing, Seed-rate and Nitrogen Level in Rice
5.	Rice Cultivars Planting-date Trial
6.	Nitrogen and Phosphorus Requirement of Rice under Gezira Conditions
7.	Chemical Weed Control in Rice
8.	Hand Weeding in Rice
9.	Frequency of Irrigation in Rice
10.	International Upland Rice Observation Nursery
11.	International Rice Observation Nursery
12.	International Rice Salt and Alkali Tolerance Observation Nursery

Source: Programme of Work Season 1976/1977, Agricultural Research Corporation (Agronomy Section).

(2) Agricultural Economy

1) Current status

Development plan

The present regime of the Sudan has formulated a new five year economic development plan with emphasis placed on agricultural sector (1970/71 - 1974/75) and executed the same from 1970/71 but, in 1974, extended the plan period for two years to the final year set in 1976/77. This plan is contemplated with a total investment of 386,000,000 Sudan pounds and is designed to develop the G.D.P. of 752,000,000 Sudan pounds in 1970 to 816,000,000 Sudan pounds in the final year of the plan with an annual growth rate of G.D.P. during the plan period set at 7.6 percent.

Agricultural production

Agriculture is the pivot of the economy of the Sudan, and it accounts for about 40 percent of the G.D.P. In 1972/74, G.D.P. was 809,300,000 or 47.9 Sudan pounds per capita.

Export and import of agricultural products

In the total export of 1975, agricultural products such as cotton, peanuts and gum arabic occupy 96 percent and amount to 141,000,000 Sudan pounds. Particularly, cotton occupies 60 percent of the total export and has thus a monocultural character. The main export items are illustrated in Tables 3-15 and 3-16 in terms of the quantities and amounts respectively. On the other hand, the import of foods such as wheat, sugar and other agricultural products constitute 30 percent of the total import amount and amounts as high as 65,000,000 pounds. The import of Wheat was 205,000 tons in 1972. But, on account of the powerful production increase plan of the government, the import has now decreased appreciably.

Table 3-15 Export quantities of main agricultural products

(Unit: 1,000 tons)

Output product	1969	1970	1971	1972	1973
Raw cotton	172	232	241	249	227
Cotton seeds	65	69	55	25	16
Peanuts	82	64	115	115	139
Sorghum	2	2	37	60	102
Benne seeds	113	82	86	87	105
Gum arabic	47	48	43	44	36
Cotton seed oil	13	9	34	31	-
Cotton oil cake	130	184	154	150	11
Cattle and sheep*	237	194	143	174	91

* Unit: 1,000 heads

Table 3-16 Export and import amounts of main agricultural products

(Unit: 1,000,000 Sudan pounds)

Products	1974		1975	
	Import	Export	Import	Export
Textile raw yarm	-	57.8	-	66.8
Material rubber, etc.	0.6	15.3	0.3	8.5
Vegetable oils and raw Materials	0.1	48.2	0.1	53.6
Cereal and products	9.7	5.0	8.5	2.5
Sugar	30.0	-	38.7	-
Coffee, tea, etc.	8.7	0.5	7.0	0.3
Feeds	-	3.6	-	4.1
Vegetables and fruits	1.6	1.2	1.4	0.8
Tobacco	2.0	-	3.4	-
Livestock	-	5.8	-	1.4
Meat and dairy products	0.7	3.8	1.0	0.1
Leather	-	4.8	-	3.0
Lumber, etc.	3.7	-	2.6	0.1
Other agricultural products	1.5	-	2.1	-

With respect to sugar, 165,000 tons was imported despite of production of 100,000 tons in 1973. But, upon completion of the large scale projects, that is, Hajar Asulayah Sugar Project (scheduled to be completed by the end of 1975; 110,000 tons) and Kenana Sugar Project (to be completed by the end of 1977; 350,000 tons), the output will fully satisfy the domestic demand and further provide an appreciable surplus for export.

Prices of agricultural products

According to the survey of 1975, the prices ex farmyard of agricultural products are as given below.

Item	Price (£S/ton)
Sorghum	72.5 - 116
Wheat	145
Millet	145

The price in domestic market of rice is £S 250/ton ex rice mill in Wad Medani. The imported rice is £S 141/ton C.I.F. Port Sudan in June 1976.

Agricultural scale and income

The forms of agriculture in the Sudan are classified largely into the modern mechanized agriculture and conventional extensive agriculture. Most of the projects where the modern mechanized agriculture is carried out are operated as national farms by the Agricultural Development Corporation, and the farmers are engaged in the agriculture as tenants. The farming works are, for a greater part, mechanized, and the control of irrigation water, fertilization and administration of chemicals are performed by the Corporation. The farmers receive the devidends of the profit on "a predetermined profit-sharing basis."

For example, in the Gezira project, the profit from the cotton which is the main product, or the sales minus direct expenses, is apportioned according to the following percentage:

Government	36 percent
Tenant farmers	47 percent
Gezira Board (Corporation)	10 percent

Reserve for price maintenance	2 percent
Local administrative organization	2 percent
Social development expense	3 percent

The prospected income from the crops other than raw cotton are entirely distributed to the tenant farmers. The projects where the mechanized agriculture is exercised are classified into four types of (1) projects provided with irrigation facilities, (2) projects with pump irrigation, (3) projects with flood irrigation and (4) projects with rain-fed cultivation. Mean area of plantation and mean annual income of the tenant farmers in the respective types of projects in 1970/71 are as shown in the following table.

Type	Project	Area (1000 Fed)	Planted area (1000 Fed)	Tenant (1000 tenants)	Mean Planted area (Fed)	Mean income[1] £S
(1)	Gezira project	2,000	1,387	93.6	14.8 (22.0)[2]	110
	Khashm El	330	270	22	12 (15)[2]	75
	Girba project					
(2)	Blue Nile		275	47	6	70[3]
	Northern Province[4]		300	75	4	40
(3)	Tokar and Gash delta		160	32	5	
(4)	Rain-fed area[5]				650-1,000	650-1,000

1) Annual income per tenant farmer (including the household workers).

2) Mean tenanted area.

3) Income from 8 feddans of planted area.

4) Almost all projects are of privaterly owned land and are operated commercially.

5) The government lends the land to the private enterprises in a unit of 650 to 1000 feddans (273 to 420 hectares) and extends financial and technical supports for establishment and management of the enterprises.

The number of farm households in 1970 is estimated at 1,600,000 of which only 300,000 households are receiving the benefits of the modern agriculture as tenant farmers. Further, there are about 200,000 households of

seasonal farming laborers employed at the time of cultivating and harvesting the crops, and thus about 1,100,000 other farm households are engaged in the conventional extensive agriculture. The area of plantation under the extensive agriculture is assumed to be about 7,000,000 feddans so that the mean planted area per household is estimated at about 7 feddans (2.94 hectares). Mean income of the farm households performing the extensive agriculture is illustrated in the following table. The gross income per household is 27.25 Sudan pounds, but it is estimated that 10 Sudan pounds is required as various production costs. Therefore, the annual net income per household is only 17.25 Sudan pounds.

Balance of Farm Household in Conventional Extensive Agriculture

Crop	Planted area (Fed)	Unit area output (kg/Fed)	Total output (kg)	Price (£/ton)	Total output amount (£)	Self consumption		Gross income	
						Quantity (kg)	Amount (£)	Quantity (kg)	Amount (£)
Sorghum	4.10	250	1,025	20	20.50	625	12.50	400	8.00
Rubber	1.00	130	130	50	6.50	30	1.50	100	5.00
Peanuts	0.75	250	190	30	5.70	30	0.90	160	4.80
Starchy roots	0.90	2,000	1,800	6	10.80	600	3.60	1,200	7.20
Raw cotton	0.25	120	30	75	2.25	-	-	30	2.25
Total	7.00				45.75		18.50		27.25

Distribution mechanism

The export and import of the cotton, peanuts, gum arabic and other important agricultural products are undertaken by the Corporation, while the domestic market facilities and trade are entrusted to the commercial agents. These agents also act as a money lender to the farmers and has an organization called "Sheil". Under such organization, the smaller brokers are given loans from the big leading brokers and make a loan to farmers in cash or kind commensurate with the prospected output and recover in return all of the agricultural products from the farmers. The fees are exorbitant and become a significant factor reducing the will of the farmers for the production increase. Underdeveloped traffic means is one of the factors hindering the development of the markets in the Sudan. A greater part of the dry agri-

cultural products such as cotton and benne are carried to Port Sudan by means of railway, but the fresh vegetables and frozen foods are not adequate for transportation by the railway which is poorly equipped. Road is the primary means of transport, but only 449 kilometers in the urban areas are paved. Facilities for storage of fresh vegetables and frozen foods are scarcely available. Dry agricultural products are stored in open-air space.

Agricultural extension activity

The agricultural extension activities are carried out by the management of the provincial governments in 13 extension offices under control of the Ministry of Agriculture, Food and Natural Resources. In some provinces and regions, an Extension Advisory Committee is formed by the directors of the offices concerned, leaders of the cooperative associations and leaders of the farmers to give guidance and advice for the extension activities in the area.

The agricultural cooperative associations are limited to the areas of jurisdiction of the nationally operated agricultural corporation and are not really present in the areas where the traditional agriculture or livestock raising is carried on. Many of the cooperative associations are present not as an association for mutual benefits of the farmers but as a "government-sponsored agency". These cooperative associations support liberation of the farmers from the burden of the exorbitant interests by the commercial financial agents or, more specifically, from the "Sheil". However, these activities are much limited and are not satisfactory. On the privately owned land, there are 266 projects of pump irrigation, and in each of these projects, an agricultural cooperative association is organized by the farmers and is performing supply of the fuel, mechanical parts and fertilizers, mediation of the loans from the Agricultural Bank and organization of the markets. The two cooperative associations of nationally operated farms having pump irrigation are made loans from the financing budget in "Five Year Plan". In the Gezira, Kosti and Singa areas where the irrigation facilities were provided and mechanized agriculture was carried on, there were 120 cooperative organizations in 1969/70. In the rain-fed cultivation areas of Blue Nile, Kassala and Kordofan where mechanized agriculture is carried on, there are 161 cooperative associations, and they are furnishing machines for harvesting. They receive technical supports from the Ministry of Agriculture, Food and Natural Resources and loans for

purchase of tractor and other machines and the expense of agricultural operation from the Agricultural Bank. In the case of the former, the term of repayment is four years, and in the case of the latter, it is of short term. This Agricultural Bank also serves for mediation of the selling and deducts the fees from the sales. In Gezira area, there are 30 market cooperative associations.

Education and training are carried out in four stages, namely,

(1) Agricultural secondary school (under the Ministry of Education),

(2) Agricultural training colleges and school (under the Ministry of Education),

(3) Faculty of Agriculture (Khartoum University), and

(4) Training after graduation (studying abroad).

Labor situation

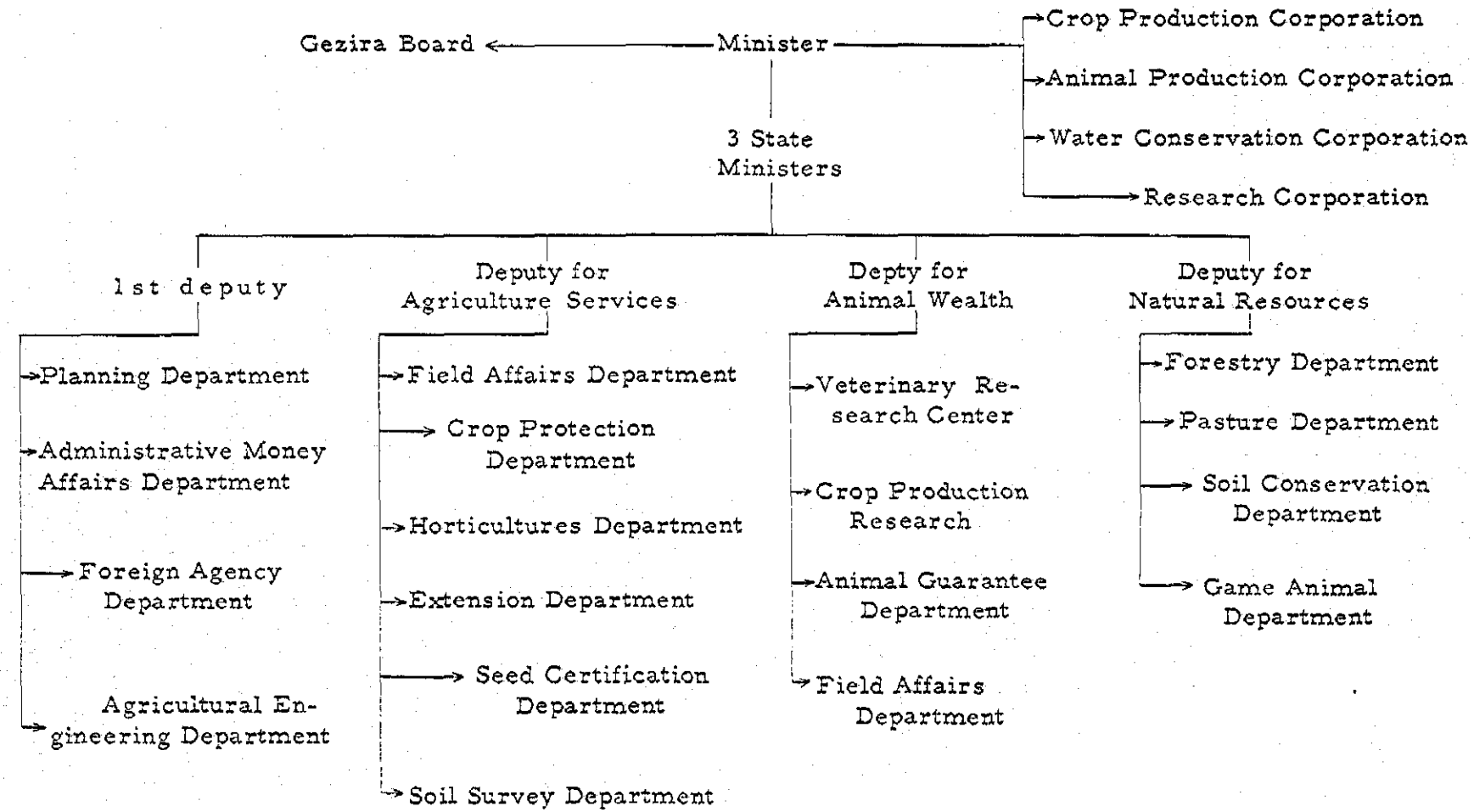
According to the survey of 1967/68, 2.5 percent of the urban population and 2.0 percent of the suburban population were the unemployed. But, in 1972, 15 to 20 percent of the urban population was assumed to be unemployed. From the fact that the population of Khartoum increased sharply from 450,000 to 800,000 in 1955 to 1970, the movement of people from the rural to urban areas is assumed to be one of the causes of such increase of unemployment. According to a certain survey, 50 percent of the population of Port Sudan and 30 percent of the population of Wad Medani and El Obeid each are assumed to be the immigrants from the rural areas.

In the rural area, the number of the seasonal workers out of employment and that of the latent unemployment are not known. In the nationally operated farms, there is a shortage of workers to be employed for picking cotton in the harvest season, and to compensate such shortage, the workers are introduced from the western and southern provinces.. Such workers number as high as 60,000 in the Gezira project alone.

Organization of the Ministry of Agriculture, Food and Natural Resources

As shown in Chart 3-2, the organization of the Ministry of Agriculture, Food and Natural Resources is such that under the Minister, there are three State Ministers under whom there are four Deputies taking care of the departments of the planning, administration, etc.; agricultural services;

Chart 3-2 Organization of the Ministry of Agriculture, Food and Natural Resources.



livestock raising, etc.; and forestry, etc., respectively. The Agricultural Development Corporation including the Gezira Board is a national organization under direct control of the Minister.

2) Problems

The agricultural sector occupying 40 percent of G.D.P. is the pivot of the economy of the Sudan, and any problem in the agricultural economy is significant in that it has an influence on the national economy of the Sudan. In the following will be discussed the problems in the current situation of the agricultural economy and measures to cope with such problems.

Export agricultural products

The monocultural productive structure of agriculture with cotton accounting for 60 percent of the total export means that the trade balance of the Sudan is subject to the weather or the trend of demand for cotton in the world. In order to get rid of such unstable economic situation and expect stable development of the economy, it will be required to diversify the export products through production of cash crops succeeding the cotton.

Establishment of the self-supporting system of foodstuff

Although the Sudan is an agricultural country, it is dependent on import for supply of wheat, sugar, rice, tea, coffee, etc. Therefore, establishment of a self-supporting system of these products upon grasping the trend of demand of the people leads to improvement of the trade balance.

Dual structural agriculture

The agriculture in the Sudan is of dual structure of modern mechanized agriculture and traditional extensive agriculture, and there is a great difference in the productivity as well as profitability between them. The modern sector is represented by the projects developed in the basin of the Nile in the central provinces. In these projects, the capital is furnished well, and the agricultural productive activity is carried out over a vast cultivated field under an organized scheme. Therefore, the productivity is relatively high, and the livelihood of the farmers engaged in the agriculture as tenants is comparatively stabilized. On the other hand, the traditional extensive agriculture holds a greater part of the land as well as labor resource, yet it is very low in the productivity and profitability. Further, between the large landowners and

the small farmers, there is a considerable difference in the area of owned land, as that is, 300 feddans from 10 feddans. The small farmers have no capital allowance for modernization. In order to correct such difference due to the dual structure or in the extensive agricultural sector and thus improve the productivity and profitability, it is required for the public organizations to extend financial and technical supports based on a long ranging prospect.

"Sheil" system

In the commercial distribution system called "Sheil", the brokers purchasing the agricultural products in advance payment demand the farmers for exhobitant interests and fees. This is one of the great factors discouraging the farmers for expansion of the production. It is essential, therefore, to reform the distribution system, allow the farmers to utilize the public financial organizations and thus liberate them from the "Sheil".

Improvement of storing and processing facilities

Presently, there are little facilities for storing and processing of perishables and frozen foods, while the cereals and cotton are stored in openair space. In order to maintain the quality and insure stable supply of the agricultural products under adequate prices, it is important to improve or expand the storing and processing facilities.

Imporvement of distribution and transport means

The area of production of the current main agricultural products of the Sudan extends over the basins of the Blue Nile and the White Nile, but such area is located 1,000 kilometers or more apart from Port Sudan which is the only trade port of the Sudan. The agricultural productive area will extend to south, resulting in greater length of transport to Port Sudan. Presently, the central provinces are connected to Port Sudan by railway and road. But, the railway is now old and at the limit of transporting capacity with shortage of the cars, while the road is scarcely paved. It is thus urgently required for stabilization of the prices of agricultural products and appropriate introduction of the necessary machines and materials to improve the port facilities in Port Sudan as well as the railway and road facilities from the production area to the consumption area and export port.

Social development and agricultural extension activities

Presently, about 40 percent of the farmers are said to be the nomads. In this respect, efforts should be exerted for improvement of the irrigation and drainage facilities and other infrastructures and also for improvement and extension of the agricultural techniques so that the nomad farmers would settle in their places and that the farmers would have the agricultural techniques improved and the livelihood stabilized. Further, it is also required to reduce the difference between the urban and rural areas through improvement of the educational and medical service facilities and rural electrification.

3.1.3 Irrigation and Drainage

(1) Current status

Nile river basin

As shown in Figure 3-2, almost all the irrigated areas in the Sudan exist along the Nile, and almost all the proposed areas are also situated along the Nile. The existing and proposed irrigation areas in the basin of the Nile are shown in Table 3-17 and Figure 3-4.

Table 3-17 Existing and Proposed Irrigation Areas in the Nile River

Schemes	Gross Area Commanded in Hectare			
	Gravity Irrigation	Pumping Irrigation	Flood Irrigation	Total
1. Existing Irrigation Areas				
A) Government Schemes				
- Schemes on the White Nile		18,060		18,060
- The Guneid Pump scheme		12,600		12,600
- Schemes on the main Nile		15,960		15,960
- The Gezira Schemes	420,000			420,000
- The Sendi Bains			21,000	21,000
- The Dongola Basins			16,800	16,800
B) Private Pump Schemes		438,480		438,480
Sub-total	420,000	485,100	37,800	942,900
2. Proposed Irrigation Areas				
A) Government Schemes				
- The Managil extention	336,000			336,000
- The Kenana extention	504,000			504,000
- The Afbara extention	210,000			210,000
- Irrigation from Jonglei Canal	210,000			210,000
B) Privates Pump Schemes		577,500		577,500
Sub-total	1,260,000	577,500	—	1,837,500
Total	4,000,000	2,530,000	90,000	6,620,000

SUDAN IRRIGATION Published by the Ministry of Irrigation and Hydro-Electric Power in 1957.

SUDAN

FIG 3 — 3 IRRIGATED AND RAINFED PROJECTS — HYDROPOWER PROJECT

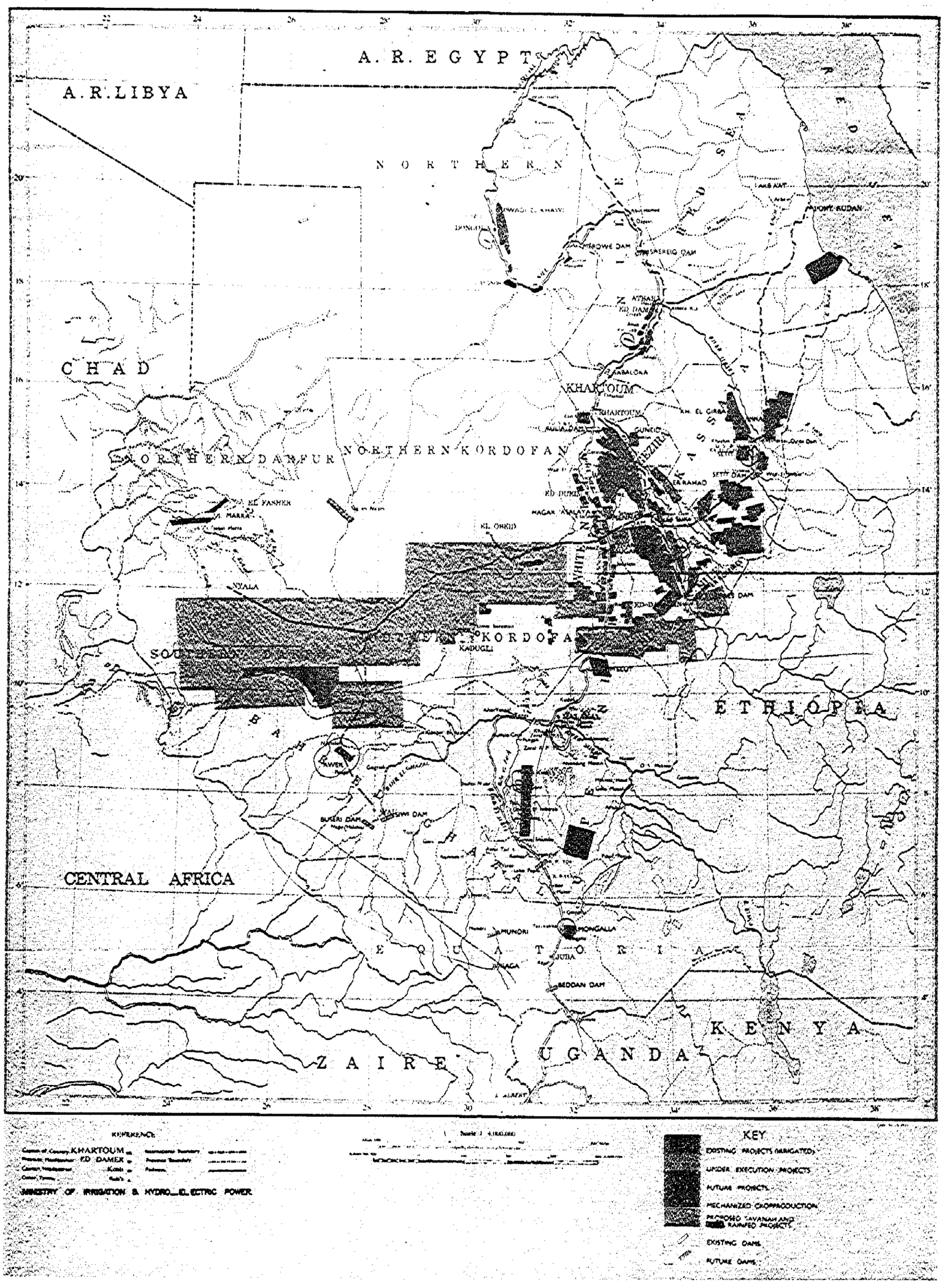
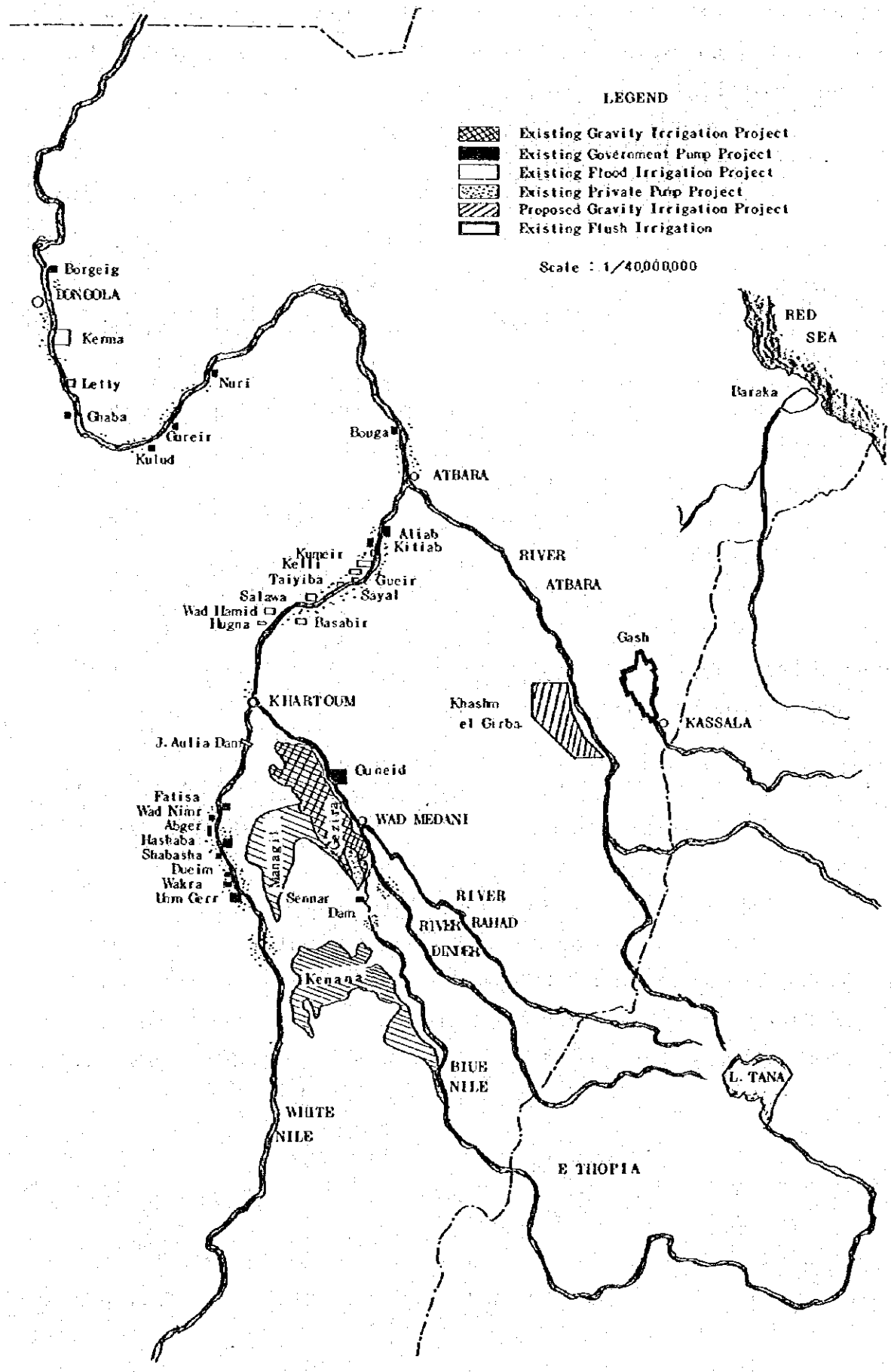


Fig. 3 - 4 EXISTING AND PROPOSED IRRIGATION AREAS IN THE NILE BASIN



"Government Pump Schemes on the White Nile" - The national pump projects on the White Nile shown in the following table are controlled and operated by the White Nile Schemes Board, one of the agricultural development corporations.

Station	Gross Area	Pump	Discharge
	(ha)	(Nos. x HP)	(m^3/hr/unit)
Fatisa	2,310	3 x 195	3,600
Hashaba	3,570	4 x 195	3,600
Wad Nimr	920	3 x 29	1,080
Abger	2,940	4 x 75	3,600
Shabasha	1,010	2 x 50	2,600
Dueim	1,180	3 x 75	2,400
Wakra	1,390	3 x 50	2,600
Umm Gerr	4,750	4 x 195	3,600

In any of the foregoing pump stations, one pump is held as a standby, and all pumps are driven by diesel engines. In order to irrigate the proposed area, the static head required for the pump at the time of full water in the Jebel Aulia Dam is 3 meters, and the cropping schedule is made so that the maximum water requirement may occur at the time of the required static head within 4 meters. The largest in the gross water requirement among the foregoing projects is the Abger project at 1.02 l/sec/ha for the benefited area. On the other hand, the smallest in the gross water requirement is the Umm Gerr project at 0.63 l/sec/ha for the benefited area.

"The Guneid Pump Scheme" - This project was completed in 1965. As a project of this type, it is said to be one of the large projects in the tropical Africa. Management and operation are made by the Sudan Gezira Board which is a typical agricultural development corporation. The project is outlined below.

- Benefited area 12,600 ha
- Type Vertical axis centrifugal pump, 4 units
- Bore 45 inches

- Engine — Diesel, 1,250 HP
- Discharge — 10,800 m^3/hr/unit
- Static head — 19 m
- Delivery pipe — 8 feet in diameter 1,100 m in length

"Government Pump Schemes on the Main Nile" - The national pump projects developed along the Main Nile include the following, and they are controlled by the Ministry of Agriculture, Food and Natural Resources.

Station	Gross Area	Station	Gross Area
	(ha)		(ha)
Debeira	840	Nuri	1,680
Borgeiy	1,890	Bavga	1,470
Ghaba	1,176	Aliab	2,016
Kulud	2,100	Kitiab	2,478
Gureir	840	Gandatie	1,470

These projects are in use of centrifugal pumps and diesel engines. The maximum static water head is 12 meters.

"Gezira Gravity Irrigation Schemes" - After completion of the pump irrigation facilities for 100 hectares in 1911, the benefited area was increased gradually, and upon completion of the Sennar Dam on the Blue Nile in 1925, the irrigation was transformed mainly to the gravity system. Now, it is one of the largest projects of the longest history in the world with a benefited area of 420,000 hectares (1957).

The trunk channel of the project is of the following dimensions.

- Maximum discharge — 168 m^3/sec
- Bottom width — 42.6 m
- Side slope gradient — 1 : 2
- Water surface width — 60 m
- Designed water depth — 4.35 m
- Designed flow velocity — 0.75 m/sec
- Canal gradient — 1 : 15,400

"The Shendi Basin" - This represents the flood irrigation projects developed on the river land of the Main Nile between Khartoum and Atobara and

includes the following

Location	Gross Area	Location	Gross Area
	(ha)		(ha)
Hanga	840	Guaieir	1,260
Wad Hamid	3,780	Taiyiba	2,940
Basabir	2,100	Kelli	4,620
Salaiva	2,940	Kumer	1,260
Sayal	1,260		

In these projects, there are provided simple gates for irrigation in use of the variation of the water level of the Nile. Consequently, irrigation is not practicable in the dry season when the river stage is lower than the elevation in the project area.

"The Dongola Basin" - This represents the projects developed in the vicinity of Dongola down the Sendi Basin for flood irrigation as in the case of the Sendi Basin projects and comprises two sub-projects, Kerma 13,860 hectares and Letti 2,940 hectares. In the project, a tube well irrigation is contemplated with 16 inch diameter tube wells bored for compensation of the unstable flood irrigation.

Preliminary survey object area

The object area forming part of the river land of the White Nile is an area subject to flooding and drying up with change in the water level of the dam stated in the foregoing, and in the dry-up season, it is used as a grass land for livestock raising. The flooding depth is assumed to be about 2.00 to 0.5 meters, but in the Gasaba area (Figure 3-5), there is a big island in the river, and the main stream runs down between the right-hand shore of the river and the island. Between the left-hand shore and the island, the flooding is shallow at about 0.5 meter in the flood season of the White Nile. Thus, the area is well conditioned for development as compared with the Shatawi (Figure 3-6) and Banonab (Figure 3-7) areas.

Jebel Aulia Dam

This dam was constructed in 1933 - 1937 on the White Nile 80 kilometers upstream or south of Khartoum. The dimensions are:

- Total length	5,000 m
- Length of masonry dam	1,693 m
- Length of embankment dam	3,307 m
- Greatest height of masonry	22 m
- Approximate total cubic of structure	1,000,000 m^3
- Reservoir level	377.20 m
- Low summer level	370.75 m
- Quantity of water stored	3,000,000,000 m^3
- Length of reservoir	300 km

J. Aulia Dam and preliminary survey object area

As stated above, the foregoing three areas are subject to flood or dry up depending on the operation of this dam, and the dam is operated accoring to the following criteria,

(1) That the first storage of water is commenced in mid-July and continued until the water level reaches 376.50 meters in mid-August,

(2) That the second water storage is commenced in mid-September and continued to a full water level of 377.20 meters in mid-October, this water level being maintained until the end of January, and

(3) That the stored water is released gradually from the early part of February until the whole quantity is released by the end of March.

Thereafter, the river discharge is allowed to run down as it is.

The pump station in Ed Dueim which is the central city of the project area is located 190 kilometers upstream of the dam, and according to the record of water level there, the annual lowest water levels are as follows;

Jun 30, 1973	EL 372.68 m
Jun 1, 1974	EL 372.74 m
May 31, 1975	372.68 m

For the highest water level, there is a record of 377.65 meters

Fig. 3-5　G A S A B A 地区

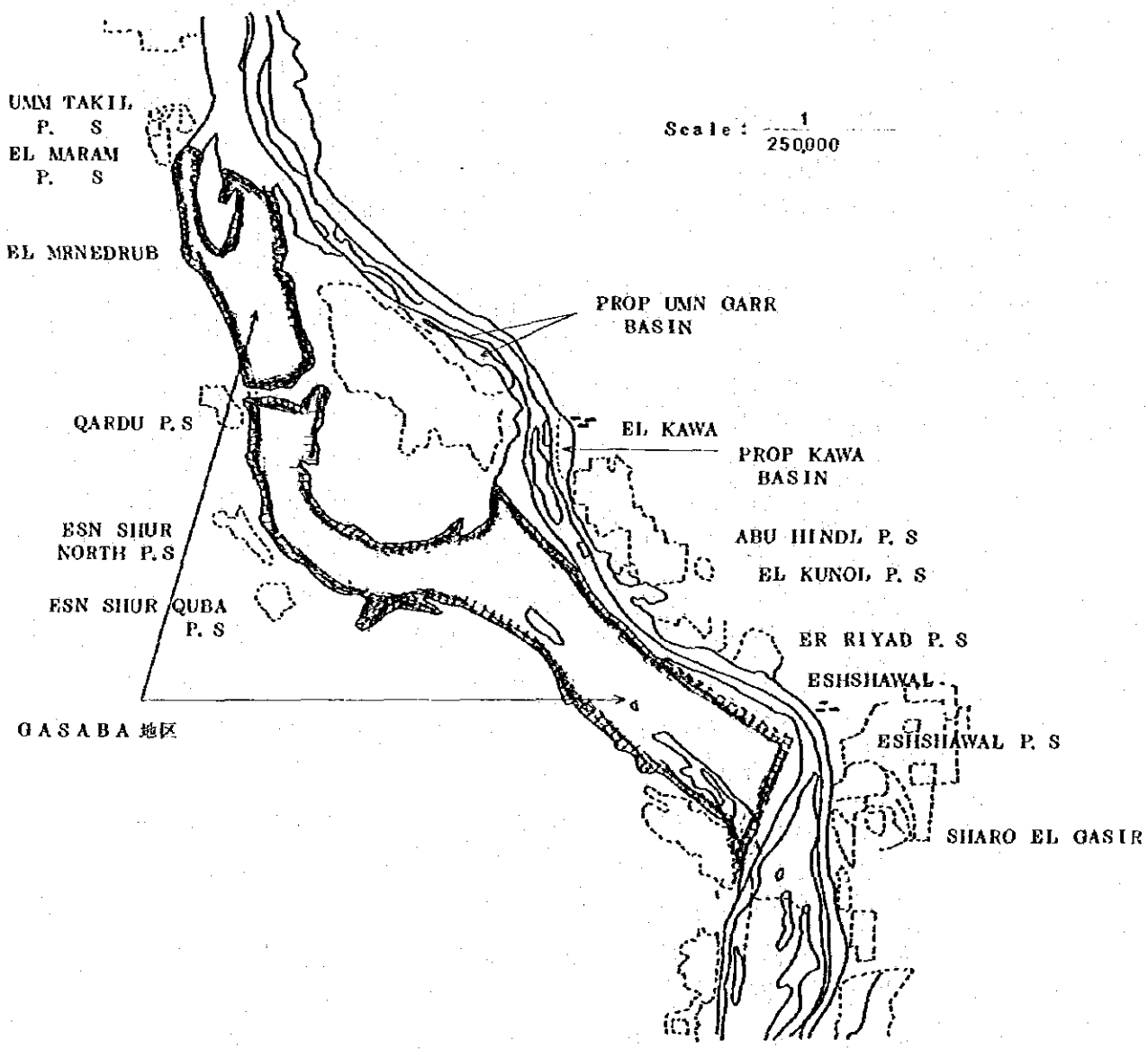
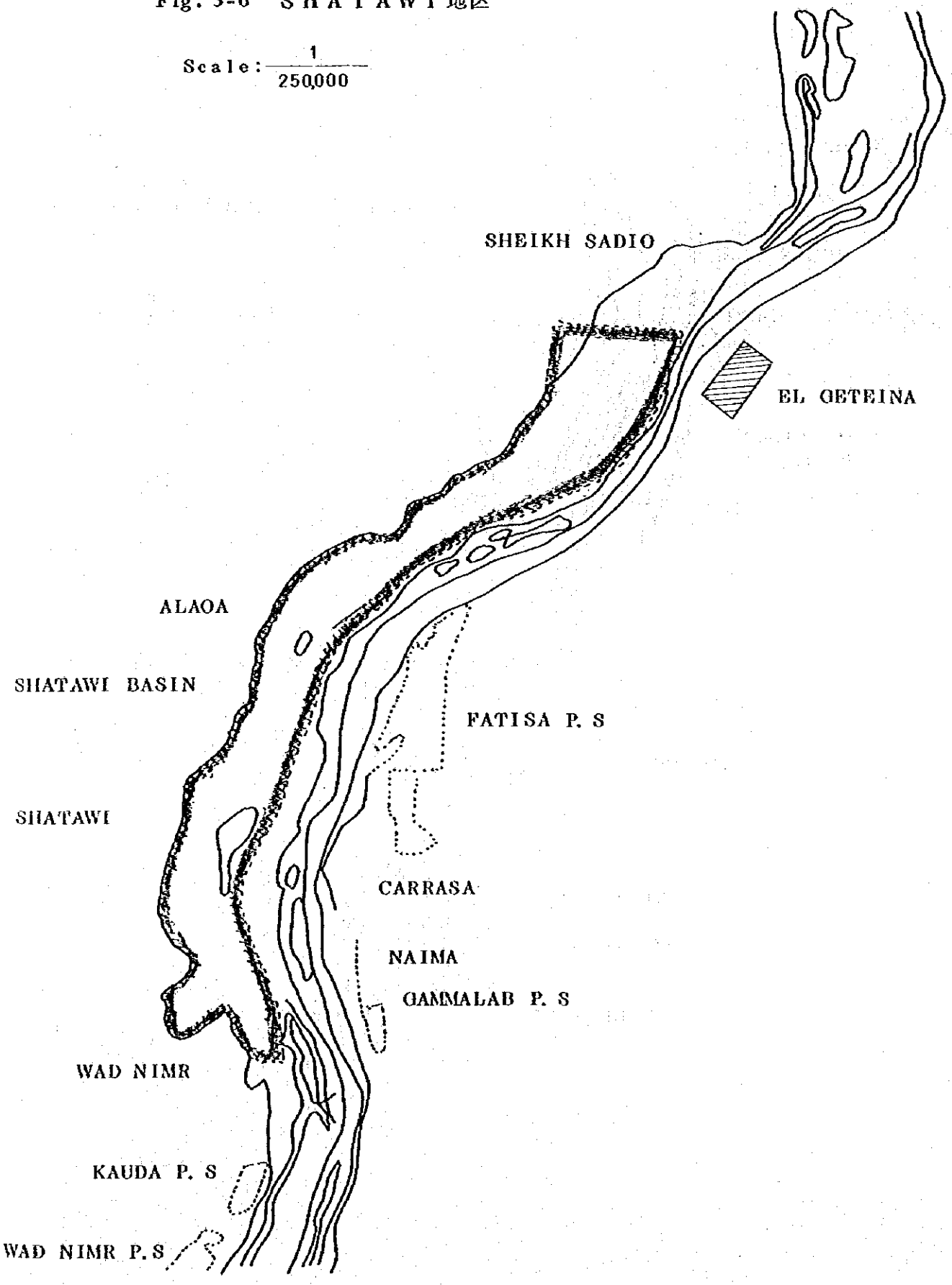


Fig. 3-6 S H A T A W I 地区

Scale: 1/250,000



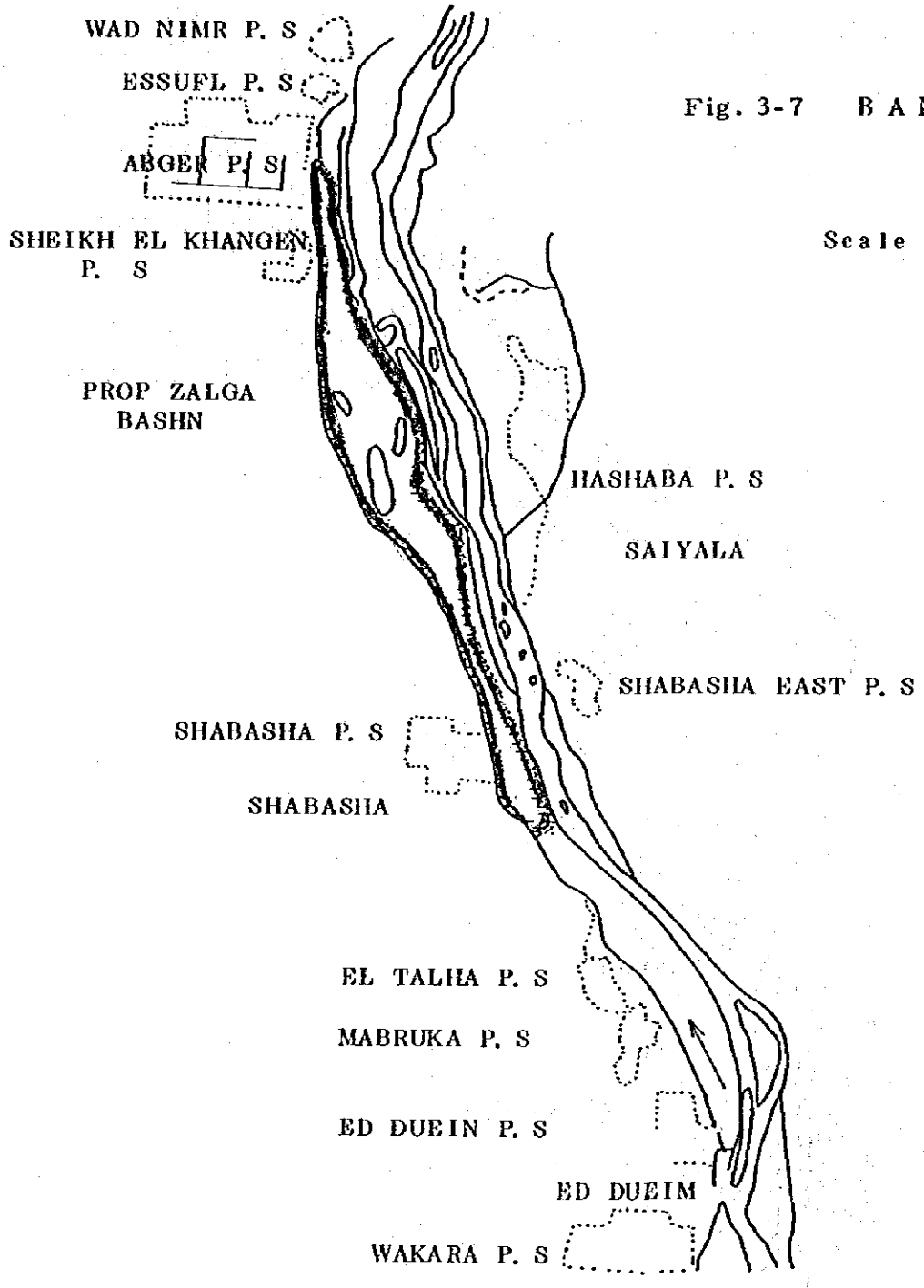
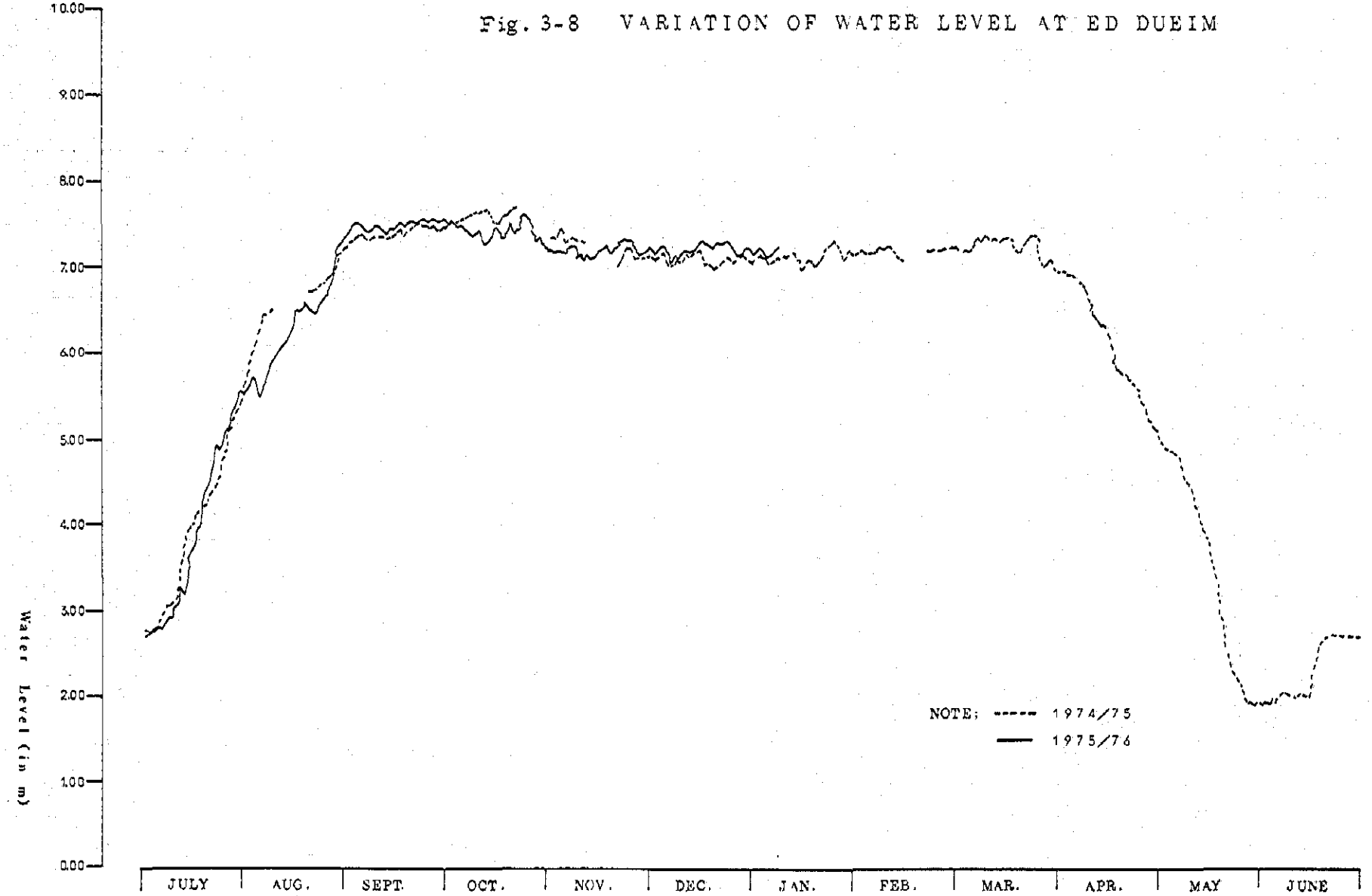


Fig. 3-7　B A N O N A B 地区

Scale : $\frac{1}{250,000}$

Fig. 3-8 VARIATION OF WATER LEVEL AT ED DUEIM



noted October 15, 1975.

Such high and low water levels constitute one of the basic factors for planning the construction and the operation in the project area.

The records of observation of the water levels (1974/75 and 1975/76 hydrological years) at Ed Dueim, are illustrated in Figure 3-8.

Soil quality

These areas consist of heavey of ilty clay with very high viscosity. The water channels in the areas are generally left as excavated, or not lined with any materials and the banking is not compacted, but no water leak is observed.

Water requirement

In the Sudan, a standard is provided for the water requirement of the respective irrigation areas. The water quantity required for normal growth of the crops is given by m^3/Feddan/day or m/Fedan, the former value being called the "Factor" and taken as a standard of nomination of the water requirement. The "Factor" is defined as follows.

Gross factor: Daily consumptive use of water per feddan (0.42 hectare) of all irrigated land except the dwelling lot and expressed in m^3, or

Crop factor: Daily consumptive use of water expressed in m^3 per feddan of the actual area of plantation.

This "factor" is variable subject to climatic and soil conditions. The "Factor" for the largest water requirement is called the "peak factor" which is used as a standard in determining the water channel cross-section or pump capacity. The water conveyance loss is taken as 8 percent, and the water operation loss as 5 percent. Examples in the Gezira area are illustrated below.

Peak crop factors (October - November)

Type of canal	minors	Majors	Branches	Main canal
Crop factor	34	32	30	28
Grass factor in case cultivation area is 40% of total	13.5	13.0	12	11.8
Grass factor in case cultifation area is 50% of total	17	16	15	14

Mean factors in minor canals (in October)

Northern are	27m^3/crop Feddam/day	Value decreasing
Central area	25 "	with increasing
Western area	24 "	rain toward south.
Southern ares		

Total consumptive use (July - December)

Crop	Field			Minor Head		Main Canal Head			
						With Losses		Losses & Escape	
	m^3/Fed.	m	mm/day	m^3/Fed.	m				
Cotton	3,400	0.81	4.5	3,500	0.83	3,700	0.88	3,900	0.93
Dura	2,300	0.55	3.0	2,400	0.57	2,500	0.60	2,600	0.62
Lubia	2,300	0.55	3.0	2,400	0.57	2,500	0.60	2,600	0.62
Wheat	1,800	0.43	2.4	1,900	0.45	2,000	0.48	2,100	0.50

Consumptive use

	Field			Minor Head		Main Canal Head			
						With Losses		Losses & Escape	
	m^3/Fed.	m	mm/day	m^3/Fed.	m				
Cotton	2,100	0.50	5.5	2,200	0.52	2,300	0.55	2,400	0.57
Lubia	1,150	0.27	-	1,200	0.29	1,250	0.30	1,300	0.31
Wheat	1,550	0.37	5.3	1,600	0.38	1,650	0.39	1,700	0.41

The method of irrigation in the preliminary survey area and its vicinity is unexceptionally of pump irrigation, and for the pump irrigation projects in the vicinity of Ed Dueim, the following standards are provided.

Gross area - Feddan	3,835 Feddans
Average gross factor - Season	13.2 m^3/Fed/day
Cropping proportion	59%
Average crop factor - Season	22.4 m^3/Fed/day
Peak month gross factor	17.3 m^3/Fed/day
Peak month crop factor	29.3 m^3/Fed/day

These standards for water requirement are provided for cotton, dura, lubia and wheat. For rice, available data are meager although there is a test of rice cultivation by irrigation conducted for the past three years in an area of about 20 feddans (8.4 hectares) in the Gezira area under the guidance

of China. Prticularly, in the area projected for development, rice cultivation is exercised only by the immigrants from Nigeria by the traditional method in an area of barely 20 ares located near the Gasaba area.

Further, at the high land in the periphery of the present project area for development, there are existing 30 national pump stations (with bores of 6" or more) which are related to the present project. Further, in the other area near the project area, there are 13 pump irrigation projects occupying an area of about 40,000 feddans (16,800 hectares). The Sudanese Government had a plan to integrate these pump stations into 8 to 10 ones and requested a survey to the McDonald Co., Ltd. in England. The Government requested the consideration for execution of the project without causing influences upon the existing pump schemes and inland water drainage facilities.

Outline of Existing National Pump Scheme

A. Gasaba right bank area

Name of Scheme	Existing Gross Area (Feddan)	
(1) Boto	530	Serving also as P.S.
(2) El Taif	7,077	
(3) El Falah	523	
(4) Garous Elnag	1,028	
(5) Muna	1,052	
(6) Elsalam	1,092	
Total	11,301	

B. Gasaba left bank area

Name of Scheme	Existing Gross Area (Feddan)	
(1) El Futuh	2,307	
(2) Hayafa	2,080	
(3) Gamarel Gadoo	2,700	
(4) El Tagwa	1,900	
(5) Fardous	760	
(6) El Ranma	3,685	
(7) El Atsham	1,400	Serving also as P.S.
(8) El Mahala	1,400	
(9) El Mihdreeb	3,900	

	Name of Scheme	Existing Gross Area (Feddan)
(10)	Abu Gimki	970
(11)	El Magam	3,166
(12)	UM Talal	3,300
(13)	El Rowda	2,005
	Total	29,618

In the Gasaba area, the following four pump schemes are installed, although their locations are not identifiable.

	Name of Scheme	Existing Gross Area (Feddan)
(1)	El Shur Hayafa	1,200
(2)	El Shur Aba	1,955
(3)	El Shur Goba	1,500
(4)	El Bcaha	272
	Total	4,927

C. Banonab area

In the upstream end of the area, the Dreig pump scheme is located, but this scheme seems to have no particular relationship with the present project.

D. Shatawi area

	Name of Scheme	Existing Gross Area (Feddan)	
(1)	El Khanger	4,900	Serving also as P.S.
(2)	Goz Elbaid	1,607	
(3)	Abger	10,044	
(4)	Wad Nimer	2,628	
(5)	El Rahawat	6,164	
(6)	El Mabbrour	924	
(7)	El Bhshra	4,300	
(8)	El Ereifab	1,057	Serving also as P.S.?
(9)	Himir	1,401	
(10)	El Waseem	264	Location not indentified.
(11)	El Bara	1,500	Serving as P.S.?

	Name of Scheme	Exist Gross Area (Feddan)
(12)	El Ekhailio	975
(13)	Ash Shatawi	594
	Total	36,358

Drainage

The drainage channels in the Gezira project are designed according to the following standards.

Catchment area (Fed.)	Estimated run-off (m^3/Fed./day)	Capacity of drain (m^3/sec)
1,000	15 (0.41 l/sec/ha)	0.174
2,000	12 (0.33 ")	0.270
3,000	11 (0.30 ")	0.382
4,000	10 (0.28 ")	0.463
5,000	9 (0.25 ")	0.521
10,000	7 (0.20 ")	0.810
15,000	6 (0.17 ")	1.041
20,000	5.5 (0.15 ")	1.273
30,000	4.8 (0.13 ")	1.667
40,000	4.4 (0.12 ")	2.037
50,000	4 (0.11 ")	2.315
100,000	3.3 (0.09 ")	3.819

As it was found in the field survey that the road with a clayey sub-grade course in the desert was generally muddy with deep ruts to cause a serious hazard to the traffic, the drainange is by no means negligible in the project area.

Miscellaneous

(1) About 100 kilometers upstream of Ed Dueim along the White Nile, there is Kosti City where a cement factory is located.

(2) About 80 kilometers north-east of Ed Dueim, there is a quarry for aggregate (apparently sandstone), and the stone materials of the quarry are used for stone pitching of the revetment or for pump houses.

(3) In the project area, there is a heliport presently.

2) Problems

In the following will be discussed the points to be considered in the feasibility study conducted hereafter.

Establishment of benefited area

This project is of a large scale rice cultivation development so that in establishing the benefited area, it is important to position the area properly through thorough investigation of any future development programs in the vicinity of the area.

Form of agricultural operation

For introduction of the rice cultivation into this country of little experience in it, it will be necessary to establish an integrated plan for plantation, water distribution and fertilization and agro-chemical application. From such a point of view, the "tenant system" employed in the other areas of mechanized agriculture with the planning, control and operation conducted by the agricultural development corporation and the farmers engaging in farming works as tenants, is a reasonably considerable farming form for the present project area when the investment effect is taken into account.

Topographic survey

The currently available topographic maps are of old age and low accuracy so that it is desirable to take aerial photos of the p ject area in a/ dry-up season and prepare topographic maps of a scale of 1/5,000 to 1/10,000 (with 25 cm contour lines). Except the Banonab area, the other two areas are vastly located so that the actual survey including the benefited area for drainage will take a considerable time and cost.

Irrigation system

The preliminary survey object area dries up for two months during the period of irrigation under the influence of the operation of the J. Aulia Dam. Presently, therefore, the pump irrigation must be contemplated, but no electricity is available for power so that generators are to be used. The benefited area being large, however, it will be necessary to examine the economic effect and investment efficiency including the installation, operation and maintenance costs along with the places of installation and number of the pumps. Gravity irrigation will also be enabled upon operation of the Jebel

Aulia Dam so that a study on the governmental basis will be required.

Irrigation plan

At the present time, there is no standard available for the water requirement for rice crop irrigation. Thus, it is desirable to collect and arrange the data on rice crop irrigation in the Gezira area and use them as a reference in planning the water requirement and, if possible, conduct a study upon the result of investigation in a test farm at the site.

Drainage plan

There is absolutely no data available for drainage of paddy field. Thus, it is required to study the drainage plan of the project area in the future survey.

Construction work

There is substantially no road which is maintained well in the vicinity of the project area. For the navigation on the White Nile, only small ferries are available. Thus, improvement of the traffic network by land and water which is fundamental for transportation of the materials, machinery and instrument as well as laborers for the construction works and for operation of the project after completion is a subject requiring urgent study. The construction work is preferably scheduled in the dry-up season from the early part of February to mid-August. Even in the flooding period, the water depth is assumed to be about 2.0 meters at the largest, the highest water level will seldom change sharply because of the large river basin and is stable at a height of 377.60 meters so that there will be little problems involved in the construction work only if the wave height is taken into consideration. For the drying period is included the rainy season of from June to September. However, the monthly mean maximum rainfall is 2,108 mm in August according to the records from 1941 to 1970 which is a value causing little influence onto the execution of construction works so that execution of the construction works throughout the year will be possible.

3.1.4 Technical Cooperation

The Arab Fund for Economic and Social Development dispatched an agricultural development survey mission to the Sudan from September 1974 to February 1975 and set up an agricultural development basic plan for ten years

from 1976 to 1985. The details are indicated in the "Basic Programme for Agricultural Development in the Democratic Republic of the Sudan (1976-1985): Resume", Kuwait, October 1976, by Arab Fund for Economic and Social Development (AFESD). For the area along the White Nile, the said Programme included the rehabilitation, renewal, and uniting plan of the irrigation pumps, etc., but for the present irrigation rice crop development project, it mentioned nothing specifically.

However, the Sudanese Government was going to set up a new six year development plan starting from July 1977, and stated that the present project should have a high priority in the development plan, to be incorporated in said Programme. Thus, this project will be considered as an objective of the loan from the Arab Fund.

But, as a premise of the loan, it is required that a feasibility study be conducted through technical cooperation of Japan and that the investigation, construction and operation of a pilot farm be conducted, with satisfactory results.

Mr. Khalid, T. Ali, Chief of said Sudan Agricultural Development Survey Mission of the Arab Fund for Economic and Social Development who was stationed in the Food and Agriculture Organization, Rome, stated to our representative that he had an expectation on the feasibility study conducted by Japan on the irrigation rice crop development along the White Nile and that he was hoping with respect to the assessment of the yield that a very accurate and highly reilable report in use of the data based on the actual results would be forthcoming. This seems to imply that the constructed and operated pilot farm has a character as a test farm for the main irrigation project.

Now looking into the details of the initial request of the Sudanese Government to the Japanese Government for technical cooperation, the basic attitude stated above can be read clearly.

On the other hand, the Japanese Government was very much concerned how to response with respect to the positioning and the scale of the pilot farm (1,000 feddans or 420 hectares were firstly requested) (In the position, the pilot farm should form a part of the main agricultural development project and be executed after confirmation of the feasibility of the project, preferably in a scale of 50 hectares at the maximum). But, as the result of

negotiation, the State Minister for Agriculture of the Sudanese Government agreed to the execution of the pilot farm cooperation concurrently with the main project itself and reduction of the scale to 500 feddans (200 hectares) (as a practical measure).

The Ministry of Agriculture, Food and Natural Resources is responsible for construction and operation of the pilot farm, but the construction of the main irrigation project is undertaken by the Ministry of Irrigation. For the project, these ministries provided a committee and had several discussions at the meetings of the committee. The Ministry of Agriculture, Food and Natural Resources represents the Sudanese Government in making the request for a feasibility study.

The Ministry of Agriculture, Food and Natural Resources had taken the pilot farm as a preliminary stage of the feasibility study of the main development project so that there was no embodiment of the main project.

The Ministry of Finance, Planning and National Econom expressed a desire that while the intention of the Japanese side was appreciable, the feasibility study should be undertaken as early as possible and be completed for a short period (by 1977).

In order to investigate the conditions of cooperation of the third countries to the irrigation projects, the survey mission visited the Ministry of Irrigation where explanation was given of the following seven large projects:

(1) Northern provinces pump schemes (with the technology and and fund of the Sudanese Government),

(2) Upper Athara (Setit) project (under consulting service of France, and with fund of the Sudanese Government and expected Arab Fund),

(3) Rahad project (under consulting service of England and with fund of the World Bank),

(4) Hagar Assalaya project (with technology and fund of the Sudanese Government)

(5) Melut project (with technology and fund of the Sudanese Government),

(6) Mangalla project (with technology and fund of the Sudanese Government), and

(7) Jonglet project (under consulting service and with fund of the Netherlands).

As seen from the foregoing, the bilateral cooperation for irrigation is limited to the Netherlands only, and the technical cooperation project of Japan will be the second.

The State Minister for Agriculture had desired to choose the site of the pilot farm not in the peripheral area of the main project (such as the peripheral high land or pump irrigation area) but in the beneficial area of the main project.

3.2 Direction of Development

3.2.1 Agriculture and Agricultural Economy

(1) Agriculture

Rice cultivation in the agricultural development project area along the White Nile seems to be fairly promising from the climatic and soil conditions of the area and examples of rice cultivation in the Gezira Province if irrigable paddy fields are created and appropriated cultivation techniques are established.

It is important to establish the technology adapted to enhance the yield per unit area. Further, in order to realize a high yield level over a wide area, a systematic study of the rice crop technology as well as the agricultural technology in general is required along with establishment of the techniques for cultivation and control including selection and rearing of adequate varieties, water control, fertilization, weed control, pest control, etc.

The rice crop season is appropriate from June to November as seen from the climatic conditions and the relationship between the crop season and the yield. Double cropping of the paddy rice does not seem to be appropriate presently from the low temperature in December to February and the high temperature and dryness in March to May.

The paddy fields to be created must be those which permits free water control for stabilization of the rice crop. Particularly, the paddy fields must permit flooding before August when the water level of the river rises up in consideration of the uniform growth of paddy rice plants or weed control. They should also permit drainage even in the flood season in order to control the soil in the fields and to secure the field surface with good trafficability for tractors and combines.

The farmers are not experienced in the rice cultivation nor skilled in the cultivation technology generally. Thus, it is required to establish the appropriate technique of cultivation as promptly as possible and, at the same time, to attach importance to rearing of capable men.

When the labor shortage is taken into account, labor saving rice cultivation in use of large machines is imperative. Modernization or mechanization of the conventional agriculture depending on man-power is also important.

As a method of rice cultivation, not only the direct sowing on dry field but the transplanting culture which is more stable in the growth of paddy rice and yield, should be considered.

(2) Agricultural Economy

The Sudan is an agricultural country with the agricultural products accounting for 90 percent of the total export, yet it relies on the import for supply of the foodstuff such as sugar and wheat to an amount equal to 30 percent of the total import. Further, under the present monocultural agriculture consisting mainly of cotton, the trade balance is not stable, being subject to the climatic condition or the trend in the textile markets in the world. Moreover, in this country where the labor resources are in absolute shortage, the labor force concentrates in one season, and this places a limit to the future expansion of the production. Under such situation, the present regime is contemplating the Six Year Development Plan commenced from June 1977. This plan is intended to achieve the self-supply of the foodstuff so far imported such as rice and sugar and export any surplus to the Middle and Near Eastern countries by increasing the area of irrigation greatly in use of an Arab Fund for Economic and Social Development. It is contemplated to irrigate newly 1,000,000 acres and, at the same time, introduce more intensive agriculture into the existing irrigation areas including the Gezira project during the planned period of six years. Next to the foregoing six year plan, importance is attached to the plan of introducing the mechanized agriculture and livestock raising into the rainfed cultivation areas in the eastern, central and western provinces. Over such savannah region, there is reportedly left an unused arable land of 2,000,000 acres.

According to the Jonglei Canal Development Plan formulated upon the "Economic and Political Integrations" agreement executed between

Egypt and the Sudan in February 1974, there is newly available 4,000,000,000 tons of water per annum which will permit to turn the vast swampy region and its periphery in the southern provinces into arable land. This will enhance the potential for expansion of the agricultural production through increase of the available water resources as well as arable land.

3.2.2. Irrigation and Drainage

The Gasaba area is more advantageously conditioned than the Banonab or Shatawi area as an object area of feasibility study, because it is located close to Ed Dueim, the capital of the White Nile Province, and Kosti which is a strategic point of traffic, the flooding depth in the flood season of the White Nile is relatively shallow and it has an appropriately wide area as a project.

The object area is waterlogged for seven months from July to February due to adjustment of the water level of the Jebel Aulia Dam and dries up during the remaining period. For agricultural development of rice crop not influenced by such variation of the external water level, it is desirable to build an embankment of polders around the object area, perform irrigation and drainage by means of pumps or joint use of pumps and water gates and thus interrupt any influence of the external water level and insure complete control of the inland water.

For the project area wanting in supply of labor force, it is considered to be very pertinent to plan a large scale mechanized agriculture. Therefore, it will be necessary to consider a facilities plan adapted to the mechanized agriculture.

In formulating the development plan, it is also required to give due consideration to the existing facilities inside and outside of the project area so that no hazard may be caused to them.

In November 1975, Nippon Koei Co., Ltd. conducted a reconnaissance survey of the area of 83,600 feddans (about 35,000 hectares) in Shatawi, Salaga (Banonab) and Gasaba and, upon the maps obtained at that time, a sample study of the area of 11,000 hectares in 11,600 hectares of the Shatawi are and area of 14,000 hectares in 20,000 hectares of the Gasaba area. The result was presented to the Sudanese Government in January 1976 as a report "Reconnaissance Report ED DUEIM RICE DEVELOPMENT PROJECT." The result of the

sample study of the Gasaba area chosen as the object area of development this time is represented briefly in the following.

As shown in Figure 3-9, it is intended to cut off the influence of the outer water upon the irrigation area by building embankment of polders around the irrigation area and to perform the irrigation and drainage within the area by means of pumps. The dimensions of the facilities are:

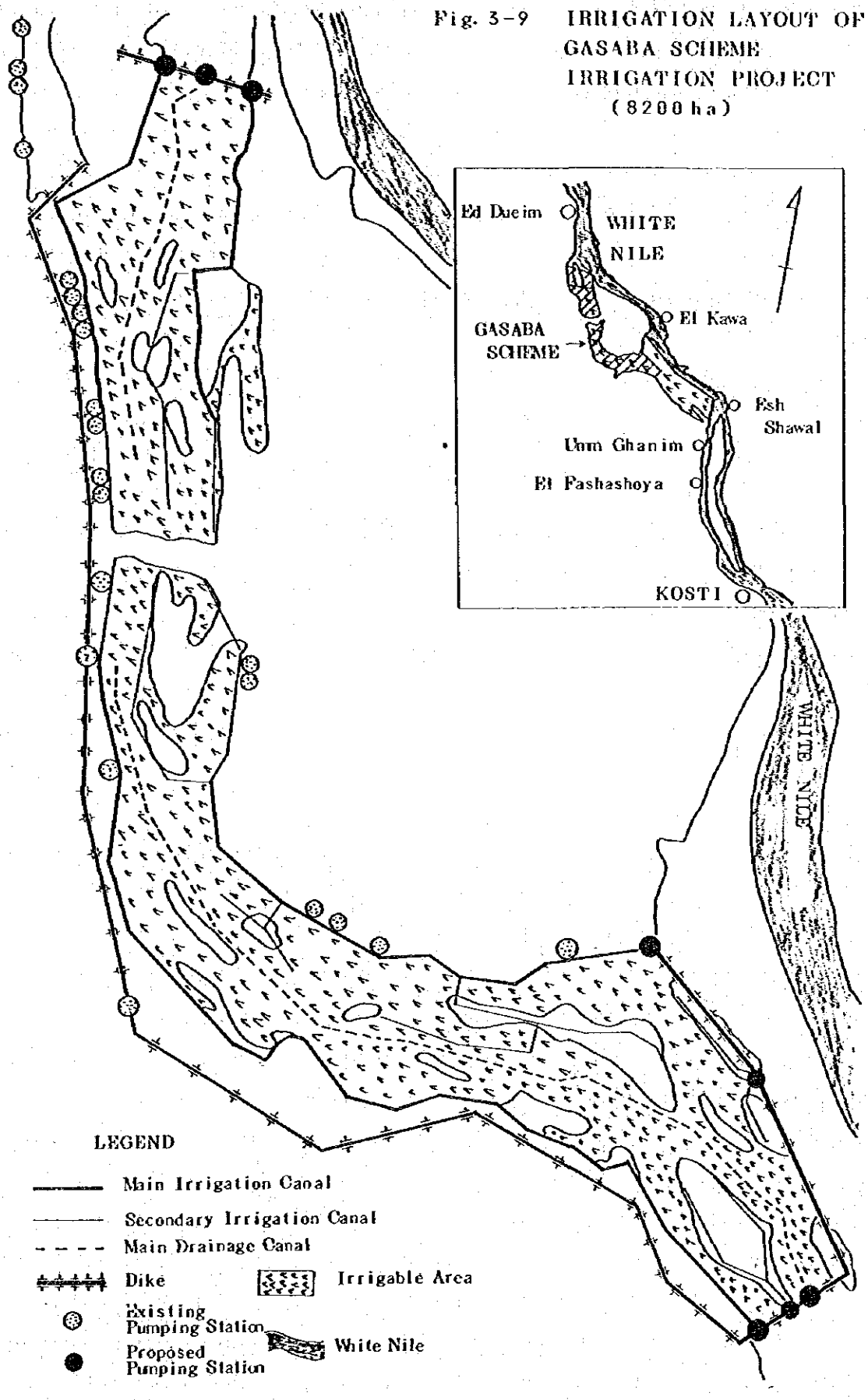
Irrigation area	8,200 ha:
Max. gross water requirement	13.12 m^3/sec;
Pumping facilities	
Type	Vertical axis mixed flow pump,
Total water head	4 - 6.2 m,
Pump capacity	
Irrigation	2,200 P.S.,
Drainage	1,400 P.S.;
Main canal length	59.4 km;
Branch canal length	110.0 km;
Main drain length	33.0 km;
Polder length	56.9 km; and
Farm road length	60.0 km.

The construction cost (including contingency at 15 percent) is calculated under the contracting system approximately as given below.

Item	Amount ($1,000,000)
Expense for civil works	15.24
Expense for construction equipment	9.26
Engineering expense	1.48
Sub total	29.88
Residual value of construction equipment	-) 1.62
Total	28.26

The plan stated above may be said to be a specifically indicated method of development suggesting a certain direction in which the development plan of the Gasaba area is to be implemented in the future. However, this plan

Fig. 3-9 IRRIGATION LAYOUT OF GASABA SCHEME IRRIGATION PROJECT (8200 ha)



is a sample study based on the existing maps of a scale of 1/50,000 so that a thorough study based on the detailed topographic maps and other data will be required further in planning the development hereafter and, particularly, of the construction cost.

For the yield, possibility of double-cropping must be proved through experiments, bu the report states that the prospected yield will be provided upon elapse of five years after completion of the construction works, with the first crop estimated at 6 tons/hectare (paddy) and the second crop at 3 tons/hectare (paddy).

3.2.3 Technical Cooperation

The mission had it as a primary purpose to conduct a preliminary survey for feasibility study of the agricultural development mainly about rice cultivation in the Sudan. For such a purpose, the mission conducted a field survey for two days in the basin of the Bue Nile, followed by another field survey of five days in the basin of the White Nile and, as the result of such surveys, picked out an area of about 20,000 hectares (including a farm land of about 10,000 hectores) in the Gasaba area south of Ed Dueim on the leftbank of the White Nile. While the circumstances during such a period will be reported separately, now looking the schedule hereafter, the desire on the side of the Sudan is so intensive that as early start of the subsequent feasibility study as possible is desirable. This area is flooded from August to April by the operation of the Jebel Aulia Dam downstream of the White Nile. In this sense, a schedule of field survey from May to July and home work from August to November is desirable. But, in this area, the haboob is predominant from February to May, while the rainy season takes place from June to August. Therefore, some appropriate measures will be required for the field works. As another condition, consideration for the budgetary execution will be required. Assuming that the next feasibility study is carried out under the budget of this year (1977) on the side of Japan, a period of at least two months will be required in almost all cases for negotiation for implementation with the Ministry of Finance instruction and excution procedures of the approved budget. Further, if the budget for the said fiscal year is not approved before the fiscal year, the execution will be delayed so much. In order to implement the field survey for feasibility study from the beginning of May, efforts of the personnel concerned

are required. The feasibility study within this fescal year will not be enabled unless the study team enters the site in the early part of July at the latest. The feasibility study team will be organized by, say, ten persons consisting of the head, three agro-civil engineers (polder, canal and land consolidation), two mechanical engineers (pump and agricultural machinery), and one respectively for agricultural economy, soil, cultivation and coordinator.

Next, the prospect of the technical cooperation in agricultural sector for the Sudan will be discussed, although this may deviate somewhat from the scope of the mission.

First, for development of the object area of feasibility study, positive contribution of the Arab Fund was expected initially. A high priority for the development is placed on the rice cultivation in the Sudan, but it is not a specific one to be called a project in the basin of the White Nile at the present stage. Thus, depending on the forthcoming feasibility study report, the response may vary. In this respect, the next feasibility study will be met with great expectation as well as ordeal. Next, in order to introduce development fund into the area, a proof corroborating that the rice cultivation by a large scale-modern agricultural method is possible in this area will be required. For such purpose, the Sudanese Government has apparently requested the cooperation for a large scale (about 1000 feddans) pilot farm along with the request for feasibility study on the main irrigation project. So far as the technical cooperation for only the pilot farm is concerned, we have but to be prudent from what we have seen this time. In this area or in its vicinity, rice cultivation is scarcely known, and the area is different in the climatic, soil and water conditions from the Gezira area which is often taken as a reference so that it is to be considered as a virgin land for rice clutivation. Presently, the Sudan has reduced the scale of the pilot farm to 500 feddans (about 200 hectares), but this still belongs to the category of large scale when the extent of technical cooperation which our country has executed in the South-Eastern Asia, etc. is taken into consideration. Therefore, for this area, it is considered to be essential to start the technical cooperation not according to the system of agricultural cooperation project of the Second Division For Technical Cooperation, Ministry of Foreign Affairs of the Japanese Government but in an individual expert dispatch system with the engineers and scientists reduced to a very small number to insure that the paddy rice culti-

vation is practicable before the cooperation in the form of a large scale pilot farm is undertaken. Specifically, two or three experts shall be assigned to the Research Extension of the Ministry of Agriculture at Ed Dueim to continue experiments until two to three harvests are experienced. Then, if the success is convinced, a combination of the project type technical cooperation and the ordinary gratis or agricultural gratis financial cooperation may be considered. Utilization of the Kennedy-Round Aid concluded with the Sudan in September or the reserved counterpart fund of the food production increase measure fund (so-called the second KR Aid) contemplated of appropriation in the budget should also be considered. By concentrating a variety of menus of technical cooperation into the basin of the White Nile, there will be established a large project within several years. On the Japanese side standing on such a long ranging prospect, steady and constant efforts are desired to form an optimum system for implementation of the technical cooperation. The area is located at a distance of about six hours travel through the desert on the left bank of the White Nile, from the capital, Khartoum, and the advance base will be located in Ed Dueim, capital of the White Nile Province, which is at a distance of five hours run from the same. The dispatched experts will be stationed in Ed Dueim normally so that it is desirable to have an appropriate person stationed in the capital Khartoum to serve as a window before these experts. The Japanese Embassy will be busy with routine works, and such person may take a form of economic investigator at the Embassy or advisor for the Ministry of Agriculture which is a counterpart agency of the Sudanese Government.

The experts to be dispatched should of course be given a treatment enough to compensate the handicap seen generally in the areas of Middle and Near East and Africa. Particularly, for the experts stationed in Ed Dueim where the conditions belong to one of the bad among the areas of technical cooperation which the Japanese Government has so far extended with, for example, the mean high temperature exceeding 40°C for two months, there will be required the sufficient accommodations such as living quarters and vehicles provided with air conditioning facilities. We feel assured that Ambassador H.E. Arimoto maintains similarly.

Anyway, the Sudan sincerely desires the technical cooperation, and while it is one of the poor among the most seriously affected countries or least less developed countries, if the possibility of the country now being

called the stock house of food in the Middle East is considered, quick yet firm response of our country is desired.

The foregoing view is that representing the response to technical cooperation frankly seen on the Japanese side. Actually, however, the other government desires earnestly to carry out the cooperation for the pilot farm concurrently with the feasibility study of the main project, while the Japanese Government is considering a gratis financial cooperation for construction of the pilot farm. Under such circumstances, the response stated above seems to take much time. Then, what is considered as the second best measure is to conduct a planning survey of the pilot farm simultaneously with the feasibility study to be conducted next by dispatching long term investigators or individual experts on consultant basis, followed by the detailed design to be made in the frame of the gratis financial cooperation, as soon as it is determined for connection to the execution in the following year.

3.3 Surveys Required Hereafter

In the following are set forth the necessary investigations and items of study for the feasibility study to be carried out hereafter with respect to the Gasaba area chosen in this preliminary survey as the project site for rice crop agricultural development.

3.3.1 Economic and Agricultural Background

(1) General and Agricultural Economy

a) Country's basic statistics
- GNP, GDP
- Population and population in area
- Labor force
- Government revenue
- Consumer price index etc.

b) Trade balance
- Main export commodities & Amount
- Main import commodities & Amount
- Export and import balance

c) Characteristics of present agriculture
- Cultivated land

- Irrigated land
- Forest land
- Farm size
- Harvested area in each crop
- Agricultural production
- O & M cost in irrigation system

d) Land tenure
- Land tenure system
- Land reform
- Size of holding

e) Communications

(2) Agricultural support services

a) Agricultural research, organization and activities

b) Extension services
- Organization
- Extension program and activities
- Agricultural corporation and agency

c) Credit
- Organization and activitie of agricultural credit system
- Other credit system

d) Farmers' cooperative

(3) Agricultural policies and plan

a) National development plan
- Target of development
- Investment

b) Extent of irrigation development

3.3.2 Survey and study on the Project area

(1) Natural Resources and Environment

a) Location and topography
- Topographic map in scale 1/5000 - 1/10,000
- Topographic maps in major structure sites (1/200 - 1/5000)

b) Meteorology
- Collection of climatic data
- Additional observation if necessary

c) Hydrology

- Water level of White Nile
- Run-off
- Ground water
- Water quality

d) Geology and soil

- Geological conditions and soil phisical conditions
- Construction materials (Gravel, sand and embankment materials)

e) Soils and land use

- Soil fertility
- Intake rate
- Land use

(2) Community and economic environment in and around the Project area

a) Population, Labor force

b) Agriculture

- Extent of existing irrigation system
- Evaluation of existing irrigation system
- Land use
- Farming practices (Cropping pattern, cropping intensity, input, etc.)
- Yield and production
- Farm income
- Land tenure situation

c) Agricultural support services

- Extension and its activities
- Research and its activities
- Credit and its activities
- Cooperative
- Marketing facilities

d) Market and prices

- Marketing (international and domestic) and prices
- Transportation system and cost

3.3.3 The Project

(1) Project concept and description

a) Project boundary

b) Purpose and identification

(2) Agricultural Development

a) General orientation

b) Cropping pattern and yields

c) Inputs

- Seeds
- Fertiliyers
- Chemicals
- Farm machinery

d) Farm labor requirement

- Family labor
- Hired labor

e) Project output

(3) Irrigation and Drainage plan

a) Water requirement

- Consumptive use by crops
- Available rainfall
- Farm irrigation requirement
- Irrigation efficiency
- Diversion irrigation requirement

b) Drainage requirement

- Drainage requirement in the project area
- Drainage requirement outside the project area

c) Proposed project works

- Irrigation system
- Drainage system
- Road system
- Pump and other major facilities
- Related structures

(5) Agricultural Income

a) Gross value of agricultural output