PRELIMINARY SURVEY REPORT
ON RHOMBE SWAMP AGRICULTURAL DEVELOPMENT PROJECT
IN THE REPUBLIC OF SIERRA LEONE

1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

At the request of the Government of the Republic of Sierra Leone, Japan International Cooperation Agency dispatched a study team to conduct a preliminary survey on the Rhombe Swamp Agricultural Development Project from Jan. 26 to Feb. 15, 1981.

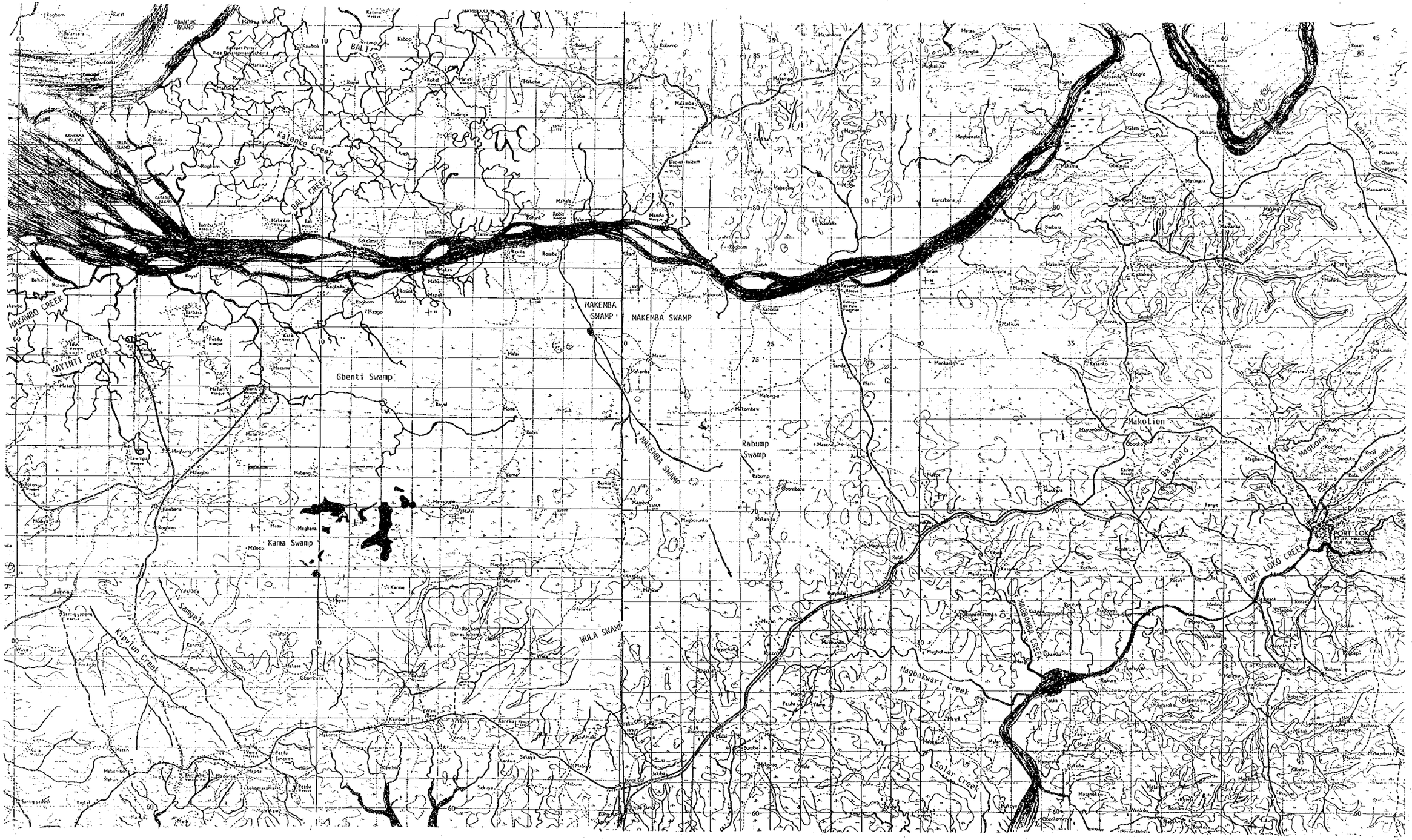
The team surveyed the natural and socio-economic conditions of the Rhombe Swamp area and studied the potentiality of agricultural development in the area.

This report contains the result of the preliminary survey and recommendations of the team. I hope it will be of use for formulation of the agricultural development plan in the Rhombe Swamp area.

I wish to express my gratitude to the officials concerned of the Sierra Leone Government for their cooperation extended to the team and sincerely hope that our mutual efforts of this kind will serve to strengthen the friendly relations between Sierra Leone and Japan.

A. Arimatsu

Akira Arimatsu
Executive Director
Japan International Cooperation Agency


BALI CREEK
Kalenke Creek
BALI CREEK
MAKAMBO CREEK
KAYINTI CREEK
Gbenti Swamp
MAKEMBA SWAMP
MAKEMBA SWAMP
Rabump Swamp
MAKEMBA SWAMP
Kama Swamp
Sangele
Kipilun Creek
WULA SWAMP
Makotion
Magbona
Kamaramka
PORT LOKO
PORT LOKO CREEK
MAGBAMBA CREEK
Magbakwari Creek
Solar Creek
Kebinta
Magbusen

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I The Report on Preliminary Survey Rhombe Swamp Agricultural Development Project the Republic of Sierra Leone

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CHAPTER I INTRODUCTION

1. Background and Terms of Reference of Survey

Rombe Swamp Agricultural Development Project which was planned by the Government of the Republic of Sierra Leone is a national project. The purpose of this project is to increase rice production and thereby to realize the plan of self-supply of rice for the State. In the future the export of rice is also expected.

For this purpose the Government of the Republic of Sierra Leone has been paying attention to the development of Rombe Swamp where rice cultivation is being practiced. The Government is going to introduce up-to-date rice growing the technique exclusively to Rombe Area in order to increase rice production.

To carry out this plan, the Government placed it in the 5 year National Plan (1981 - 1985/6) and wishes to raise a fund for the plan from the Africa Development Bank.

In this respect it has become necessary to make a feasibility study on the development of Rombe Area. Japan was asked for technical cooperation of the study. Therefore, Japan International Cooperation Agency sent a team to make a preliminary survey prior to the feasibility study. The purpose of this survey is as follows:

a. Studying the possibility of an agricultural development of Rombe Swamp Area from technological point of view.

b. Seeing how the Government of Sierra Leone has been buckling to the project.

c. Seeing how the development project at Rhombe Swamp Area contributes to the economic growth of Sierra Leone.

d. Studying whether Japan can carry out the feasibility study of agricultural development at Rhombe Swamp Area.

e. Seeing how the African Development Bank considers this project.

2. The Personnel Organization of the Team

Assignment	Name	Position
Leader	Mr. Tomoyuki Oshino	Deputy Director, Construction Dept., TOHOKU Regional Administration Office, Ministry of Agriculture, Forestry & Fisheries
Drainage	Mr. Yokichi Yoshida	Technical Officer, Design Div., Construction Dept., KANTO Regional Administration Office Ministry of Agriculture, Forestry & Fisheries
Swamp Development	Mr. Takashi Ohta	Chief, Technical Section, Land Consolidation Div., NIGATA Prefectural Construction Technical Center
Irrigation	Mr. Kazuyuki Kobayashi	Chief of 1st Design Examination Section, Design Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry & Fisheries
Agro-economy	Mr. Isao Hirayama	Deputy Director, Regional Planning Div., Planning Dept., HOKURIKU Regional Administration Office, Ministry of Agriculture, Forestry & Fisheries
Soil Science	Mr. Yasuike Suzuki	Technical Officer, Resources Div., Planning Dept., TOKAI Regional Administration Office, Ministry of Agriculture, Forestry & Fisheries
Agronomy	Mr. Sataro Yazawa	Senior Instructor, Uchihara International Agricultural Training Center, Japan International Cooperation Agency
Coordination	Mr. Yoshihiko Nishimura	Officer, Technical Affairs Div., Agricultural, Forestry & Fisheries Planning and Survey Dept., Japan International Cooperation Agency

3. Intenerary

	Date	Group 1	Stopping	Group 2	Stopping
1	Jan.26	Mon. Tokyo ⟶		Tokyo ⟶	
2	27	Tue. Rome	Rome	Paris	Paris
3	28	Wed. Data collecting in FAO	Rome	Paris ⟶ Abijan	Abijan
4	29	Thu. Rome ⟶ Monrovia	Monrovia	Meeting with AfDB	Abijan
5	30	Fr. Meeting with the Embassy of Japan in Liberia	Monrovia	Abijan ⟶ Monrovia	Monrovia
6	31	Sat. Survey team meeting			Monrovia
7	Feb. 1	Sun. Monrovia ⟶ Freetown			Freetown
8	2	Mon. Meeting with Ministry of Agriculture and Forestry and other authorities concerned			Freetown
9	3	Tue. - do -			Freetown
10	4	Wed. Field survey (Port Loko)			Port Loko
11	5	Thu. Field survey (Katonga and Gbenti)			Port Loko
12	6	Fri. Field survey			Freetown
13	7	Sat. Team meeting			Freetown
14	8	Sun. Team meeting			Freetown
15	9	Mon. Meeting with authorities concerned			Freetown
16	10	Tue. Freetown ⟶ Monrovia			Monrovia
17	11	Wed. Meeting with the Embassy of Japan in Liberia			Monrovia
18	12	Thu. - do -			Monrovia
19	13	Fri Monrovia ⟶ Amsterdam			Amsterdam
20	14	Sat. Amsterdam ⟶			
21	15	Sun. Tokyo			

Group 1: Oshino, Yoshida, Suzuki, Hirayama, Ota, and Yazawa

Group 2: Kobayashi and Nishimura

CHAPTER II SUMMARY

1. Outline of the Republic of Sierra Leone

The Republic of sierra Leone is Located in the west of Africa on the south west coast. It is situated at 7°N to 11°N, 10°50'W to 13°18'W. Total area of this country is 72,339 Km^2. Population; 2,960,000, climate; tropical rain type, railfall; 3,500 - 5,000mm annually at the coastal area, and annual average temperature; 27°C.

2. Outline of the Agricultural Policy

Such mining industries as diamond and iron have played an important part in the economic growth of this country since 1930's. However, the share of mining in G.D.P. has decreased from 20% to 10% these 5 years.

On the other hand, the share of agriculture has increased from 30% to 39%. In addition, about 80% of the labourers of this country work in agriculture.

Therefore, it is only natural for the Government to lay great emphasis upon the agricultural development as the key economic policy.

3. Rhombe Swamp Agricultural Development Project

(1) Outline

In August, 1980, the Government of Sierra Leone worked out a national plan for food production with agricultural development project which is to reinforce the economic growth and is to replace the declining mining industry with agriculture. Rhombe Swamp Agricultural Development Project is a part of this plan. So the Government has been paying special attention to this.

(2) Step of Development

In order to carry out this plan, it is necessary to ask the African Development Bank for fund through the negociation between Sierra Leone and the bank.

Japan sent a preliminary survey team for the purpose of preparing for a feasibility study mission the purpose of which

would be making out a F/S report which was necessary to obtain a fund from the African Development Bank. The team examines the technological as well as economic aspect of the agricultural development project in Rohombe Swamp.

(3) Request of the Government of the Republic of Sierra Leone

The Government requested strongly the establishment of a general plan for developing the whole Rhombe Swanp area, and it involved an agricultural development which covered approximately 60,000 of this area. However, surveys for agricultural development in this area was with three times is the past, but none of the surveys could possibly succeed in realization of its contents.

Thus the Government takes keen interest in making a plan of high feasibility.

Because of this, this plan will be carried out by the cooperation of the Ministry of Agriculture and the Ministry of Development and Economic Planning.

(4) General Idea of Development Plan

A. Development Plan

a. Development of Rhombe Area will be possible judging from economic and technological point of view (including farm management, civil engineering etc.)

b. Judging from the size of national annual revennue (1978/79: Le 170,594,000), it would be impossible to develop the whole project area at once.

c. It is consequently recommended to adopt a phased programme which, in the first place (Phase I), covers a limited area in the swamp in the first phase.

d. In performing the Phase I, special attention should be paid to education and infrastructure.

B. Development Policy

a. Deciding size of the development project on the base of the size of national revenue and economic situation.

b. Completing irrigation and drainage networks that enable double-cropping.

c. Increasing the yield in each harvesting season.

d. Establishing a central organization in order to introduce agricultural techniques.

e. Completing distribution systems (completing traffic networks and marketing systems)

C. Outline of the Size of Development

a. Demarcation of the site of Phase I

Rhombe Area is roughly devided as follows:

i The delta area of the river
ii The lowland area in the inland
iii The upland area in the inland

Genti North in the "Delta Area" is suited for translating the Phase 1 project into reality.
The reasons are as follows:

i There are already considerable number of cultivated fields. The population density here is higher than those of other places.

ii It is extremely probable that the area would be the centre of river transport and once connected with the surface transport, Ghenti North would be the core for the development of the Rhombe at large.

iii Experiences in agriculture and a keen desire for development of the inhabitants in Gbenti North are noticeable.

iv The Government of Sierra Leone is also interested in the development of Gbenti North.

b. Area to be developed

(a) Area size

Out of 3,240 acres of Gbenti North, the area which is to be allotted to the development is to be decided in accordance with the sum of the national revenue.

(b) Proposed contents of the project

i Water supply that is practicable in the dry season.

- Pumping up underground water with diesel engines.
- Irrigating water from swamp.
- Irrigating water from a dam and diversion works.

ii Pump irrigation is highly recommendable, judging from a financial viewpoint, the size of the area under development, and the basic role of the Phase I of the plan as a piloting model.

iii Consolidation of the farmland
A growing period of rice should be made shorter for the introduction of double cropping system. Such preparation of farmland as land levelling is necessary in regard to the possible use of small size agricultural machines.

iv It is desirable to settle the farmers who acquired modern frarming techniques.
It is desirable to provide each farmer with over two ha of cultivated land.

CHAPTER III CONTENTS OF THE REQUEST OF THE SIERRA LEONE GOVERNMENT

1. Background

The Government of the Republic of Sierra Leone feels Keen interest in the agricultural development which is expected to promote the rice cultivation as a part of the programme for an increased yield of agricultural products.

The Government has an eye on Rhombe Area which is thought to be a place of high potentiality for an increased yield of rice. The Government strongly intends self-supply of rice for the preversation of the people by an increased yield of rice through the agricultural development of this area. Furthermore they are thinking of exporting surplus.

They tried to make a plan of developing this area three times(*1). These plans were called off every time they were made, because of the great expense or the technological insufficiency.

The Government of the Republic of Sierra Leone, holding an unshakable belief in the feasibility of the plan, placed the plan in the national development project and asked the African Development Bank for a found. The Bank said that the plan shown to them was not feasible enough for them to great the fund and that reconsideration was necessary.

Thus the Bank showed terms of reference which was necessary for the consideration. The granting of the fund depends on whether the results of reconsideration is satisfactory and on the Government's way of management of the project.

In 1979 the African Development Bank asked Japan for the feasibility study according to T/R, and in August 1980, the Government of Sierra Leone made an official request to Japan for cooperation to carry out the study. In response to the request, the Japanese Government sent

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(*1) 1. Rhombe Swamp Engineering Feasibility Study (February, 1971) MRT consulting Engineers Ltd.

2. Proposal for Consult Survey for a Feasibility Study on Development Rice Producing (1975) Euro Consult Netherlands.

3. Proposal for the Rhombe Swamp Feasibility Book (1976). Tate & Lyle Technical Services Ltd.

a mission through JICA to carry out a prefeasibility study in Rhombe Area according to the T/R.

2. Outline of the Project

The aim of this project is to enhance a rice production in the delta of the River Little Scarcies, 100 Km northeast of Freetown. The area to be developed is approximately 60,000 acres (24,000 ha.), and is devided into six sub-areas (see Table 1). This deviding was carried out by MRT consulting Engineers, Ltd.
The name of Rhombe Swamp came from the name of one of the villages. According to the climate conditions, the area is devided into three.

a. Delta area on the river (mangrove swamp)
b. Lowland area in the inland
c. Upland area in the inland

Cultivated land exists mainly in the delta area where rice cultivation is practised with one harvest a year. A lot of un-cultivated land still remains, so the expansion of cultivated land will be possible by completing an irrigation-drainage system and a consolidation of farmland.

The area which is subjected to the feasibility study is about 8,500 ha. excluding Gbenti Mouth. The area which was subjected to the study is as follows:

In the north, along the river Little Scarcies from Kotoma village to Katik village; in the east, the road which connects Kotonga village to Mabundulai.

In the South, the road which connects Port Koko to Lungi; in the west, by the road which connects Petifu Junction and Benti.
These roads run along the basin. The extent of the area is about 18 Km from the east to the west, and about 10 - 13 Km, from the south to the north.

Table 1 Outline of Rhombo Swamp Area

Sub-area	Area	Rice Cultivation Area
RHONBE	304 ha	202 ha
MAKEMBA NORTH	1,623	243
MAKEMBA SOUTH	2,554	121
GBENTI NORTH	1,311	931
GBENTI SOUTH	2,703	809
GBENTI MOUTH	652	526
Total	9,147	2,832

This project is important on the national level and adopted as part of the Five Year Plan of National Development which covered the period of 1981/2 - 1985/6. This project is to be carried out by the Ministry of Agriculture and Forestry and the Ministry of Economic Planning.

The study to demarcate the development area and fix the development method in the Phase I will be necessary as well as the study for developing the whole area of 60,000 acres.

Three feasibility studies which were made in the past were nullified. Therefore the feasibility study which leads actual implementation of the development project shall be carried out.

This prior feasibility study area, Rhombe Swamp is in Port Loko in the North state. Three percentage of rice crop is very high. (See Table 2)

Table 2 Conditions of Rice Crop in Port Loko

	Upland Rice		Suamp land Rice		Total Rice	
	Area	Rate	Area	Rate	Area	Rate
	acre	%	acre	%	acre	%
Southern Province	233,935	38.9	36,193	17.5	270,128	33.4
Eastern Province	140,909	23.5	50,392	24.4	191,301	23.7
Northern Province	224,726	37.4	119,298	57.7	344,022	42.6
(Port Loko)	(64,409)	(10.7)	(42,981)	(20.8)	(107,390)	(13.3)
Western	1,178	0.2	928	0.4	2,105	0.3
Total	600,747	100.0	206,810	100.0	807,557	100.0

Out of four states and 12 districts, percentage of the yield in rice crop is 10.7% in upland rice, 20.8% in swampland rice. These figures are very high and show the strong basis of yield.

3. Agricultural Development Plan

Sierra Leone has not finished any long-term plans for its social and economic development yet. Agricultural development project has now reached a working stage. It involves such production as coffee, cocoa, coconuts, rice and sugar cane in a lot of areas of this country.

Outline of Agricultural Survey by FAO

F.A.O. had its office in Sierra Leone from 1976 to 1980. F.A.O.'s study in the Republic of Sierra Leone finished its Phase I.

As to Phase II, hydrological survey is planned but the date of the survey is not yet decided.

Comment of the African Development Bank on the Rhombe Swamp Agricultural Development Project

The Government of Sierra Leone asked the African Development Bank for a fund in order to carry out the Rhombe agricultural development project. The Bank was interested in the project and ever since J.I.C.A. has been kept in touch with the Bank. The study mission of JICA visited the Bank and had a chance of meeting.

a. The African Development Bank has long been interested in this project. And they made T/R and showed it to the Government of Sierra Leone.

b. At this stage, the Bank would like Sierra Leone to make a comment on the T/R.

c. This project shall be carried out according to the procedures set by the Bank (see Fig. 1) and each step taken is subject to the appraisal of the Bank in reference to the procedures.

d. This project is to be carried out according to a flow-chart of the procedure (made out by Mr. Adjaottor and Mr. Kodera).

e. At this stage the African Development Bank did not grant a financial aid to the project. The bank had to estimate the priority of the project in comparison with other projects which were applied to the Bank.

f. The fund which is expected to be granted by the Bank depends on the result of F/S and the attitude of the government of Sierra Leone.

   i. Whether the project was made as the State's programme.

   ii. Whether the economic analyses of F/S are feasible.

g. Economic section of the Bank will make a final decision as to the grant of the fund.

h. The fund is expected to be available in 1 or 2 years after the submission of the F/S report. This report can be placed on the agenda of the conference between the Bank and the Government.

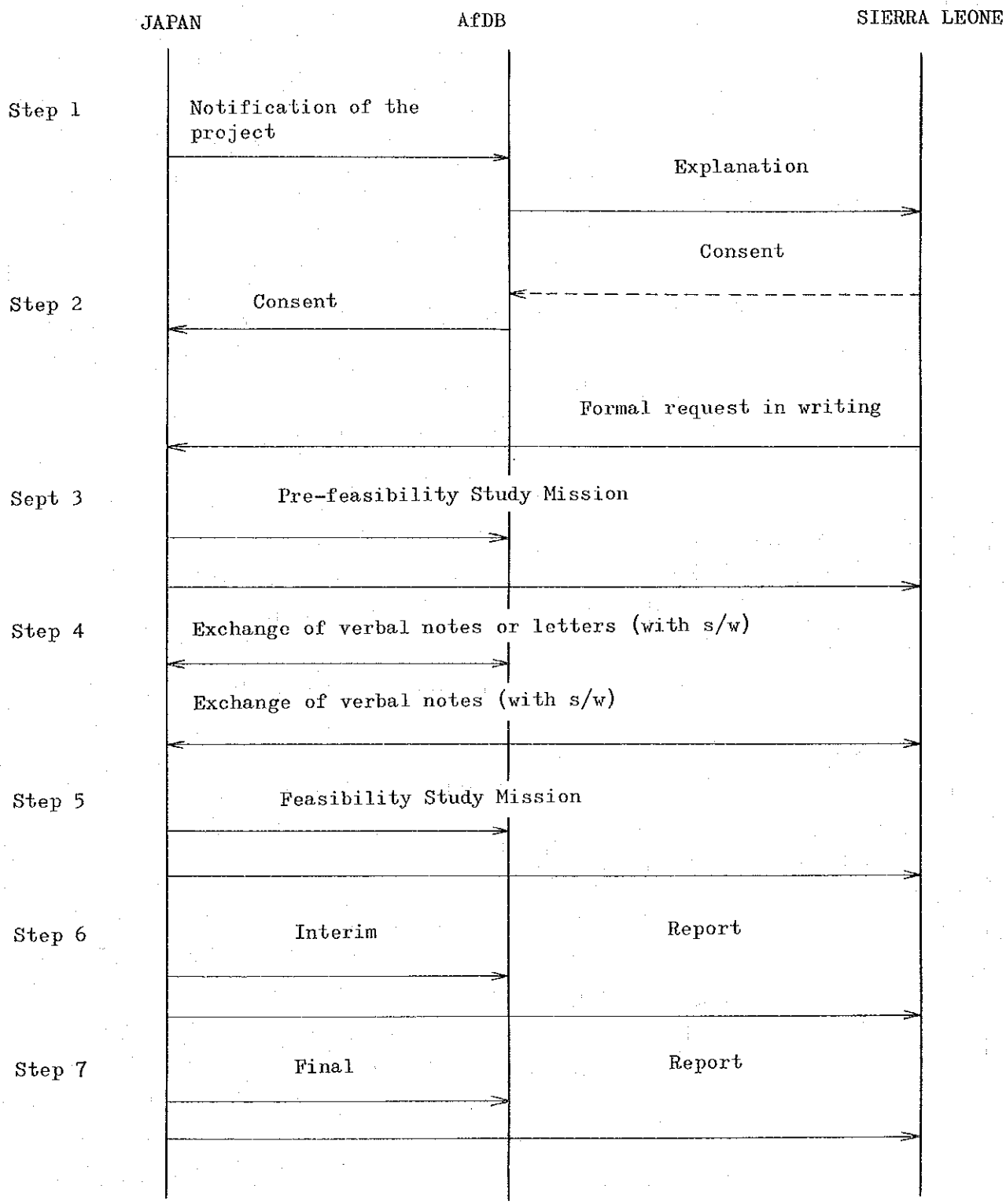


Fig. 1 Feasibility Study Procedure

CHAPTER IV THE RESULT OF SURVEY AND COMMENT

1. Development Plan

(1) General Plan

The Government drew up an agricultural development plan including agricultural production schedule. In this plan agriculture and livestock farming are two main points (1977 - 78 36% of GDP, 35% of export and 75% of labour power). In other words the Government are going to maintain and also increase the national economic grawth by the development of agriculture to make up for the decrease of mineral production.

The three basic strategies in the plan are;

a. self supply of rice,

b. acquisition of foreign currency, and

c. a better balanced regional development.

In order to attain the targets mentioned above, the following programms are taken into consideration.

a. Integrated agricultural development project

b. Increase the commercial availability of crops

c. Agricultural survey and service

d. Price policy to stimulate the crop production

Using these as a bases, 15 projects have been drawn up in the period 1980/81 - 1985/86 as externally Funded Project, and 20 projects as a Domestically Funded Project. Rhombe Swamp Project is one of these.

The total amount of the expenditure necessary for the projects is estimated at approximately Le 152 million as far as the Ministry of Agriculture and Forestry is concerned. (Table 3, 4, 5)

Table 3 Grand Total of Projected Development Expenditures

(Le' 000)

1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	Total
24,382	35,119	27,790	27,972	23,950	12,604	151,817

Table 4 Externally Funded Projects (1980/81 - 1985/86)

Project	Total cost		Term	
Eastern LADP (2)	Le'000 6,135	IDA/IBRD 2,473	1976 - 80	Swamp Rice, Cocoa Oil Palm
" (3)				
Northern IADP (1)	9,168	IDA/IBRD 6,658	1976 - 80	Swamp Rice Upland Rice Ground Nut
" (2)	25,000		1981 - 86	Rice, Ground Nuts Live Stock
Koinadugu IADP	11,600	EDF 7,080	1980 - 81	Rice, Ground Nuts Tomato etc.
Magbopi IADP	USS'000 15,700	IFAD 12,700	1980 - 84	Rice Maize, Cassava, Millet
Moyamba IADP	Le'000 11,700	ADF 10,200	1980 - 84	Construction of Survice Center Shops, etc.
Kambia IADP	14,288		1980 - 83	
Bo/Pujetrun IADP	23,000		1980 - 85	Rice, Cassava, Coffee Cocoa, Road Construction
Torma Bum Rice Project	9,839	ADF	1980 - 84	Rice
Land Resources Survey Project	1,165		1980	
Mechanical Cultivation Work Shop	1,600		1980 - 81	
Acre Project	6,159		1980 - 83	
Extension Training Project	1,150		1980 - 81	
Sugar Cane Project	8,000		1980 - 85	
Seed Multiplication Project	1,880		1980	Seed Breeding
Crash Rice Programme	1,700		1980 - 81	

Table 5 Domestically Funded Projects (1980/81 - 84/85)

Project	Total Cost	Project	Total Cost
	Le'000		Le'000
Intensive Rice and Vegetable Production	488	Extension Staff Housing, Offices and Stores	
Onion Growing Scheme	31	Agric. Machinery and Equip. Eva. Dep. Center	61
W.F.P Storage and distribution	153	Boliland Irrigation Study	
Extension Service Mobilization	611	Rhombe Swamp Dev.	122
Rokupr Rice Station Station Development	1221	Agric. Research Institute	
Fibre Project		Rice Marketing Milling and storage Project	
W.F.P Inland Project	305	Oxen cultivation Training Project	244
FFHC Village Agric. Stores		Power Tiller Evaluation	
Mech. Cult. (spare parts)	305	EEC Micro Project	
Low cost Oil Palm Mills		Agric. Machinery	183

(2) Area to be developed

The aim of this project is to reclaim 6,000 acres of swamp areas on the lower course of the River Little Scarcies which runs through the northwest part of Sierra Leone. Double cropping is also in the intention.

(3) Development Project

Considering the present sum of the national budget and the level of agricultural technology, it is not advisable to cover the whole area at once.

Therefore, a phased development programme in which they demarcate the area involved in development in Phase I is highly recommendable.

(4) Outline of Development Plan

A. Total Development Plan

With socio-economic development, rapid changes in various aspects of Sierra Leone are now expected in keen contrast with the slow changes in the past.

In the future Port Loko will be the centre of this area, and Kotonga, Gbenti and Komrabal will consist its out skirts.

The main purpose of the agricultural development project is to complete irrigation and drainage system, and farmland itself so as to realize double cropping.

Sources of water for irrigation are expectedly as follows:

a. Building a dam or an inlet (in the middle reaches of the River Little Scarcies)

b. Making use of the existing swamps (in the neighbourhood of Manangpe Area)

c. Introduction of pumping-up system

In the schemes mentioned above, building a dam or an inlet is desirable from the viewpoint of future management and maintenance.

In the case of building a dam, generating electricity is also expected, and the electricity can be made to use for irrigation and drainage pumps.

Main Structures

- Dam or inlet
- Irrigation and drainage structure
- Bank, watergate and irrigation/drainage station etc.

Separate construction of the banks is advisable from the viewpoint of area development.

B. Phase I Development Project

a. Selection of Area

Gbenti North area (3,240) is selected as an object for Phase I development plan. The reasons are as follows:

i There is a lot of cultivated land there and the density of population is higher than those of the other areas.

ii The area can be not only the centre of water traffic but also the core of the whole Rhombe area once connected to surface traffic.

iii Farmers there have considerable agricultural experiences and will welcome the new agricultural technique.

iv The government of Sierra Leone accepted the above mentioned suggestion willingly.

b. The Projected Area

(Components of the project)

i Making cultivated land with well-functioned irrigation-drainage system that enables double cropping and two crop system.

ii Training farmers.

iii Completing such infrastructure of the farm villages as roads, farm houses and educational facilities.

(Scope of Area)

Demarcating the projected area in accordance with the budget of the Government out of 3,240 areas of Gbenti North Area (existing cultivated land is 2,200 acres)

Another survey is necessary to select the area finally.

C. Comment

a. Source of Water Supply

The followings are would be source of water for planting in the dry season.

i Pumping up with diesel engines
ii Introducing water from swamps
iii Introducing water from a dam or an inlet.

b. Building a Net Work of Irrigation/Drainage

Considering the size of budget and of area, pumping up would be most appropriate.

The fact the Phase I development is the model of development leads us to the same conclusion, too

c, Reclamation of Farmland

Double cropping makes cultivation period shorter. In that case small sized agricultural machines become necessary and such farmland improvement as land lebelling, too.

d. Farm Managing Plan

It is desirable to have farmers settled who have been trained with modern agricultural technique for double cropping.

It is necessary for every farm to have more than 2 ha. and it is also necessary to build a training centre for farmers.

2. Agricultural Economy

According to WARDA survey, the yield is about 1,500 Kg./ha. (Table 6), through it shows an increasing tendency. Not much difference in yield is seen between upland rice and swamp rice, or between different areas.

Table 6. Change of rice yield (kg/ha)

Year / Yield	1960-64	1965-69	1970-74	1975	1976	1977	1978
National Average	1,055	1,357	1,408	1,401	1,385	1,522	1,522

At Port Loko, the subject of the survey, the yield of the upland rice is higher by 16% and the yield of the swamp rice is higher by 7% than the average yield of this country (Table 7).

Table 7 Areal Average of Rice Yield 1970/71

	upland rice	swamp land rice
Southern	1,330 kg/ha	1,450 kg/ha
Eastern	1,470	1,620
Northern	1,200	1,430
(Port Loko)	(1,530)	(1,590)
Western	1,530	1,590
Total Average	1,310	1,480

Price of rice is controlled by Sierra Leone Produce Marketint Board (SLPMB), which is one of the governmental organizations. The rice price of the country is:

Producers' rice price

1979 - 1980	7 Leon/bushel
1981	8 Leon/bushel (unhulled)

Consumers' rice price

1981 24 Leon/1 bag = 3 bushel

As for the consumers' price, according to the distance from the market etc., it rises gradually, so it is difficult to know its actual conditions.

WARDA survey shows that the price of rice in Sierra Leone is very low, though all the prices for producer, wholesale and retail have shown uptrend (Table 8).

In 1977 the price of rice was US$0.94 per Kg. in China, 0.26 in Ivory Coast; 0.27 in Liberia, 0.22 in Upper Volta, 0.20 in Mauritania, 0.18 in Gambia, and 0.17 in Senegal, Niger, Togo and Sierra Leone follow them with 0.16 per Kg.

Table 8 Official Rice Price in Sierra Leone

	1970-74	75	76	77	78	
Producers' Price/Kg	8.8	18.3	16.5	18.3		cent
	0.11	0.20	0.15	0.16		US$
Wholesale Price/Kg	21.9	41.3	41.3	41.3		cent
	0.27	0.46	0.37	0.36		US$
Retail Price/Kg	25.9	44.5	44.3	47.5	48.2	cent
	0.31	0.49	0.40	0.41	0.46	US$

WARDA

Consequently, if gross income of a farm is claculated by that of rice only, the calculation is as follows:

1,522 Kg/ha. (average yield in 1977) x US$0.16/Kg (Official Producers' Price in 1977) = US$244/ha. = 50,000 yen. The size of the cultivated land owned by most farmers, is 1 - 5 acres (1 - 5 acre of farmers occupy 47% of all the farmers). Supposing 2.5 acre as an average area (2.47 acre = 1 ha.), an average farmer earns 50,000 yen annually (as we calculate by means of rice only, adjustment of the figures with the other crops is necessary).

The cultivation style is using rain water, no fertilizer, no agricultural chemicals, no agricultural machines. Farmers

sell their products by themselves. If the cost of family labour can be neglected, US$244 is regarded as their net income.

Swamp land rice is single-cropped and the yield is low as mentioned above.

Comment

The following must be kept in mind is order to carry out the plan in this area hereafter.

a. Completing irrigation and drainage for double cropping.

b. Trying to increase the yield at each harvesting season. It is necessary to train farm leaders for extension. Is it possible to train them within the project?

c. The production cost at the present is only that of domestic labour. In case it is necessary to procure any agricultural materials in the future, farmers decrease the income at that rate.

d. In the area in which we surveyed, they transport their crops individually to Free Town. So the improvement of the roads to the market, securing of the market and rearrangement of distribution system are also necessary.

e. The maintenance cost of the structures should be minimized.

f. It is necessary to study the size of project based on the whole development plan and the governmental finance.

3. Cultivation

(1) Situation of Cultivation

Rhombe Swamp area at the estuary of the River Little Scarcies is called Mangrove Swamp. Mangroves dominate in this area. The effect of ebb and flow is great.

Around 1885, removal of the Mangroves and simple cultivation of rice started in this area. The fertility of the soil in this area has been kept by pile of silt which was brough from other places and by salty water. The farmers tell that the yield of rice now is the same as that in the past. Judging from that, the stable way of cultivating the land has been established

in supply of fertile soil by flood and salty warter, thorugh the yield is still low.

The weather data such as temperature, rain-fall and duration of sunshine, are surveyed at Rice Research Station, Rokupr, 12 Km north of Rhombe Swamp Table 9 and Fig. 2). Annual average temperature in Sierra Leone is 26.7°C, and the change in the year is small. As for rainfall, contrast of the dry season and the rainy season is sharp. About 97% of total yearly rainfall concentrates upon 7 months from May to November with a peak in August. The duration of sunshine is short in heavy rainly season of July/September (2 - 4 hours a day).

The River Little Scarcies is the source of water in this area. The ebb and the flow exert a great influence upon Rhombe Swamp, which is located near the river month. At high tide the salty counter current comes up into the rice fields. But in rainy season, the current does not damage the rice field, because the flux is so rich that the salty water can be diluted. On the other hand in the dry season (March - May) when the flux is low, and the water level is low, the salinity in the river becomes high and the use of the water for agriculture becomes impossible.

Consequently the rice cultivation in this area usually starts in June when the salinity in the water is low with a lot of rain and the harvest in the dry season of December and January.

The soil and water analysis which is important for cultivation is mentioned in Section 4, CHAPTER IV.

Table 9 Meteorological Data at Rokupr, Sierra Leone

Latitude=9°01'N : Longitude=12°57'W : Height above sea level=7.9m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average	No of yrs data recorded
Rainfall (mm)	4.3	1.0	10.2	52.3	185.4	373.1	576.3	750.5	511.3	367.3	154.2	18.3	2984.0	36
Temperature °C														
Maximum	32.8	33.6	33.7	33.7	32.7	30.6	28.9	27.8	29.5	31.0	31.4	31.8	31.5	26
Minimum	20.1	20.8	21.9	22.7	23.0	22.4	22.3	22.3	22.3	21.9	22.1	20.5	21.8	26
Average	26.5	27.2	27.8	28.2	27.9	26.5	25.6	25.1	25.9	26.5	26.8	26.2	26.7	
Relative Humidity(%)														
09.00	88	88	84	81	84	88	92	93	91	88	89	87	88	17
15.00	49	48	51	55	64	73	80	84	78	71	68	56	65	17
Daily sunshine(hrs)	7.7	7.9	7.9	7.0	6.3	5.2	3.3	2.1	4.1	6.3	6.7	7.3	6.0	26

Rice Research Station, Rokupr

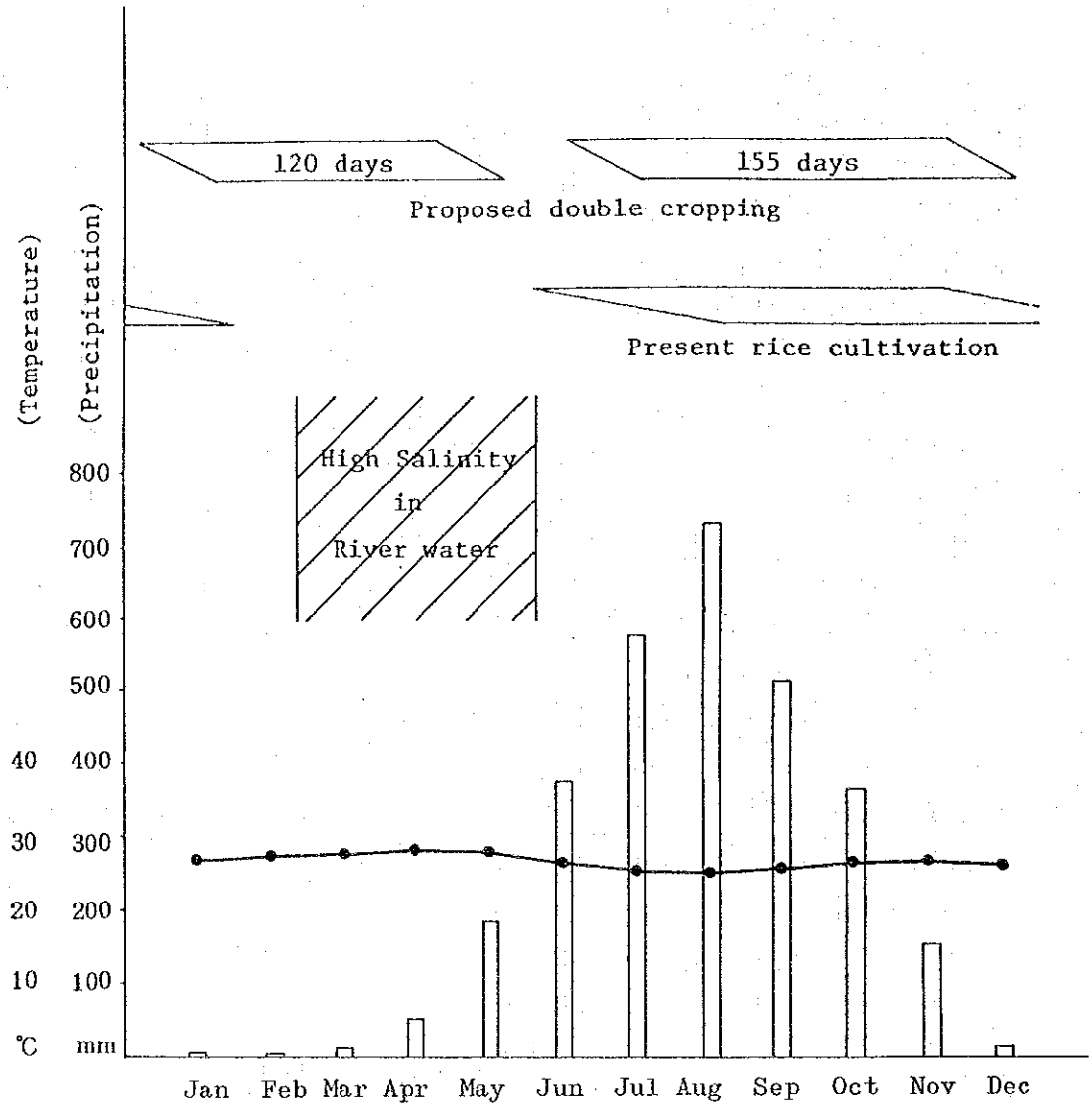


Fig. 2 Temperature, Precipitation, Salinity in the River Water and the Time of Rice Cultivation

(2) Outline of Rice Cultivation

The planting is made at the beginning of the rainy xeason (June/July) and the harvest is made in the dry season (November/ December). The programme of farming work is as follows (See Table 10 and Table 11).

1. Brushing 2. Burning and Clearing 3. Tilling
4. Nursery Work and Transplanting
5. Pest Control (Fencing, Bird and Monkey scaring)
6. Weeding 7. Harvesting 8. Threshing and Winnowing.

Nursery work starts around June when the salt which covers the surface of the land is washed away by rain, and the salinity in the water way becomes low. About 35 day rice plants are trans planted. Tilling is carried on by manual labour using hoe. Tilling is usually carried on when 5 - 10 cm deep water cover the rice field and it has aspect of puddling of the rice field in preparation for young rice plant (from a farmer's comment).

Study result about the comparison between manual digging and mechanical digging and the weeding effect is shown in Table 12. The effect of mechanical digging is remarkable.

Fertilizer has not been introduced. Study result of fertilizing effect is shown in Fig. 13. According to the figure the yield is increased by 32 to 40% by fertilizing.

The average yield of rice in the Rhombe Swamp is shown in Fig.14 and Fig. 15. Figures of rice yield varies 1.7 ton/ha. to 3.5 ton/ha depending on the year and the area. The Rhombe Swamp along the River Little Scancies is in the North Region of the country. The rice yield is high there compared with other areas in the swamp. It is about twice as much as the average yield of Sierra Leone. It is quite natural that the Government of Sierra Leone regards Rhome Swamp as being highly potential for rice cultivation.

Agronomic characteristics of rice varieties for Mangrove Swamp is shown in Table 16.

Table 10 Summary of Average Labour Use Per Acre (Man-days) on Sierra Leone Mangrove Swamp Rice Farms, 1971/72

Farm Activity	Region	
	1	2
1. Brushing	17.0	5.9
2. Burning and Clearing	2.3	3.7
3. Tilling	48.5	11.0
4. Nursery Work and Transplanting	80.5	36.7
5. Pest Control (Fencing, Bird and Monkey Scaring)	0.9	0.1
6. Weeding	1.6	0.0
7. Harvesting	33.3	26.2
8. Threshing and Winnowing	6.8	n.a.
9. Total Labour[a/]	184.1	83.6
10. Hired Labour - Total	30.7	11.8
- Percent (%)	16.7	14.1
- Value Per Man-day (Le.)[b/]	0.31	0.37

Notes: n.a = Not Available.

a/ Excludes threshing and winnowing.

b/ Weighted average amount paid for hired labour. Includes estimate of value of payment in kind where appropriate.

Source: Field Survey

Table 11 Monthly Distribution of Labour Per Farm on Mangrove Swamp Rice Farm in Sierra Leone - Region 1 (Scarcies), 1971/1972 (Average Farm 2.16 Acres)a/

Activity	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Brushing and Felling	0.0	0.0	0.0	0.0	19.7 (13.3)	6.1 (10.1)	10.4 (15.1)	0.6 (1.4)	0.7 (1.9)	0.0	0.0	0.0	37.5 (32.4)
Burning and Clearing	0.0	0.0	0.0	0.0	0.0	0.1 (0.6)	1.2 (3.4)	2.3 (3.2)	1.4 (4.3)	0.0	0.0	0.0	5.0 (11.3)
Ploughing and Puddling	0.0	0.0	0.0	0.0	11.7 (8.9)	27.3 (30.2)	44.7 (32.1)	13.7 (11.5)	6.8 (12.8)	0.0	0.0	0.0	104.6 (66.4)
Nursery Work and Transplanting	0.0	0.0	0.0	0.0	29.9 (13.5)	16.6 (14.8)	27.4 (28.7)	68.5 (38.0)	34.6 (36.6)	0.0	0.0	0.0	177.0 (90.8)
Pest Control	0.0	0.0	0.0	0.0	0.0	2.0 (4.9)	0.0	0.0	0.0	0.0	0.0	0.0	2.0 (4.9)
Weeding	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3 (5.8)	3.6 (16.5)
Harvesting	36.6 (31.5)	7.8 (22.2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.9 (27.8)	73.3 (42.0)
Threshing & Winnowing	0.7 (2.7)	9.5 (12.3)	4.3 (7.6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5 (1.7)	15.0 (11.9)
Total Hired Labour	7.3 (10.9)	3.8 (8.6)	1.5 (3.5)	0.0	4.6 (3.9)	8.2 (10.7)	16.4 (19.2)	10.1 (13.0)	7.4 (13.3)	0.0	0.0	8.2 (7.9	47.5 (51.9)
Total Labour b/	38.9 (30.4)	7.8 (22.3)	0.0	0.0	61.3 (27.4)	52.3 (32.7)	85.7 (50.7)	85.1 (43.0)	43.5 (44.4)	0.0	0.0	30.5 (27.2)	405.0 (191.6)

a/ Standard deviations are in brackets.

b/ Exclude labour for threshing and winnowing.

Source: Field Survey

Table 12 The Effect of Tillage and Weed Control on Yield (KG PER HA) of Rice in Associated Swamp at Rokupr

(Rice Research Station 1974)

Cultivation Method	No. Weeding	Weed Control Method Handweeded x 2	Handweeded x 3	Herbicide +Handweeded	Means
Manual	1,472	3,457	3,575	3,863	3,092
Mechanical	2,965	4,007	4,229	4,028	3,807
Means	2,218	3,732	3,902	3,945	

C.V. = Cultivation methods = 4.1% S.E. Cultivation method = ±35.8

C.V. = Weed control methods=14.8% S.E. Weed control methods = ±255.4

L.S.D. (0.05) for comparison of two cultivation means = 162

L.S.D. (0.05) for comparison of two weed control means = 536

L.S.D. (0.05) for comparison of two weed control methods at same cultivation = 758

L.S.D. (0.05) for comparison of two weed control methods at different cultivations or same weed control method at different cultivations = 674

Table 13 Average Grain Yield (Kg/ha) and Response of Mangrove Rice Varieties to Fertilizers in the Tidal Swamp at Rokupr

(Rice Research Station 1974)

Varieties:	Fertilized:	Unfertilized	Response:	increase over un-fertilized:
DD 2	3758 (129.5)	2850 (134.2)	908	31.9
ROK 4	3877 (133.6)	3769 (130.4)	1108	40.0
ROK 5	4179 (144.1)	2996 (141.1)	1183	39.5
Local	2901	2124	777	36.6

Figures in parenthesis indicate the percentages taking control yield as 100.

Table 14 Average Rice Yields on Sierra Leone Mangrove Swamp Rice Farms

Source	Year	Region	Yield per ha (Kg)
Spencer Survey[a/]	1971/72	North	3572
	1971/72	South	1711
	1971/72	Sierra Leone	2642
Central Statistics Office[b/]	1970/71	North	2615
	1970/71	Sierra Leone	2870
	1970/71	Sierra Leone	2616
Rice Research Station[c/]	1971/73	North	3238
Pillai[d/]	1921	North	2479

a/ Field Survey.

b/ Agricultural Statistical Survey of Sierra Leone.

c/ Will and Janakiram, Mean Yield of Unfertilized Improved Variety Rok - 5 in Rokupr trials.

d/ Report on Rice Cultivation.

Table 15 Rice Yield on Sierra Leone

From FAO Prod. Yearbook 1979

Year	1969 - 71	1977	1978	1979
Area harvested	331	410	425	400
Yield Kg/ha	1,431	1,463	1,459	1,200
Production 1,000 MT	474	600	620	450

Table 16 Agronomic Characteristics of Swamp Varieties

(Rice Research Station, Rokupr)

	CHARACTERISTICS	VARIETIES		
		BD 2	ROK 4	ROK 5
1.	Parentage:	Selections from the cross SR 26 x Wellington		
2.	Total Trillers/m^2	314	282	288
3.	Height (cm)	159	165	148
4.	Panicles/m^2	296	282	286
5.	Days to Flower	106	107	110
6.	Maturity (Days)	135	129	139
7.	Photo-sensitivity	Weakly ensitive	Weakly sensitive	Weakly sensitive
8.	Growth Form	Erect	Erect	Erect
9.	Disease reaction:			
	(a) Blast Leaf	I	I	I
	Neck	I	S	I to S
	(b) Helminthosonrium	I	I	I
	(c) Rynchosporium	I to S	I to S	I to S
10.	Lodging	S	S	S
11.	Vigour	Early	Early	Early
12.	Grain appearance	White	White	White
13.	1000 Grain Weight (gm)	36.36	29.52	28.48
14.	Grain Length/Breadth Ratio	Slender	Slender	Slender
		3.43	3.04	3.58
15.	Protein Content (Brown Rice) %	7.2	5.4	5.9
16.	Amylose Content (Dry Basis) %	27.5	27.5	27.8
17.	Eating Quality	Excellent	Very good	Excellent

R. = Resistant; I. = Intermediate S. = Susceptible

(3) Problems concerning Rice Cultivation

According to the talks of the farmers in Rhombe Swamp area, the problems they are now facing are as follows:

a. Damage of Flood after Transporting

If young rice plants are small, they will be covered with the water or washed away. Becuase of this, young rice plants must be grow again and tranceplanted again. In this case delaying of harvest and decreasing of yield necessarily follow.

b. Loss of the Product at Harvest Time

Because of shortage of labour, timely harvest is impossible. Untimely harvest also comes from irregular growth of rice caused by the irregular seeds and rough farming. Untimely harvest makes rice grains excessively dry and brings about considerable loss of grains at threshing.

c. Damage by Crabs at Transplanting (Crabs eat the yount rice plants)

d. Decrease of Yield by Weed

The problems proposed by the report of Rokupur Rice Laboratory are as follows:

a. Unsuitable or delayed digging.

b. Manual tilling which requires a great deal of labour.

c. Lack of usage of machines.

d. Unskilled cultivation, low planting density, and lack of weeding and supplimentary planting.

e. Failure of row planting

f. Usage of aging plant and plant of bad quality.

g. Inappropriate fertilizing or non-fertilizing cultivation.

h. Usage of variety of low productivity.

Rice cultivation at present is quite alien to such conditions which guarantee constant high yield as control of water and usage of improved variety, fertilizer, agricultural chemicals, and

improved agricultural machines. Low productive cultivation has been kept by the use of rain water in rainy season, usage of irregular seeds and local variety, and traditional way of agriculture without contact with the result of Rice Research Station and the new agricultural technique.

In order to change the traditional way of farming to double-cropping system which is the aim of the government, the problems mentioned above must be solved, and the problems arising from introducing new technique must also be solved.

(4) Comment

A. Estimated Yield

Table 17 Fertilizer Application Test

Variety	ROK 5		Local Variety	
Fertilizer Application	+ (b)	- (c)	+ (b)	- (c)
Yield (a) kg/ha	4,179	2,996	2,901	2,124
(a) x 0.60	2,507	1,797	1,740	1,274
(b) / (c)	1.39		1.39	

Rice Reasearch Station Rokupr 1971 - 1974

* Amount of Fertilizer Applied per ha. N=67 kg P=45 kg K=0 kg

Table 17 shows the yield of ROK5 which is improved for mangrove swamp by Rice Research Station Rokupur and local variety in the case of fertilization and non-fertilization. Considering the fact that traditional farming method is non fertilizing one and they do not practice appropriate cultivation technique, if we regard 60% yield of the station as estimated yield, ROK5 reaches 1,797 Kg/ha. and local variety reaches 1,274 Kg/ha.

Local variety allow some latitude in its yield. It is understandable that there is little disparity even when we introduce improved variety into the traditional farming. Nevertheless, once

fertilized, yield of Rice Station variety reaches 4,179 Kg/ha. Even if 60% of the yield is obtained, it reaches 2,507 Kg/ha. This is twice as large as that of non-fertilized local variety. Consequently if we are going to increase the yield, introduction of new variety and the extension of fertilizing technique as well as water control concerning the improvement of farm land are necessary.

Introduction of new variety, the technique of using fertilizer and water control together with farm consolidation is necessary to increase yield.

In case double-cropping is introduced, the second cropping will be in the dry season. The double-cropping test started in 1979 at Rice Research Station. The result has not reported yet. It is difficult to forecast the yield in dry season because of the following uncertain factors.

a. Physiological trouble of the plant caused by acidification of the soil in dried rice field.

b. High salinity in irrigated water.

c. Farmers' understanding to new techniques

B. Some Comment on Introduction of New Cultivation Skills and Double Cropping System (See Fig. 2).

The first one out of double cropping would be rainy season cropping like traditional way. The variety of about 155 day growing period with weak photosensitivity can be used and the cultivation follows the example of an existing one. The second cropping is to be practised using the variety of about 120 days growing period with non-photosensibility. At each cropping time perfect digging, weed control, fertilizing, pest control and using high quality of seeds are required to increase the yield. Particularly the second cropping is new and it requires an appropriate water control. In this respect, training farmers in advance is necessary.

The followings are conditions and matters to be considered to introduce a double cropping system.

a. From March to May to prevent salty water from flowing into channels which are connected to the River Little Scarcies with civil engineering work and obtaining fresh water from other resources. This is the basic condition.

b. To water rice field for at least a month after transplanting, and two months around the time for earing. In case of cultivating rice in dry season, the main factor determing the yield is water.

c. To till and weed sufficiently after the harvest. If they cannot use working cows because of desease in Africa, introduction of tractors must be considered in order to till. Considering a deep rice field, and carrying tractors by boat, 4-6 H.P. small tiller is desirable.

Supposing a small tiller spends 2 - 3 hours on tilling 10 ha. of field, it spends three days on tilling 1 ha. of field. In case planting continues for a month, a tiller can till 10 ha.
If the project area is 2,000 ha., and a farm has 2 ha. in the area, a tiller can cover 5 farms; therefore, 200 tillers would be required in the area. The machine centre to keep these 200 tillers and the training of farmers to use the tiller are indispensable. At present Honda's small-sized tiller obtains gratifying results at Rice Research Station, Rokupr.

d. To use Fertilizer properly

In growing rice repeatedly, fertilizer is necessary to get high yield. 80 tons of nitrogen is required in a season under the following assumption.

About 40 Kgs of nitrogen should be used for fertilizing 1 ha. of field, and the project area to be fertilized would be about 2,000 ha. 40 Kgs/ha. x 2,000 ha. = 80 tons in one season.

About 400 tons of ammonium sulphate is equivalent to 80 tons of nitrogen. It is necessary to build warehouses to keep agricultural equipment as well as fertilizer.

e. To train farmers and instructors to deal with high quality seeds, water control, fertilizer and pest control.

f. To adopt traditional ways of cultivation as much as possible in the case of rainy season cropping. These would maintain fertility of the soil and would be accepted by the farmers easily.

g. To introduce technique to prevent the damage by insects and birds in dry season cropping.

h. To grow leguminous crops once in three years to keep the soil fertile and to avoid monoculture of rice is project area.

i. As for double cropping in Mangrove Swamp, they started testing as late as in 1979 at Rice Research Station at Rokupr. They have not got satisfactory results. So it is necessary to test double cropping in advance to the feasibility study.

Bibliography

1. Spencer, D.S.C. "The Economics of Rice Production in Sierra Leone, Mangrove Swamp Rice" Department of Agricultural Economics and Extension, Njala University College (Univ. of Sierra Leone) Bulletin No.2 June 1975.

2. Will H. and Janakiram D.

"Improved Swamp Rice Varieties for Sierra Leone Farmers" Bulletin No.2 Rice Research Station, Rokupr Min. of Agriculture & Natural Resources, December 1974

3. Mahapatra, I.C.

"Recent Advances in Agronomic Research on Rice in Sierra Leone" Rice Research Station, Rokupr

4. Janakiram, D.

"Performance of Improved Upland and Mangrove Swamp rice Varieties Developed in Sierra Leone"
Rice Research Station, Rokupr

4. Soil & Water Analysis

(1) Formation of Soil

Old crystalline rock is weathered rapidly by hot and humid climate in Sierra Leone. Silicic acid mineral is resolved into silicic acid, base (Ca. Mg. K. Na), aluminium and iron. Among these minerals silicic acid and aluminum become kaolinite type clay which is reluctant to preserve fertility of soil. The others, particularly quartz remains in the soil and changes into sand. On the other hand, surplus iron and aluminium are combined to become infusible mineral. Aluminium is combined with exchangeable complex and has an injurious effect on the balance of water and nurishment of the soil. Generally Sierra Leonean dark-coloured basic rock provides more iron and aluminium, and less quarts than such light-coloured rock as oxidized granite and gnesis. Weathering is remarkable in Rhombe Area where they have much rain. The parent material of the soil in the area was weathered in the past.

(2) Oxidization and Reduction

The soil of the swamp has been exposed to flood every year for a long time and it is more or less reduced. In the place where the water covers the land, the soil is fully reduced and shows a gray tint. At the place where the land is covered by the water partially the soil is oxidized and reduced alternately and shows gray or red mottled tints. In Sierra Leone where high humidity and dryness alternates, the red mottle in the lower layer grows to be a clod. When it faces air, it reacts irreversibly and becomes Plinthite.

(3) Accumulation of Organic Matter

The soil of swamps generally contains rich organic matter, because plants are resolved in swamps slowly and swamps are kept in natural condition. The organic content in the upper layer is relatively high, (2 - 5% of organic carbon). The fertility of the soil deeper than 30 cm from the top is low.

(4) Salinity in Soil

The influence of salty water from the sea on the farm is weakened by rainfall is rainy season,whereas in dry season the influence of the tide is considerable. Because of this the salinity changes throughout the year. Electrical conductivity of the soil is 1-2 $m^{\mho}/cm$ in rainy season while it reaches to 30 $m^{\mho}/cm$ in dry season (WARDA, 1977), although the value 30 $m^{\mho}/cm$ is not certified yet. 30 $m^{\mho}/cm$ is coverted to 18,000 P.P.M in salinity. Any plant cannot grow at this salinity.

(5) Reaction of Soil

In the natural condition, namely fully reducing condition, sulfer compound provided by the sea water changes into sulfide and keeps the soil neutral. But it this is drained, sulfide is oxidized and becomes sulfate and sulfuric acid, which puts down PH of the soil to 2 - 3. Such soil is called cat clay. At the same time, phosphorus is combined with iron and manganese and becomes insoluble matter. Excessive acidity produces free aluminium.

(6) Cation-exchange Capacity

Cation exchange capacity of the soil is between 8 and 20 me. The soil is fertile by nature and good for growing plants.

(7) Soil Texture

In general badly drained soil is for the most part silt clay or silt loam. According to the field survey with boring stick, a little amount of silt sand is seen near Rhombe village, and around Benti Creek at most all the soil is clay. The result of survey at left side of the middle course of Benti Creek is as follows:

Available soil depth:	more than 1 m		
Plongh layer	: approx. 15 cm		
Colour	: 0 - 15 cm	black-gray	(moist)
	: 15 - 28 cm	gray-blue	(")
	: 28 - 50 cm	blue	(")
Humus	: 0 - 15 cm	much	
	: 15 cm	little or non	
Mottle	: 25 - 50 cm	sharp red mottle	
Moisture	: 50 cm	moist	
	: more than 50 cm	humid	
Gley horizon	: 28 cm -		

(Feb. 5, 1981)

Compared with above data, the paddy soil around the Rhombe village contains less humus and has remarkable oxidized deposit between surface soil and 20 cm depth and around 50 cm depth, and gley horizon around 20 cm - 30 cm depth. It is characteristic that these soils have no gravel, no crumb structure, or no pore space.

(8) Summary of the Soil Properties

Summary of the soil properties is shown in Table 18.

Table 18 SUMMARY OF SOIL PROPERTIES (FAO, P - 57)

	Munsell colour of subsoil (1)	Subsoil drainage	Texture topsoil (2) subsoil	Topsoil Organic carbon (%)	pH (1:1H_2O) topsoil subsoil	CEC (Meg %) topsoil subsoil	Base set. (%) topsoil subsoil
1	N3	Water-logged	SiC-C SiC-C	4.0	5.2 2.8 (3)	14.6 16.5	42 53
2	10YR 5/1, mottled	Very poorly drained	SiL-C CL-C	2.3	4.6 4.5	5.9 3.1	31 55
3	10YR 6/2-2.5Y 7/2, mottled	Poorly drained to very poorly drained	L-CL C	3.2	4.6 4.8	22.0 12.0	13 -

Footnotes

(1) Indicative of drainage condition
(2) Defined here as any humic horizon above 50 cm
(3) Analysed after drying

NB Only those soils for which reasonably reliable analytical data are available are listed.

Texture symbols

C - clay
L - loam
S - sand (y)
Si - silt (y)
g - gravelly
vg - very gravelly
st - stony
Co - coarse

(denotes incomplete data)

(9) Analysis of Water (Salinity of Irrigation Water)

The survey in the past shows the relation between the quality of water, the flux of river and the tidal level. Outline of this is as follows:

The salinity of water relates both to the flux and the high tide level when the flux of the River Little Scarcies is more than 700 cusecs (20 m^3/s). When the flux is below this, the salinity is only influenced by the high tide level. In spring when the flux of the river is low and the tide level is high, sea water goes up into the river most in the year. The test of electrical conductivity in this season with which the salinity can be measured is as follows:

Place	E.C(μ℧/cm)	Approximate Distance from the River Mouth
Sirian	400	30 Km
Katoma	4,700	23 Km
Kikan	10,000	19 Km
Konta	14,000 - 25,000	15 Km
Kagbulo	16,000 - 8,000	9 Km

Judging from the above date, the water quality near Mabama is estimated to be somewhere between 5,000 μ℧/cm and 15,000 μ℧/cm.

At Benti Creek the influence of the tide is seen up to Robis.

Suitable salinity for rice growing is above 830 P.P.M. (NaCl). It is converted to E.C. 1400 - 1600 μ℧/cm. At Mabana in Benti North, E.C. reaches 5,000 - 15000 μ℧/cm; therefore, rice must be grown carefully. Generally upper water in the creek of the swamp area is considered to be appropriate for agricultural use; however, attention must be paid to the salinity and oxidization of the water. When sunshine duration is long, algae grow rapidly, which may prevent the waterflow.

(10) Land Utilization

This area is a low flat land drained poorly; furthermore, in dry season, the influence of the tide is so great that only the variety of rice with high tolerance to salt can be planted. In Rhombe and Bendi North quite a lot of rice cultivation is seen as seen Table 1. Besides rice, the cultivation of sweetpotatoes can be seen on rare occasions along Benti Creek.

(11) Comment

A. Soil

The soil property seems to be nearly uniform in the project area. Essential survey must be made to get necessary data.

a. Choice of Survey Point

The place of test drilling should be set in one place every 25 ha. The soil sample should be collected in one place every 100 ha. and besides it should be collected from each layer of soil.

b. Record of the Test Results

Soil profile survey paper should be used.

c. Others

Acidization of water is the soil caused by dryness shall be surveyed.

B. Quality of Water

The most serious problem on the agricultural water in this area is high salinity in the dry season. Because of this the following survey is necessary. It is unnecessary to survey general items. Nevertheless the survey of nitrogen and phosphor in the water which seems to stimulate the growing of algae is necessary in relation to fertilization.

a. Water Quality of the River

Salinity of water in the river should be examined on the different distances from the river mouth, different fluxes of the river, different seasons and the different levels of the water.

b. Quality of the Waters (Creek) in the Swamp Area

Salinity of the water should be surveyed in relation to the test results of the river water quality, because water quality in the swamp area is sure to be influenced by the water of the river.

c. Influence of acidization of soil water caused by the dryness of the soil on the water in the project area

In case existing poorly drained rice field turn out to be a well drained one, the soil would become more acid. The influence of this phoenomenon on the irrigation channel water outside the rice field need to be studied.

5. Hydrology

(1) General Conditions

A. Location and Topography

Sierra Leone is situated in West Africa with an area of 73,326 Km^2, and is bordered with Guinea and Liberia. About 56% of the land of this country is within 500 feet above sea level. (Table 19, Fig. 3)

One of the topographic features of the country is swamps dotted along the coast line, almost all of which are several feet above sea level and are thickly grown with mangroves. The estuary with numerous low islands and sand hills is a complex of land and sea. Rhombe Swamp is one of those swamps.

Rivers are the Gt. Scarcies, the Little Scarcies, the Roker, the Jong, the Sewa Waanje, the Moa and so forth. Rhombe area is located at the delta of the river month of the Little Scarcies. (Fig. 4)

B. Weather and Hydrology

The basin of rivers in Sierra Leone is small compared with that of other African Countries. The biggest, the Sewa has 5,460 square miles of basin, followed by the Little Scarcies (4,970 square miles) and the Jong (2,900 square miles).

A thorough survey of the flux of the rivers has not been made yet. There are few reliable data. In connection with the amount of rainfall, the water level of the rivers changes between 50 and 60 feet. In the upper courses, the rivers become narrow in dry season. In the lower courses, the rivers are influenced by the change of tide level of 7 to 12 feet.

There are two main factors concerning the rainfall in Sierra Leone. They are 1) thunder storms at the beginning and the end of rainy season, and 2) monsoon type rainfall from mid-June through late September.

Average Rainfall During the Year

Generally speaking the rainfall decreases gradually in the east inland area. However it changes in accordance with the change in topography and altitude. (Fig. 5)

In coastal area average rainfall is 120 inches, and it ranges from 130 inches at the estury of the two Scarcies to 120 inches at the South end of the country.

Monthly Change of the Rainfall

Except for coastal highland near Freetown and the northern part of the country, monthly change of the rainfall is small, approximately 10%.

Table 19 Area height relatiohship

Contour Interval (ft).		Percentage of Land	
		Absolute	Cumulative
Over	3,000	0.40	0.40
2,000	3,000	2.06	2.46
1,000	2,000	26.97	29.43
500	1,000	14.73	44.16
0	500	55.84	100.00

Rainfall in Rainy Season (From May to November)

Almost all of the annual rainfall concentrates in rainy season. In the highland and the north part of the country, the rainfall is from 10 to 12 inches every month from June through October with least monthly changes. In coastal and eastern hilly area, for at least two months during the period of July, August and September, the rainfall records higher than 20, or even 30 inches.

Temperature

There is little monthly change of temperature. For example at Katonga in Rhombe Swamp monthly average temperature is 78°F in August and 83°F in May. (Table 20, Fig. 6)

Table 20 Temperatures

a) The mean maximum temperature in °F
b) The mean minimum temperature in °F
c) The mean daily temperature in °F

Station		Jan	Feb	Mar	Apr	May	J e	Jly	Aug	Sep	Oct	Nov	Dec
Katonga 1971	a)	92	91	94	86	91	88	86	83	85	88	89	88
	b)	68	71	70	73	74	72	72	72	72	72	71	72
	c)	80	81	82	80	83	80	79	78	79	80	80	80

(2) Hydrology in Rhombe

Most reliable data for hydrology of Rhombe is "Rhombe Swamp Engineering Feasibility Study" made by MRT consultant in 1972. The following data is reported in the volume 2 of it.

The report collected data from 1946 to 1971 from 1955 to 1971 for Rokupr. The counterparts in the surveyed places explained that temperature, rainfall, and the flux of river in MRT data is reliable, though these items are not measured now because annual change is small. However it is not conceivable that they stoped the observation which had been continued for 26 years at the stage of MRT data. Furthermore, on account of the fact that there is an international airport at Lungi, the survey is most likely to be continued. Outside the area, the data for daily rainfall and evaporation at Bumbuna from 1st September, 1972 to 31st January 1975 are reported in "Hydrological Year Book of Sierra Leone".

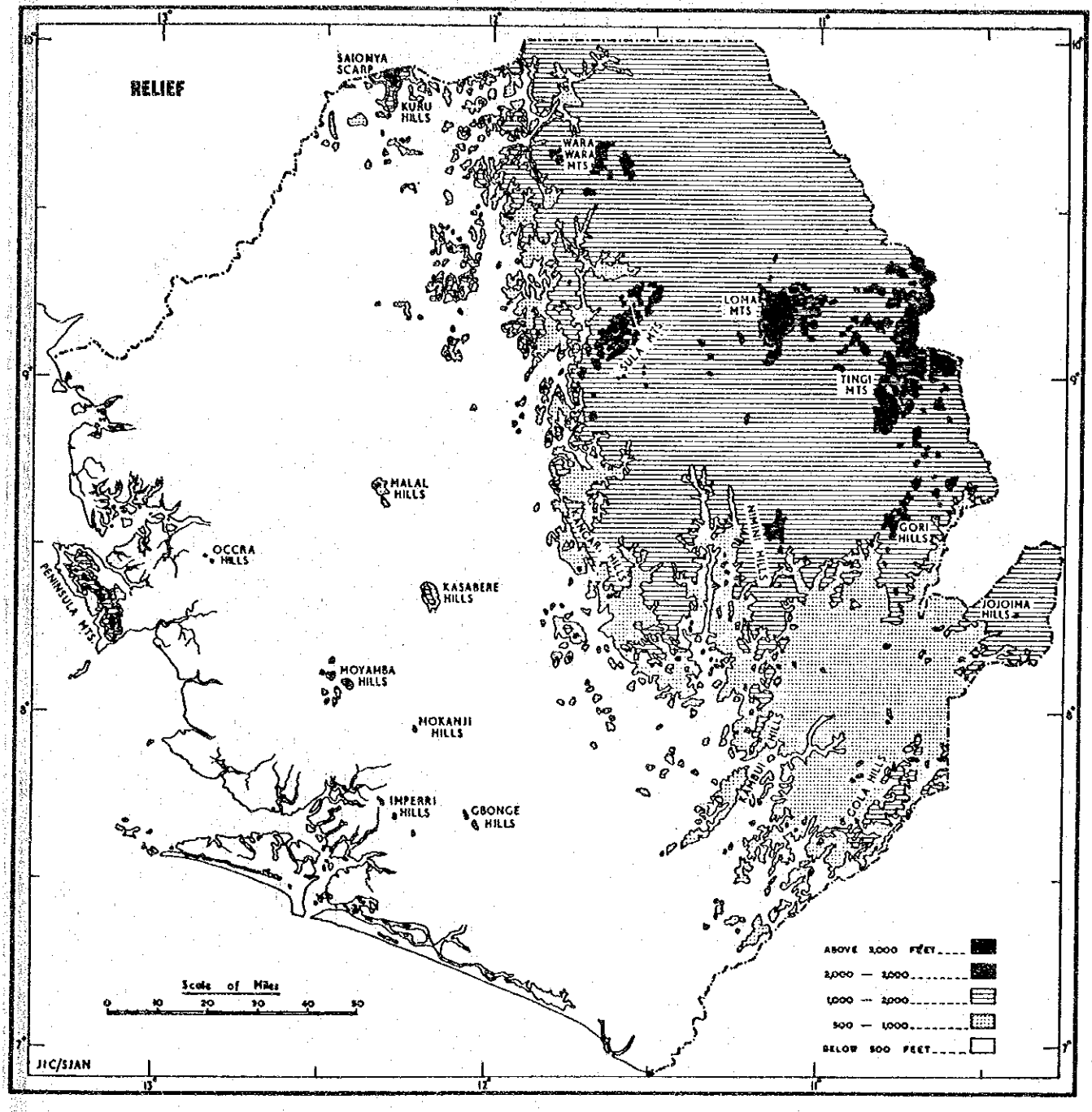

RELIEF
SAIONYA SCARP
KURU HILLS
WARA WARA MTS
LOMA MTS
SULA MTS
TINGI MTS
MALAL HILLS
OCCRA HILLS
PENINSULA MTS
KASABERE HILLS
GORI HILLS
NIMBIM HILLS
JOJOIMA HILLS
MOYAMBA HILLS
HOKANJI HILLS
IMPERRI HILLS
GBONGE HILLS
KWAHU HILLS
GOLA HILLS
Scale of Miles
0 10 20 30 40 50
ABOVE 3,000 FEET
3,000 — 2,000
2,000 — 1,000
1,000 — 500
BELOW 500 FEET
JIC/SJAN

Fig. 3

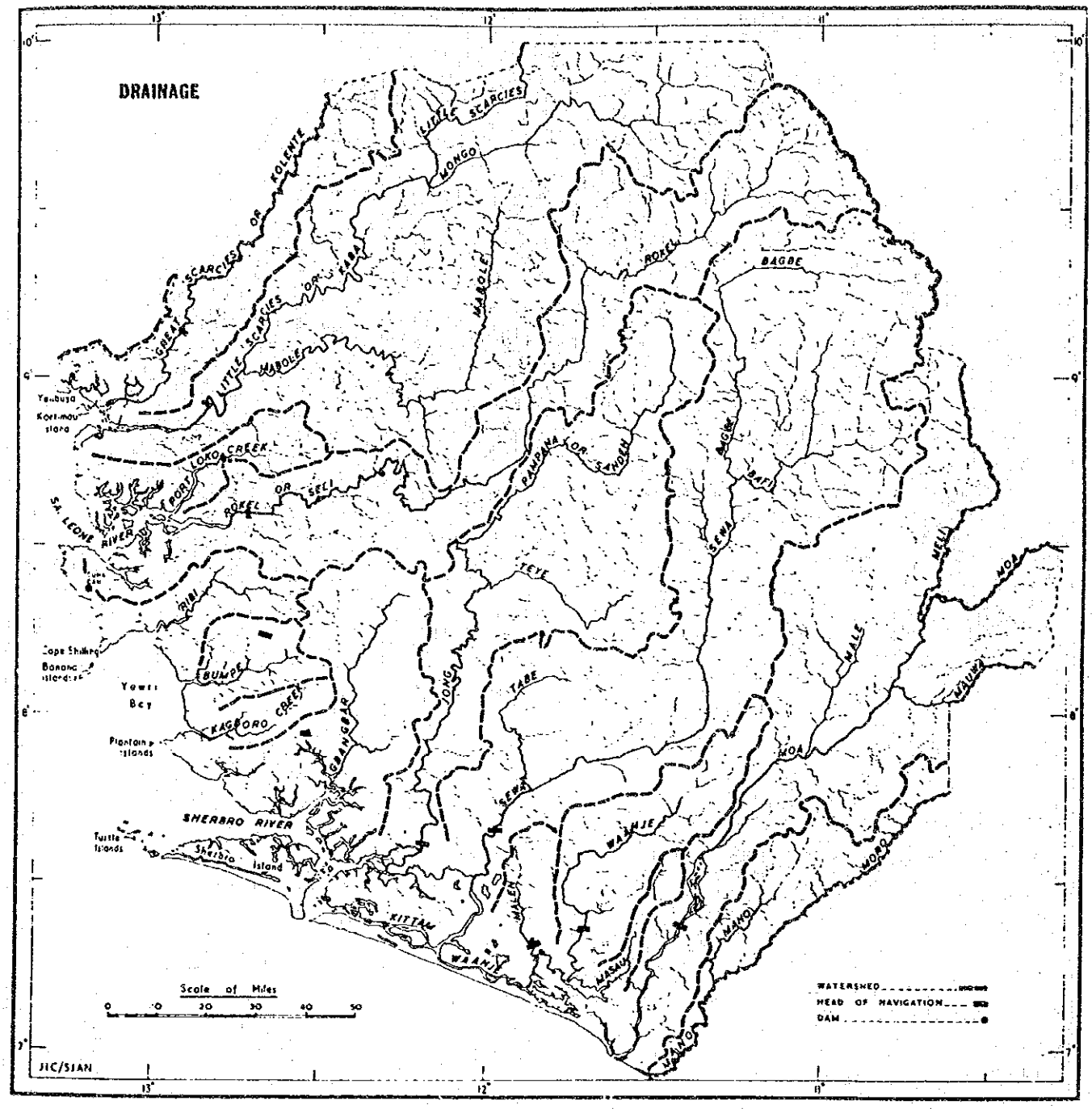

DRAINAGE
GREAT SCARCIES OR KOLENTE
LITTLE SCARCIES
MONGO
LITTLE SCARCIES OR FABA
MAROLE
ROKEL
BAGBE
PORT LOKO CREEK
ROKEL OR SELI
PAMPANA OR SYHOLE
BAGBE
SEWA
SA. LEONE RIVER
RIBI
TEYE
MELI
MOA
Cape Shilling
Banana Islands
BUMPE
Yawri Bay
KAGBORO CREEK
TABE
JONG
MALE
WAUMA
Plantain Islands
GANGBAR
MOA
SHERBRO RIVER
SEWA
WAANJE
Turtle Islands
Sherbro Island
KITTAM
MALEN
MORO
WANJE
MASAM
MANDI
BAN OF
Scale of Miles
0 10 20 30 40 50
WATERSHED
HEAD OF NAVIGATION
DAM
JIC/SIAN

Fig. 4

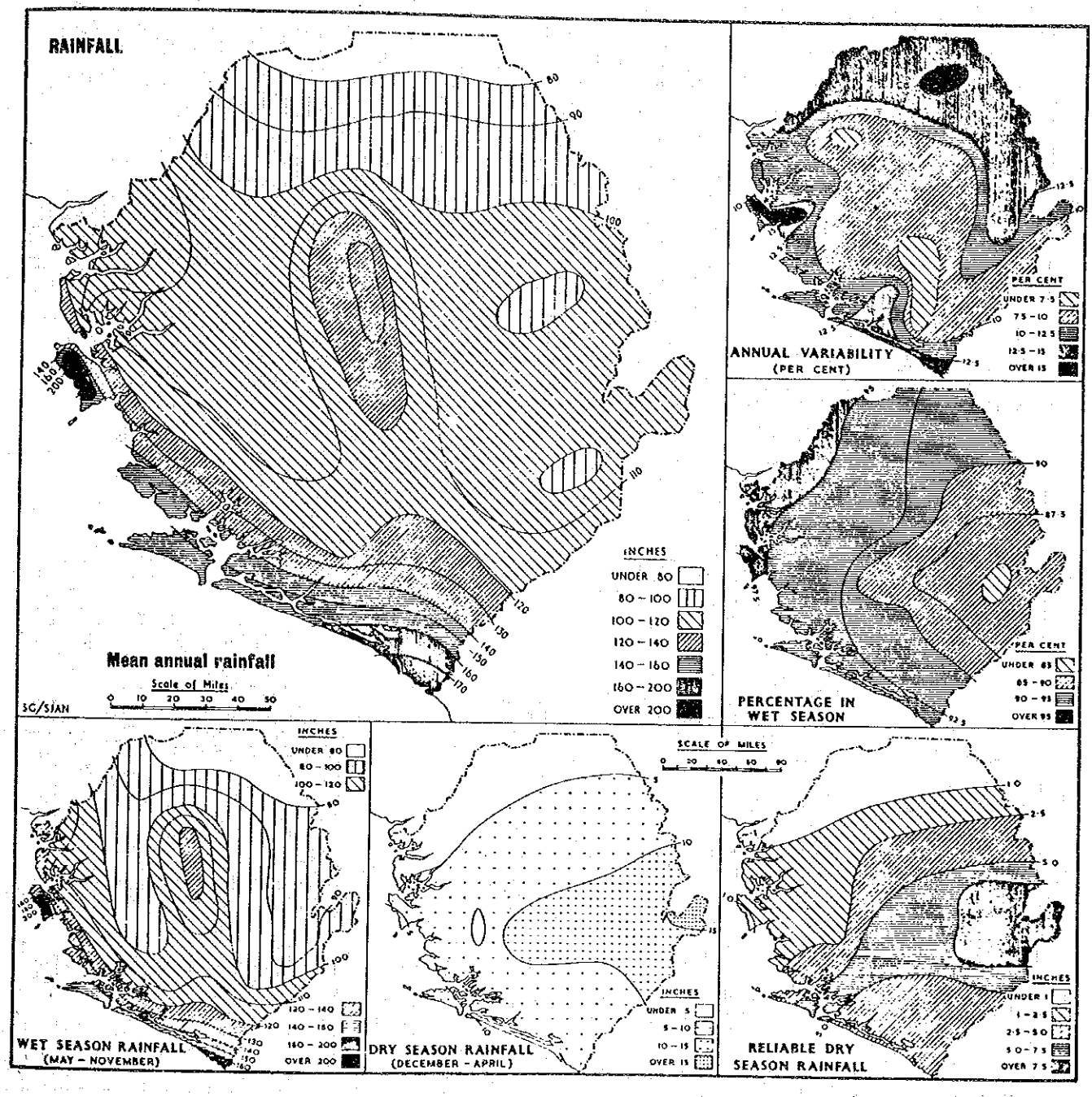

RAINFALL
Mean annual rainfall
Scale of Miles
0 10 20 30 40 50
SG/SJAN
INCHES
UNDER 80
80 – 100
100 – 120
120 – 140
140 – 160
160 – 200
OVER 200
ANNUAL VARIABILITY
(PER CENT)
PER CENT
UNDER 7·5
7·5 – 10
10 – 12·5
12·5 – 15
OVER 15
PERCENTAGE IN
WET SEASON
PER CENT
UNDER 85
85 – 90
90 – 95
OVER 95
WET SEASON RAINFALL
(MAY – NOVEMBER)
DRY SEASON RAINFALL
(DECEMBER – APRIL)
SCALE OF MILES
0 20 40 60 80
INCHES
UNDER 5
5 – 10
10 – 15
OVER 15
RELIABLE DRY
SEASON RAINFALL
INCHES
UNDER 1
1 – 2·5
2·5 – 5·0
5·0 – 7·5
OVER 7·5

Fig. 5

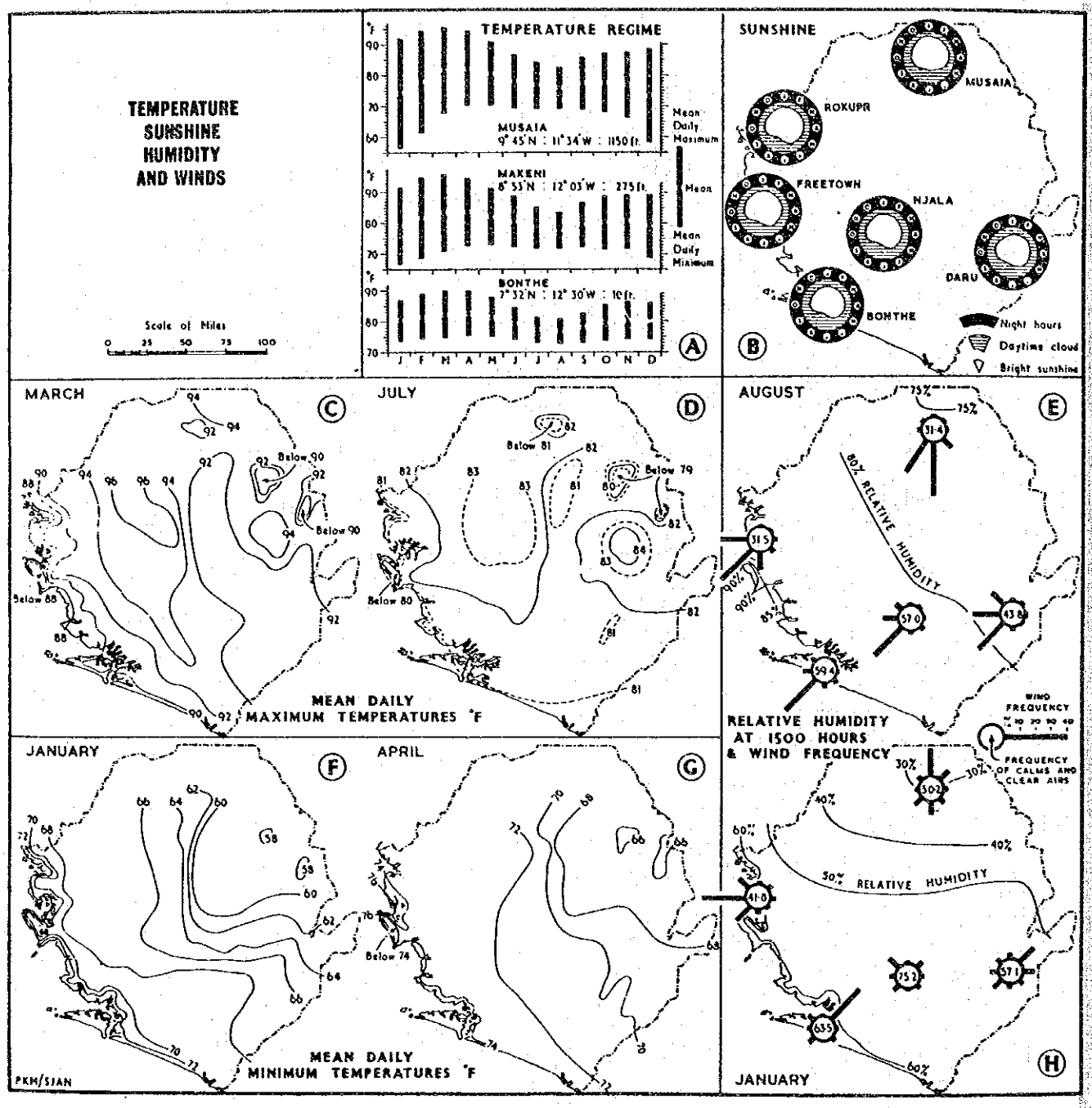

TEMPERATURE
SUNSHINE
HUMIDITY
AND WINDS
Scale of Miles
0 25 50 75 100
TEMPERATURE REGIME
MUSAIA
9° 45'N : 11° 34'W : 1150 ft.
MAKENI
8° 53'N : 12° 03'W : 275 ft.
BONTHE
7° 32'N : 12° 30'W : 10 ft.
Mean Daily Maximum
Mean
Mean Daily Minimum
J F M A M J J A S O N D
A
SUNSHINE
MUSAIA
ROKUPR
FREETOWN
NJALA
DARU
BONTHE
B
Night hours
Daytime cloud
Bright sunshine
MARCH
C
JULY
D
AUGUST
E
MEAN DAILY
MAXIMUM TEMPERATURES °F
80% RELATIVE HUMIDITY
RELATIVE HUMIDITY
AT 1500 HOURS
& WIND FREQUENCY
WIND FREQUENCY
FREQUENCY OF CALMS AND CLEAR AIRS
JANUARY
F
APRIL
G
50% RELATIVE HUMIDITY
MEAN DAILY
MINIMUM TEMPERATURES °F
PKH/SJAN
JANUARY
H

Fig. 6

Table 21 shows monthly evaporation at Lungi and Kotonga. Fig.7 shows geographical relation between observation point and Katonga. Fig. 8 shows rough estimate of the change of rainfall in Rhombe Swamp. Table 22 shows temperature. Table 23 shows the rainfall at Rokupr. Table 24 shows the rainfall at Port Loko. Table 25 shows the rainfall at Lungi. Table 26 shows the rainfall at Katonga. Table 27 shows the rainfall at Makot.

Table 21

Evaporation data for Lungi and Katonga

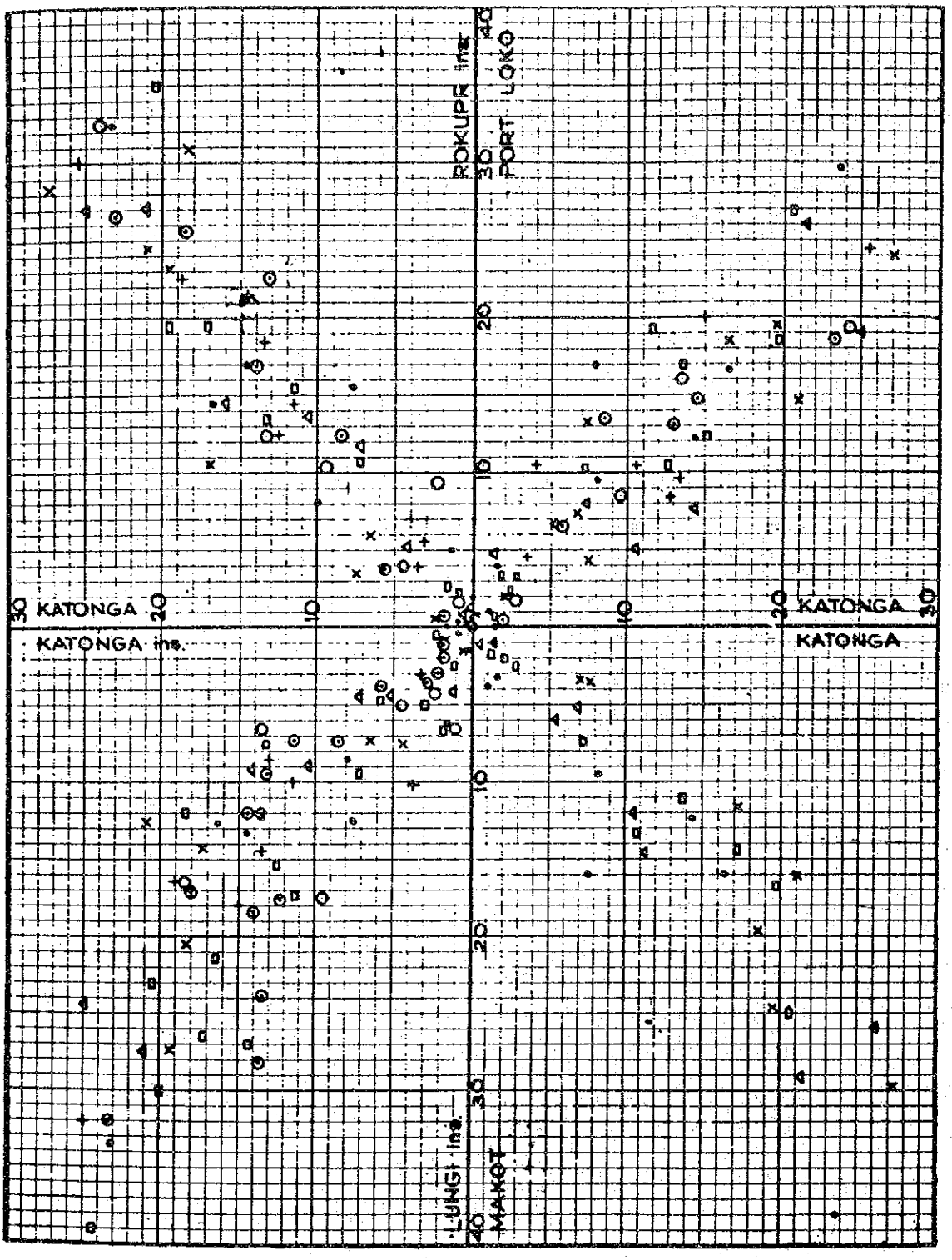
Evaporation given by a class 'A' type evaporation pan
a) Monthlu evaporation in inches
b) Mean daily evaporation per month in iches

		Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sep	Oct	Nov	Dec
Lungi mean 1959-70	a)	5.8	6.8	9.0	8.7	7.3	6.0	(5.8	5.2	5.6	6.8)	5.9	5.8
	b)	0.19	0.24	0.29	0.29	0.24	0.20	(0.19	0.17	0.19	0.22)	0.20	0.19
Lungi 1971	a)	6.70	8.01	9.06	6.51	8.11	5.92					6.50	
	b)	0.22	0.28	0.29	0.22	0.26	0.20					0.22	
Katonga	a)	4.7	5.3	5.6	6.1	6.0	3.9	3.4	2.2	3.3	4.9	4.3	
	b)	0.15	0.19	0.18	0.20	0.19	0.13	0.11	0.07	0.11	0.16	0.14	

( ) Valaes unreliable

The survey on the flux of the River Little Scarcies is not enough. Still, "Hydrological Year Book of Sierra Leone" reports the water level at Manga at the upper course of the Rhombe from 1st April, 1972 to 31st March, 1976. However Manga survey station expressed an opinion that H-Q curve was not available because of t e influence of the change of tide level.

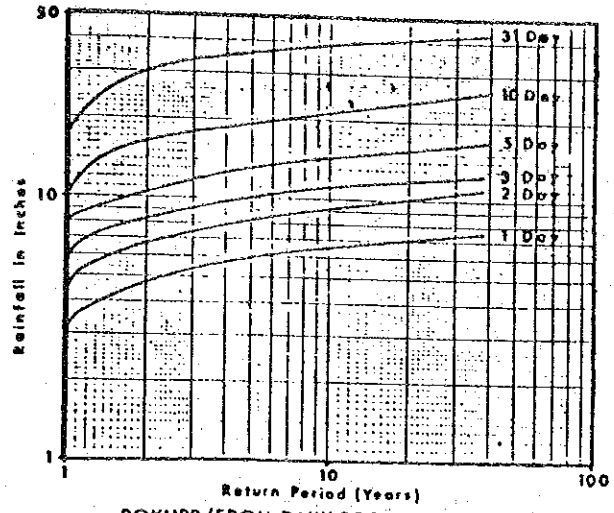
The survey of flux of the river is important for planning the engineering works. However, the area outside the phase I development area is regarded as a vast riverbed. In this sense outside water level is more important for the planning that the flux. There are data for the water level in MRT report Vol. 2 (See Fig. 9) in addition to Hydrological Year Book of Sierra Leone (See Fig. 10). As for the tide level, reference shall be made to "Tide Tables".



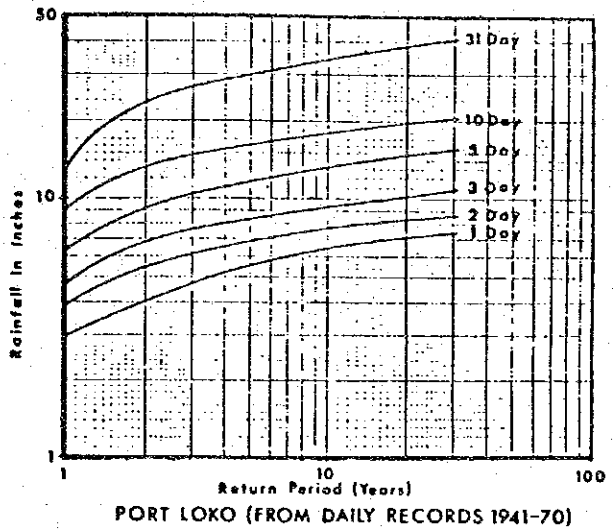
⊙ 1960
O 1961
+ 1962
× 1963
▲ 1964
□ 1965
• 1966

RAINFALLS
FOR
GIVEN YEARS

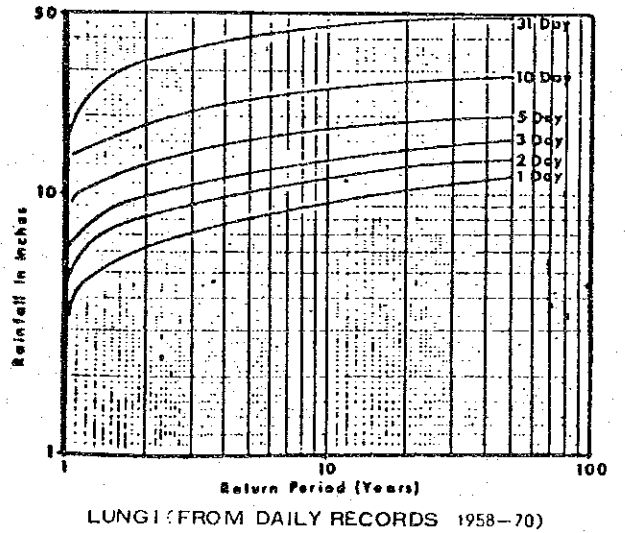
Fig.7 Comparison of Monthly Rainfalls with Katonga



ROKUPR (FROM DAILY RECORDS 1934-70)



PORT LOKO (FROM DAILY RECORDS 1941-70)



LUNGI (FROM DAILY RECORDS 1958-70)

Fig.8 Rainfall Return Periods for Rokupr, Port Loko and Lungi

Table 22

Temperatures

a) The mean maximum temperature in °F
b) The mean minimum temperature in °F
c) The mean daily temperature in °F

Station		Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sep	Oct	Nov	Dec
Lungi mean 1948-7	a)	87	87	87	88	87	86	82	81	83	85	86	87
	b)	72	74	76	76	75	73	73	73	73	73	73	73
	c)	80	81	81	82	81	79	77	77	78	79	80	80
Rokupr mean 1939-64	a)	91	93	93	93	91	87	84	82	85	88	89	89
	b)	68	70	72	73	73	72	72	72	72	71	72	69
	c)	80	81	82	83	82	80	78	77	79	80	80	79
Lungi 1971	a)	88	87	87	87	88	85	83	82	82	85	85	85
	b)	72	74	74	74	74	73	73	72	73	72	73	73
	c)	80	81	80	81	81	79	78	77	78	78		
Rokupr 1971	a)	92	91	93	92	92	90	85	84				
	b)	65	68	68	71	71	70	72	72				
	c)	78	80	80	82	81	80	78	78				
Katonga 1971	a)	92	91	94	86	91	88	86	83	85	88	89	88
	b)	68	71	70	73	74	72	72	72	72	72	71	72
	c)	80	81	82	80	83	80	79	78	79	80	80	80

Table 23

Rainfall Records for Rokupr (inches)

Year	Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sep	Oct	Nov	Dec	Annual
1971													
1970	NIL	NIL	NIL	0.67	9.08	10.98	34.98	33.83	25.82	11.50	6.42	0.12	133.40
1969	0.70	NIL	5.47	1.56*	6.87*	17.02	23.15	34.42	26.96	23.16	7.87	0.07	147.25*
1968	NIL	0.29	NIL	0.56	5.63	17.10	14.30	21.05	21.00	17.77	7.78	2.24	107.72
1967	NIL	NIL	NIL	1.70	8.00	16.97	16.83	36.78	17.29	13.23	5.75	NIL	116.55
1966	NIL	NIL	0.12	0.50	10.07	15.65	14.58	32.33	23.72	17.13	5.73	1.44	121.27
1965	0.90	NIL	NIL	1.45	11.06	15.42	19.24	19.30	35.11	13.33	1.91	NIL	117.72
1964	NIL	NIL	0.32	0.50	11.88	16.65	26.90	38.54	27.29	13.87	4.21	0.08	140.24
1963	0.62	0.05	0.30	TR.	6.02	10.30	23.21	28.33	30.92	24.69	3.12	NIL	127.56
1962	NIL	NIL	NIL	5.66	4.00	22.53	18.61	30.02	21.78	14.84	12.36	0.10	129.90
1961	NIL	TR.	0.27	1.67	4.03	10.31	22.78	32.64	25.74	12.54	9.34	TR.	119.32
1960	NIL	NIL	TR.	0.40	7.95	17.27	26.46	24.17	22.88	12.77	3.87	0.09	115.86
1959	1.77	NIL	2.06	0.01	10.81	15.65	24.40	28.57	23.84	11.03	6.72	NIL	124.86
1958	0.21	0.02	0.27	5.60	10.93	15.44	12.21	18.39	24.48	16.02	16.93	2.12	122.62
1957	TR.	NIL	NIL	2.58	1.54	11.78	13.18	34.65	20.40	13.21	3.22	0.78	101.34
1956	NIL	0.23	0.24	4.93	8.89	23.57	22.91	25.23	20.82	14.24	5.04	2.78	128.88
1955	0.05	NIL	2.33	7.81	8.37	12.46	24.36	36.30	16.77	12.67	6.14	2.23	129.49
1954	NIL	0.07	0.89	6.32	8.11	13.42	34.88	39.78	12.87	8.49	9.48	0.74	135.05

* An assessed record

Table 24

Rainfall Records for Port Loko (inches)

Year	Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sep	Oct	Nov	Dec	Annual
1970	NIL	NIL	3.41	4.24	4.24	11.23	14.94	30.66	12.40	17.16	4.62	3.00	105.90
1969	NIL	NIL	3.15	1.91	3.39	15.00	19.23	14.73	8.58	16.98	3.15	1.12	87.24
1968	NIL	NIL	NIL	0.58	7.86	15.80	14.56	13.26	13.56	9.31	4.10	NIL	79.03
1967	NIL	NIL	NIL	0.43	8.74	16.73	19.97	21.14	16.06	8.61	2.46	NIL	94.14
1966	NIL	0.25	0.97	1.02	9.50	16.97	16.41	29.47	18.78	12.25	3.99	1.84	111.45
1965	2.28	NIL	0.11	0.98	10.25	19.03	12.21	18.31	27.57	16.99	3.15	0.00	110.88
1964	NIL	NIL	NIL	0.18	7.99	7.32	26.27	27.69	19.12	4.84	6.28	4.70	104.39
1963	2.13	0.08*	0.42	1.02*	7.32	13.10	19.47	24.16	16.40	14.90	4.54	0.00	103.54
1962	NIL	NIL	NIL	4.60	10.32	12.29	9.92	24.27	20.00	11.29	8.31	0.00	101.00
1961	NIL	NIL	0.27*	3.57*	4.47*	8.39	33.73	19.17	10.53	16.32	1.89	0.00	98.34
1960	NIL	0.12	1.14	0.37	4.45	14.86	18.38	23.33	12.98	13.41	6.67	0.67	96.38
1959	NIL	NIL	2.28	0.01	10.3*	12.05	22.72	19.37	11.60	9.48*	6.49	NIL*	94.30
1958	0.11*	0.17*	2.46*	5.26*	9.81*	14.4*	12.5*	15.2*	16.9*	13.3*	13.5*	2.94*	106.55
1957	NIL	0.00	0.08	0.28	3.70	10.46	20.87*	15.52*	15.75*	15.33*	4.17*	1.38*	87.54
1956	NIL	0.04	1.51	5.51	4.19	6.70	19.27	15.83	20.02	16.32	7.67	2.99	100.05
1955	NIL	0.00	1.57	5.08	9.73	10.87	17.71	21.07	16.85	12.89	2.36	1.13	99.26
1954	NIL	1.05	1.50	6.50*	8.05*	12.85*	26.80	33.35*	9.73*	10.08*	9.51	0.94*	120.36*

* An assessed record

Table 25

Rainfall Records for Lungi (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec	Annual
1970	NIL	NIL	0.51	1.14	9.21	16.29	33.94	37.32	21.19	12.48	5.67	1.36	139.11
1969	TR.	NIL	3.56	1.92	12.93	17.04	48.83	32.88	25.08	9.72	4.71	0.23	156.91
1968	TR.	1.02	NIL	1.00	8.03	18.44	32.70	23.12	16.43	10.54	7.59	2.91	121.78
1967	NIL	TR.	NIL	0.07	5.59	12.65	26.76	42.19	26.78	13.68	6.04	0.02	133.78
1966	NIL	TR.	1.49	0.01	8.52	12.86	11.74	33.71	29.62	13.29	6.41	2.70	120.35
1965	0.70	TR.	TR.	2.40	9.45	17.23	26.40	30.04	22.65	7.51	4.93	NIL	121.31
1964	NIL	TR.	TR.	0.32	4.45	8.96	27.58	34.72	24.77	8.98	4.51	4.36	118.65
1963	0.81	TR.	TR.	1.44	7.07	14.28	27.30	41.97	20.66	12.23	4.46	NIL	130.22
1962	NIL	NIL	TR.	2.93	10.02	16.38	14.58	32.00	17.95	10.21	8.48	NIL	112.53
1961	TR.	NIL	TR.	6.67	5.08	17.43	48.60	32.05	16.51	6.75	4.20	NIL	137.29
1960	0.88	1.17	NIL	0.95	3.24	12.05	32.36	30.12	23.93	7.32	3.81	0.77	116.60
1959	2.72	0.04	0.70	TR.	11.26	17.49	31.11	33.41	19.28	6.95	10.37	TR.	133.33
1958	0.07	0.16	3.74	2.74	7.22	17.82	18.50	16.85	28.48	9.22	12.08	1.94	118.82
1957	0.01	TR.	TR.	1.43	6.75	15.37	39.30	27.22	21.77	12.32	5.25	1.06	130.48
1956	NIL	0.08	1.59	4.65	9.86	11.32	28.44	21.28	17.43	11.73	1.68	2.88	110.94

Table 26

Rainfall Records for Katonga (inches)

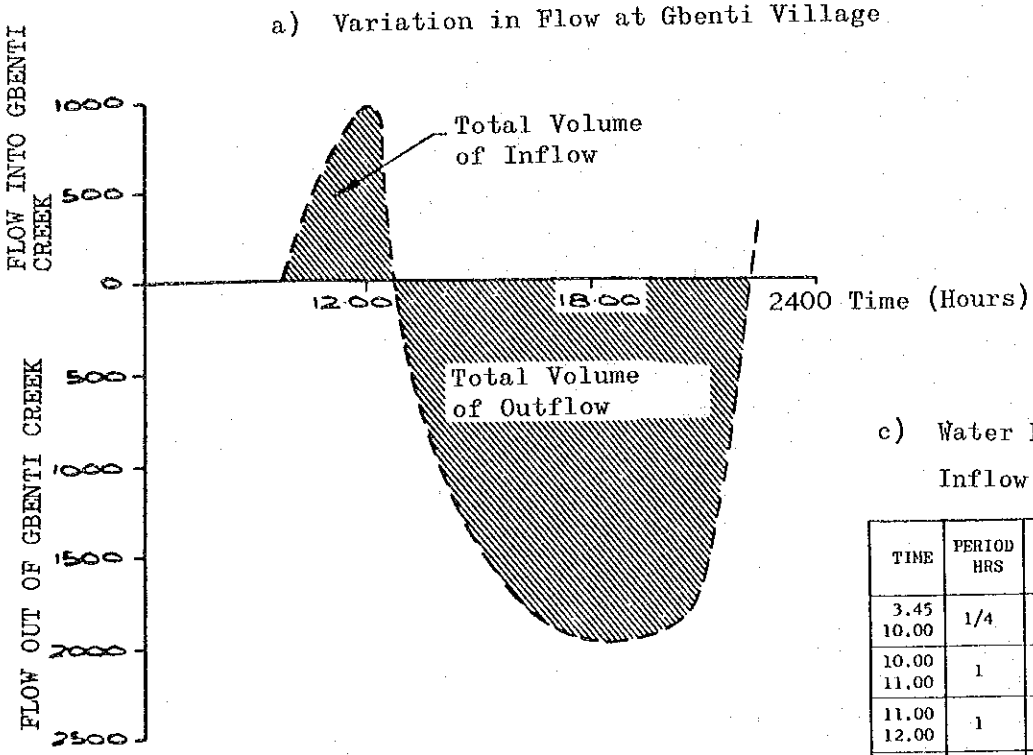
Year	Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sep	Oct	Nov	Dec	Annual
1967	0.94												
1966	1.99	NIL	0.04	1.09	8.12	7.82	16.48	23.69	-	14.42	1.48	NIL	
1965	2.17	NIL	NIL	1.25	7.14	11.22	17.02	19.84	20.62	13.37	2.91		95.54
1964	NIL	NIL	NIL	0.67	7.13	14.27	21.21	37.35	25.07	10.56	5.21	1.22	122.69
1963	2.10	TR.	NIL	0.72	6.81	17.26	19.47	27.20	18.54	21.00	7.76		120.85
1962	NIL	NIL	NIL	3.36	3.90	18.85	13.46	25.41	14.86	11.54	12.91	TR.	104.29
1961	NIL	NIL	0.08	0.93	4.71	9.77	31.53	24.07	18.43	13.70	2.57	NIL	105.88
1960	NIL	NIL	0.05	1.87	-	14.35	23.33	30.41	13.19	8.72	5.75	NIL	
1959	NO RECORDS AVAILABLE												
1958	0.20	0.22	2.32	3.86	11.54	12.19	13.95	18.25	13.97	13.27	13.67	1.93	105.37
1957	TR.	NIL	0.06	0.44	1.95	12.66	24.59	14.73	17.64	18.43	4.68	1.09	96.63
MEAN	0.74	0.02	0.28	1.58	6.41	13.15	20.12	24.55	17.79	13.9	6.33	0.74	

Table 27

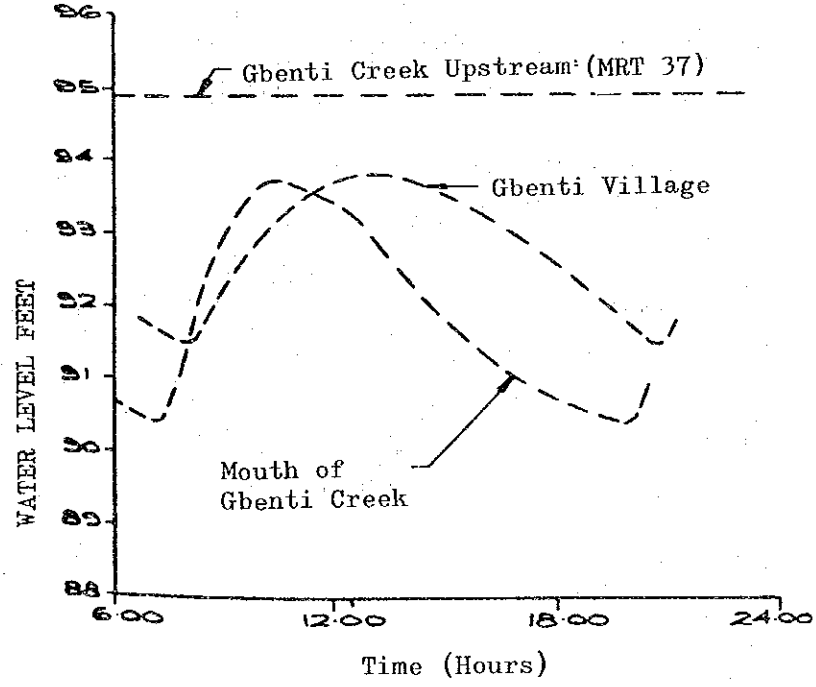
Rainfall Records for Makot (inches)

Year	Jan	Feb	Mar	Apr	May	Jne	Jly	Aug	Sec	Oct	Nov.	Dec	Annual
1971													
1970	NIL	NIL	0.28	1.23	10.11	15.05	38.20	28.14	17.11	5.74	0.17	127.79	
1969	NIL	NIL	4.45	1.12	5.66	20.75	19.58	29.47	16.43	18.45	3.58	1.65	121.14
1968	NIL	0.26	NIL	3.41	6.53	18.04	20.34	25.65	14.78	19.88	6.85	0.90	116.64
1967	NIL	NIL	NIL	0.44	9.67	15.84	25.12	35.90	18.46	9.92	6.36	0.04	121.75
1966	NIL	NIL	0.08	3.81	9.58	16.25	16.08	37.98	26.77	12.64	3.38	2.43	129.00
1965	2.04	0.01	NIL	1.58	7.20	14.91	14.26	16.90	25.00	10.74	2.22	NIL	94.86
1964	NIL	NIL	0.31	0.10	5.07	11.00	29.90	36.90	26.20	12.44	6.16	1.39	129.47
1963	0.11	NIL	0.90	1.10	3.20	11.70	24.60	29.80	19.76	16.10	3.30	NIL	110.57

a) Variation in Flow at Gbenti Village



b) Water Level Variations



c) Water Balance in The Creek

Inflow Taken as Positive

TIME	PERIOD HRS	MEAN FLOW CUSECS	VOLUME CUSECS HRS	CUMULATIVE VOL CUS HRS
3.45 10.00	1/4	100	25	25
10.00 11.00	1	430	430	455
11.00 12.00	1	840	840	1295
12.00 12.45	3/4	650	488	1783
12.45 13.00	1/4	-120	-30	1753
13.00 14.00	1	-700	-700	1053
14.00 15.00	1	-1280	-1280	-227
15.00 16.00	1	-1630	-1630	-1857
16.00 17.00	1	-1840	-1840	-3637
17.00 18.00	1	-1950	-1950	-5647
18.00 19.00	1	-1960	-1960	-7607
19.00 20.00	1	-1930	-1930	-9537
20.00 21.00	1	-1830	-1830	-11367
21.00 22.00	1	-1150	-1150	-12517
22.00 22.15	1/4	-190	-48	-12565

Net outflow = 12600 cusec hrs.
Total outflow = 14400 cusec hrs.

Fig.9 Flow Gauging Throughout the Tidal Cycle for Gbenti Creek On 27-8-71

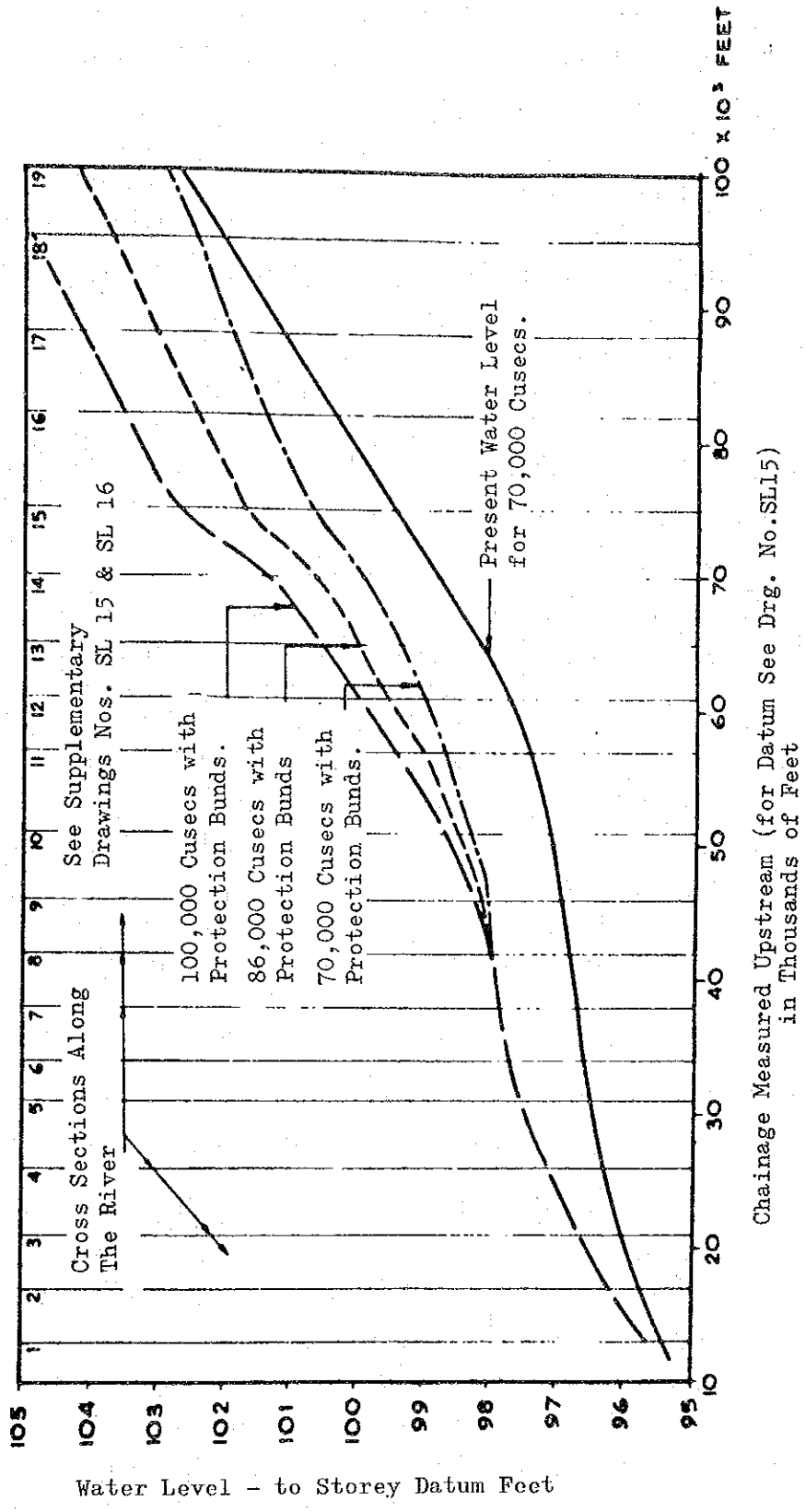


Fig.10 Caluculated Water Levels Along the Little Scarcies River with Flood Protection Bunds

Taking the whole Rhombe development plan into consideration, the survey of the flux is of vital importance, so it is desirable to start survey it at once in some appropriate upper course.

(3) Comment

In the future, the following item should be surveyed,

a. Producing topographical map with a 1/10,000 scales and 50 cm interval contour for the area.

b. The survey of salinity of water at the expected intake point in each case of different water levels and different seasons.

c. The survey of the change of the outer water level at phase I development area.

d. The survey of the rainfall and evaporation in the phase I development area.

e. The survey of the flow rate of the River Little Scarcies.

6. Irrigation/Drainage

(1) Outline of Phase I Development Plan at Gbenti North

A. Topography of Gbenti North

This time with the aid of a 1/50,000 map, we crossed the River Little Scarcies by boat and visited the villages along the river such as Rhombe, Konta and Kagbuls, but we missed almost all the villages in Gbenti North which is in estury.

Nevertheless the following are to be guessed.

The area is the delta of the River Little Scarcies with a low damp inland behind. It is as far as 6 - 12 Km from the river-mouth; consequently, there is a strong influence of the tide. The gap of the tide level is about 1 m according to the record. Because of this inflow of salty water to the area is expected in dry reason when the water level of the river is low.

Considerable attention must be paid to irrigation is January/March in the case of double-cropping.

B. Area to be developed

At present the only map we have is 1/50,000 one. So we have only to guess from it. The data made out by MRT consultant in Britain in 1972 shows that the area to be developed is 3,240 acres (about 1,300 ha.) including area possibly to be developed. About 70% of the area, that is 2,200 acre (about 900 ha.), is cultivated as rice fields. Here, for convenient's sake, area to be developed, is defined to be 1,300 ha. which includes one possibly to be developed, taking an increase in cultivated area and partly settlement into consideration.

C. Irrigation Plan

Irrigation should be made from January through March is order to enable double-cropping. Planting is made in January when the area runs out of water most servely. This is certain from the annual rainfall. After April there is a rainy season; therefore, irrigation would not be necessary. Harvesting ends in May or June in accordance with the varieties, and then another cropping starts.

The amount of irrigated water might be about 3 m^3/S, provided maximum rainfall is 20 mm/day.

D. Construction Plan (Main Structure)

The point of water intake is situated in the middle of the small river the both ends of which connect with the River Little Scarcies near Mabana Village. At this point the inflow of salty warter can be easily cut off by constructing regulation gates at both ends of the small river. Pumping up is operated by 2 pumps with diesel engine at a pumping station (ø900 mm, 110 Kw, H = 5.0 m, 90 m^3/min.). Maximum Q is 3.0 m^3/s (Fig. 11, Fig. 12 700 m driving channel connects with main canal crossing the centre of the area and deviding water east and west.

Main canal in the form of a earth canal runs 1,000 m to the east and 4,000 m to the west. Standard size of the main canal is 3.0 m wide at the bottom, 9.0 m at the top and 2 m in depth. 6 m wide road should be constructed on the right bank of the main canal for traffic. The slope of the canal is 1/4,000.

When the water intake with a dam or a headwork at the upper course of the river is possible in the future, the main canal will be connected with the canal from the upper course. In this respect, the shrink of the canal at its end is not desirable. In that situation it is likely that the pump station might be disused. Taking floods in the rainy season into consideration, construction a driving channel of burried pipe would be necessary. To prevent flood water from flowing into the main canal in rainy season, the gates must be set at both ends of the canal. As for the secondary canal, the complete prevention of flood water from flowing into the canal might be impossible at first, but burying the pipes would be desirable in the future. From topographical point of view, drainage canals, meeting the main canal at right angles, open into the river. Lock gates should be constructed where they cut the main canal at right angles.

Almost all the main canals are made up of banking. Consequently the place which seems to be soft ground should be cut and displaced. In order to make the banking, it is advisable to use the soil of hillocks and that produced by the cut of the drainage canal. Anyway the through geological survey of the site should be carried out.

(2) Comment

Items of survey which will become necessary hereafter.

A. Geological Survey

A series of geological survey must be carried out as geology affects the ground work of the main structures, and there are no data for it.

B. Topographical Mapping

There being a topographical map of 1/50,000 scale, at least that of 1/10,000 scale and 0.5 m interval contour map should be prepared.

C. Flood Stage (High Water Level)

Flood stage data at one or two places in Rhombe Area are necessary. Especially Data of water level change near the pumping station are extremely necessary.

D. Salinity and Inflow of Salty Water

It is necessary to make a survey of salty water at several places including a pumping station.

7. Swamp Development

(1) Policy of a Consolidation of Land

a. The shortening of the cultivation period caused by the introduction of double cropping makes it necessary to introduce small-sized agricultural machines. In parallel with it, field levelling, preparation of drainage canal in the farm and the road for cultivation are necessary.

b. It is preferable to use materials which can be obtained at the site, in the sense of reduction of the construction cost, as well as easiness of maintenance after the construction.

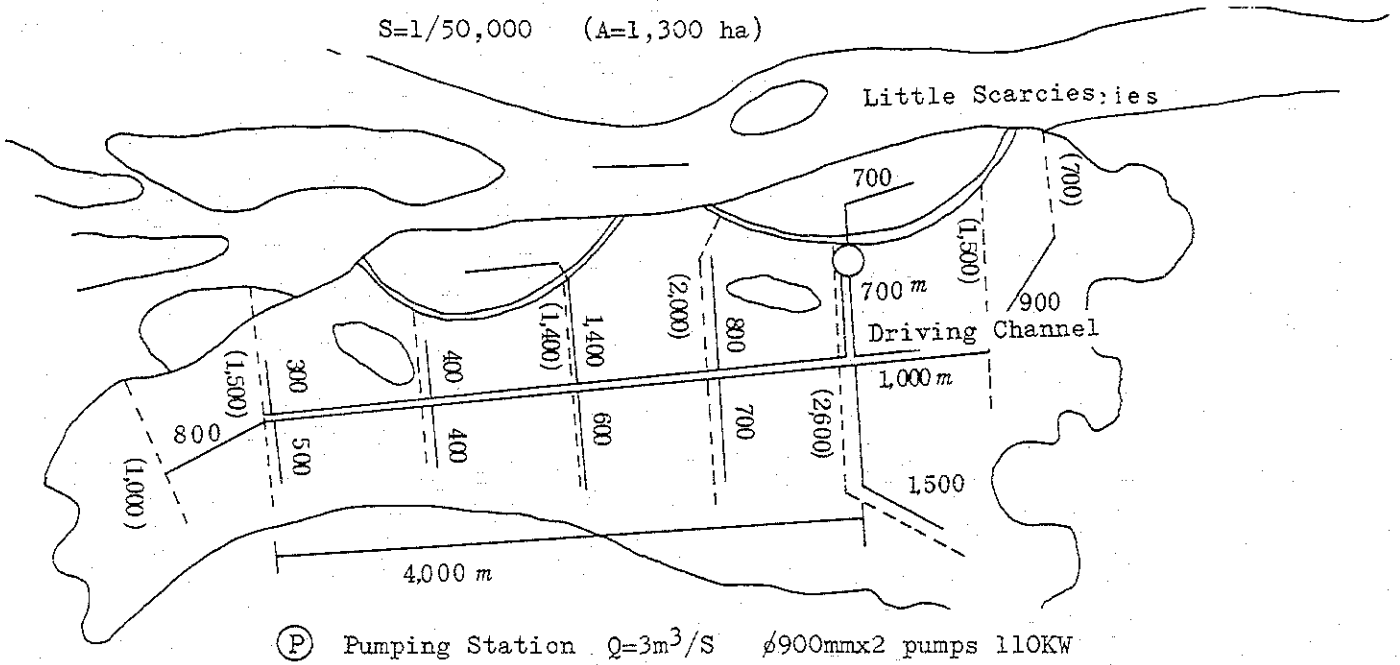
c. The existing main road between Port Loko and Gbenti should be repaired. Paving the road is desirable (See Fig. 13).

d. A new trunk road connecting village in the project area for the transport of crops, the communication of villages and the improvement of the farmers' life should be constructed. And the route should start from Gbenti through as many villages in the area as possible to the road for Katonga.

e. The details such as direction, width, and height of the

Fig. 11 General Idea of Gbenti North Phase I development Progect

S=1/50,000 (A=1,300 ha)



Ⓟ Pumping Station Q=3m³/S ϕ900mmx2 pumps 110KW

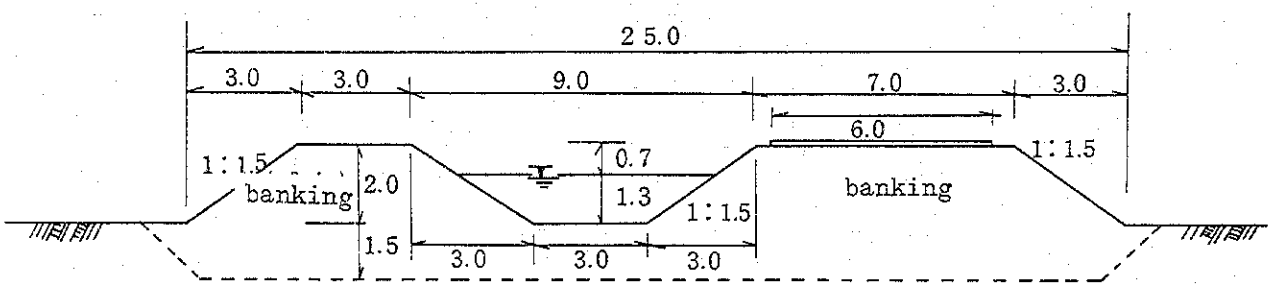
═══ Main canal (Driving Channel 700m) 5,000m

——— Secondary Canal 9,000 m

- - - - Drainage Canal 11,700 m

Fig. 12 Profile of Main Canal

Q=3.0 ㎥/S I=1/4,000



main road and the trunk road should be determined at the time of detailed survey.

(2) Outline of a Consolidation of Farms

A. Block Readjustment (Fig.14)

a. Farm levelling would be necessary for introducing small sized agricultural machines and for keeping proper depth of water in the rice field.

b. The appropriate size of a lot would be 20a (20m x 100m) to 30a (30m x 100m) in the point of the efficiency of agricultural machines and the proper distribution of irrigation water.

c. The farm land is almost horizontal and from the viewpoint of efficient use of irrigation water, the tertially irrigation and drainage canal should be separated, although the construction cost becomes a little higher.

d. Taking the space between connecting roads in the farmland, the operation of irrigation/drainage, and the farming area a farmer (2 or 3 ha. after the project) concerned into considerations, one farm block consisted of ten lots is most preferable.

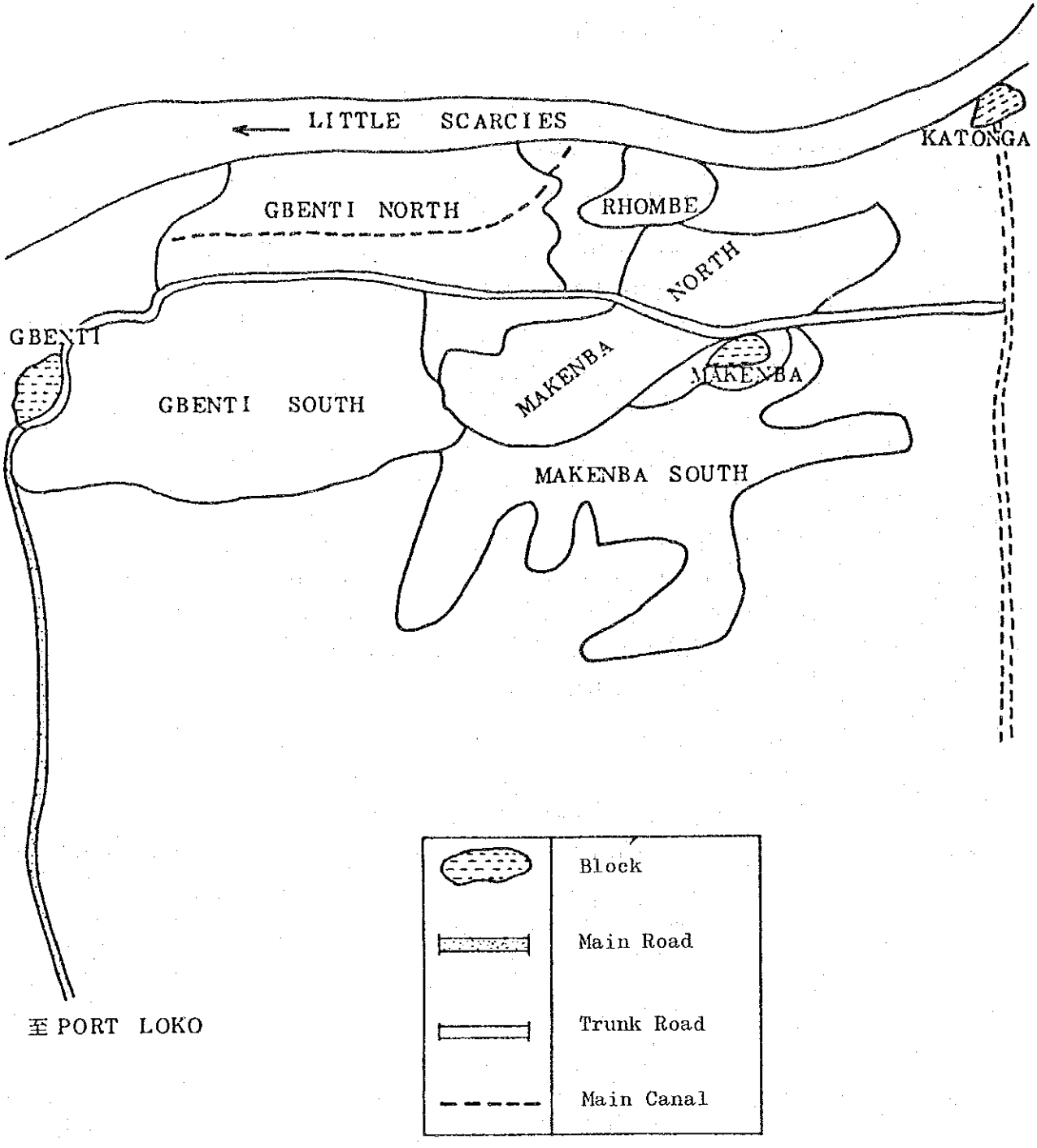
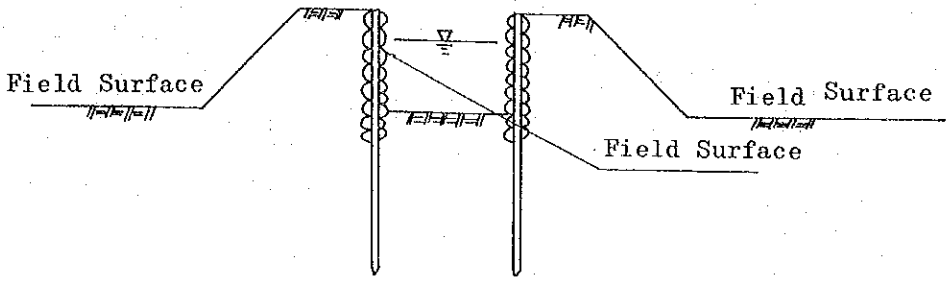


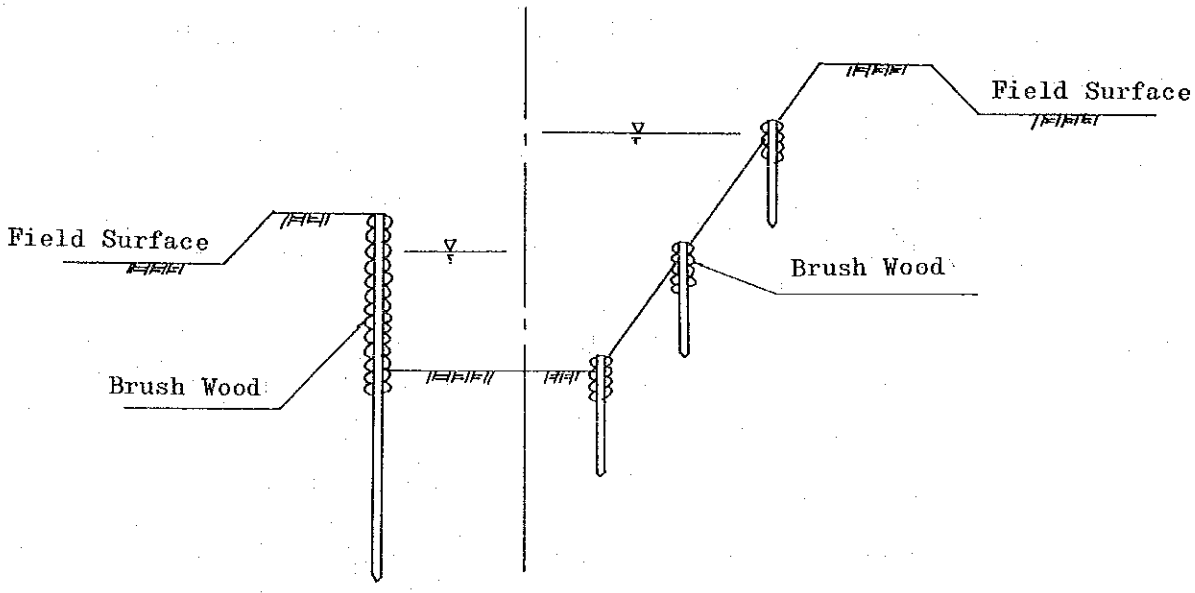
Fig. 13 The Chart of Rhombe Swamp Area

Fig. 16 Example of Tertiary Canal

(Irrigation)



(Drainage)



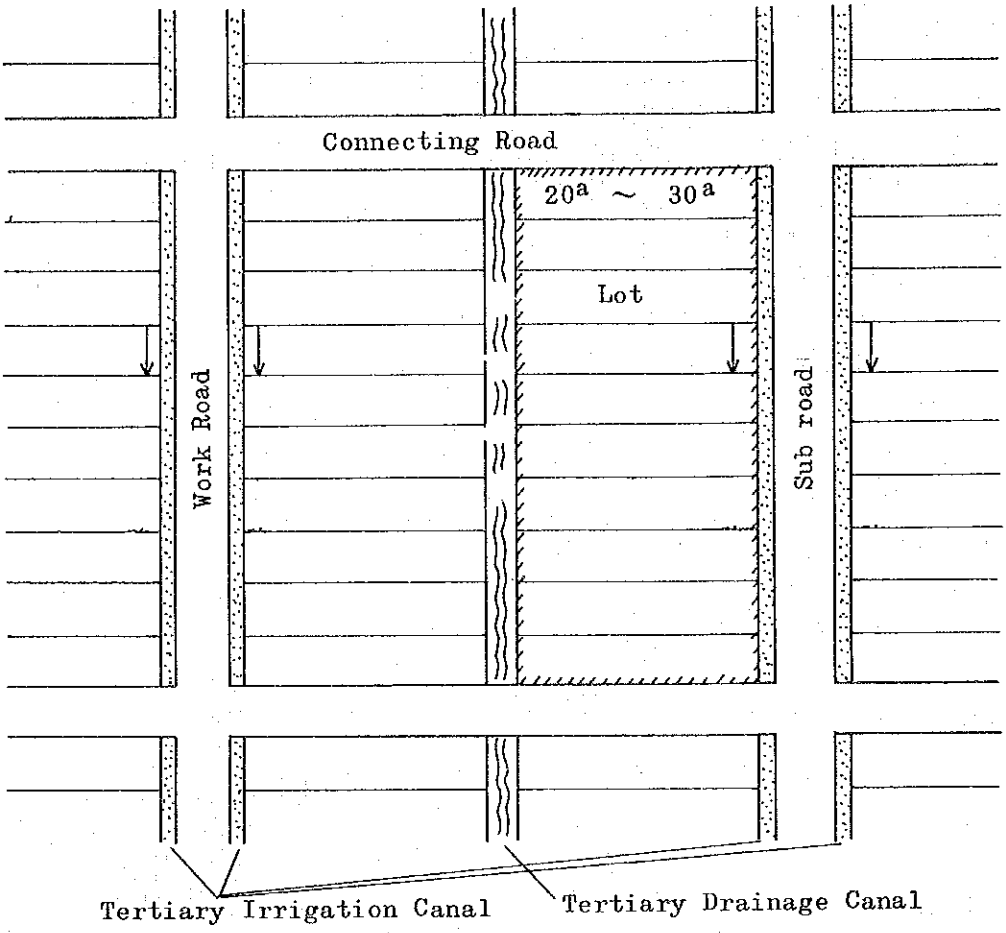


Fig. 14 One Example of Block Readjastment

B. Construction of the Farm Road (Fig. 14, Fig 15)

a. Sub roads, connecting roads, and work roads should be constructed in the farm land. And they should be connected to the trunk road aiming more efficient farming.

b. The width of the farm roads mentioned above would possibly be 3 to 5 meters.

c. The structure of the farm roads should be suitable for easy maintenance. The construction cost of the roads should not be so high.

d. A slope protection work of the farm roads would be necessary for preserving the slope against the erosion by the flood water in the rainy season. The work should be done using the materials obtainable in the neighbourhood of the project area.

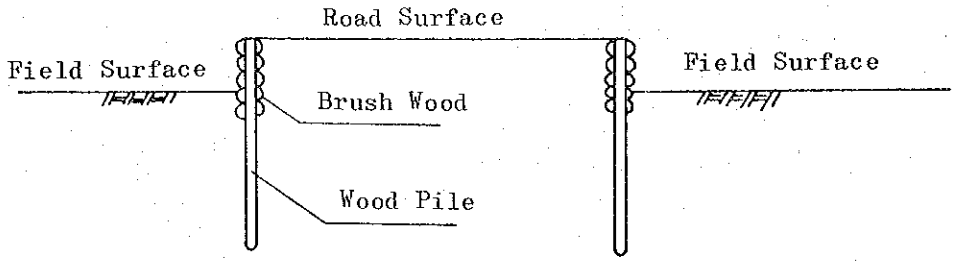


Fig.15 Example of Farm Road

C. Completion of Irrigation/Drainage Net Work in Farm Land

a. Separation of irrigation and drainage canal would be necessary for efficient irrigation, because the area is almost flat.

b. In forming irrigation plan, to say nothing of the cultivation period of rice and the efficiency of agricultural machines, the labour force in the area and work efficiency of the farmers must be taken into consideration.

c. Irrigation/drainage canal must be constructed economically. And such structure of the canals as to be kept and managed easily (eq. earth canal) should be taken up.

d. A slope protection work of the canals would be necessary for preserving the slope against the erosion of the flood water in the rainy season. The work should be done using the materials obtainable in the neighbourhood of the project area.

CHAPTER V TOPICS FOR FURTHER DISCUSSION

1. Development Plan

   (1) Relation between the whole Rhombe development plan and the phase I development plan.

   (2) Demarcation of the area for the phase I development.

   (3) Necessity of a topographical map of 1/10,000 scale and 0.5 m interval contour.

   (4) Location and the size of sources of irrigation water.

2. Agricultural Economy

   (1) Cost and benefit analysis

   (2) Marketing and distribution system

   (3) Determination of the size of the development plan on the basis of the size of national revenue.

3. Cultivation, Soil, and Quality of Water

   (1) Plan to introduce improved varieties

   (2) Keys for introducing double cropping

      i Allowable salinity in irrigation water in the dry season

      ii Irrigation period

      iii Possibility for introducing of small-sized agricultural machines

      iv Agricultural extension method

      v Pest control in the dry season

   (3) Soil

      Survey of soil quality

(4) Quality of water

Survey of water quality concerning the River Little Scarcies (especially salinity).

Hydrology and Infrastructure

(1) Survey of salinity on the point of the prospective pump station

(2) Study of the change of the water level in the development area

(3) Study of rainfall and evaporation in the development area

(4) Geological survey of the place where the main structures will be built.

(5) Survey of water requirement in depth

(6) Basic data for estimating engineering expenses

(7) Number of farmers in each village in the development area

SUPPLIMENT

I. The Report on Preliminary Survey Rhombe Swamp Agricultural Development Project The Republic of Sierra Leone

February 10th, 1981

The Hon. Minister of Agriculture and Forestry,
Tower Hill,
Freetown,
Sierra Leone.

Dear Sir,

RE: THE RESULTS OF JAPANESE PRELIMINARY SURVEY FOR THE RHOMBE SWAMP AGRICULTURAL DEVELOPMENT PROJECT

I have the pleasure to submit herewith the "REPORT ON PRELIMINARY SURVEY, RHOMBE SWAMP AGRICULTURAL PROJECT, THE REPUBLIC OF SIERRA LEONE", Containing the outline of the results of the survey and suggestions for the next phase of the procedure, on behalf of the Japanese Preliminary Survey Team for the Rhome Swamp Agricultural Development Project in the Republic of Sierra Leone.

I take this opportunity to express mu heartfelt thanks for your active cooperation extended to us and I also wish that the friendship and co-operation between the Republic of Sierra Leone and Japan will be strengthened further.

Yours faithfully

Tomoyuki Oshino
Leader of Japanese Preliminary Survey
Team for the Rhombe Swamp Agricultural
Development Project

THE REPORT ON PRELIMINARY SURVEY

RHOMBE SWAMP AGRICULTURAL DEVELOPMENT PROJECT

THE REPUBLIC OF SIERRA LEONE

I. OBJECTIVES OF THE SURVEY

In response to the request of the Government of the Republic of Sierra Leone, the Government of Japan decided to send a preliminary team, through the Japan International Cooperation Agency (JICA), for technical cooperation for the planning of the Rhombe Swamp Agricultural Development Project.

The team stayed in Sierra Leone from February 1st to February 10th, 1981 and conducted studies with the following objectives:

i To discuss with the authorities concerned of the Government of the Republic of Sierra Leone on the contents of her request for possible technical cooperation by the Government of Japan to the Rhombe Swamp Agricultural Development Project.

ii) To study the significance of the scheme of the Rhombe Swamp Agricultural Project on not only the economic development but also on the overall national development programme of Sierra Leone.

iii) To study the project for further technical and economic investigations to be taken up as the feasibility study.

II. FINDINGS AND SUGESTIONS

1. General

1) The Government of the Republic of Sierra Leone has given top priority to the implementation of the Rhombe Swamp Agricultural Development Project within her new development programme.

2) The strategy aims at increasing the agricultural production, especially in rice, which would be exported abroad after reaching self-sufficiency, and developing the rural area.

3) Investigations and Surveys for the Rhombe Swamp Agricultural Development Project have been done several times, but the actual work on the project has not been implemented.

4) The African Development Bank, the main financial organization of the project, suggested the necessity of a final feasibility study, prior to the embarkment on the project.

5) The Japanese Government will assist to make the feasibility study reports of the project, after clearing the cooperation procedure formalities among the African Development Bank, the Government of Sierra Leone and the Government of Japan.

2. Agronomic and agro-economic study

1) Agricultural Background

1) Average yield of paddy rice is 1.4 - 1.5 ton per ha. in swamp land and 1.2 - 1.3 ton per ha. of upland rice in the whole country.

2) Producer's price of paddy rice under the control of SLPMB is 7 Leones per bushel in 1979 - 1980 and 8 Leones per bushel in 1981, which is ranked the lowest price, higher than only Mali among all West African countries.

3) Therefore, when the benefit of the project is considered, it is essential to study the possibility of double cropping to achieve higher production of paddy rice, taking off from present single cropping.

2) The Rhombe swamp is considered as a high potential production area for paddy rice and if the following countermeasures are provided, double cropping of paddy rice can be introduced.

1) Prevention of the intrusion of saline water into the project area during the dry season cropping.

2) Provision of irrigation water in dry season cropping

3) Training of the farmers to adopt the proper water management, fertilizer application and plant protection standards for the cultivation of high-yielding varieties in dry season cropping.

4) Introduction of simple machinery such as small power tillers for plowing and puddling of the field on optimum time.

5) Introduction of simple complementary mechanisation such as for harvesting and threshing to facilitate the timeliness of field operations and also elliminate the high cost on labour otherwise insurred.

6) Provision of necessary agricultural inputs and storage facilities.

7) Data collection on the performance of double cropping cultivation of paddy rice on several plots in benefitted area prior to the implementation of the whole project.

3) Civil engineering study

1) General

1) Considering this project from civil engineers' point of view, we get the conclusion that it is feasible to develop the whole of the Rhombe Swamp Area (totaling approximately 20,000 acres).

2) It is impossible or inadvisable for the whole Rhombe Swamp Area to be developed simultaneously or under a single phase development project.

The reasons are:

i) the limitation of the Sierra Leone Government budgets

ii) the present level of social development in the area concerned

iii) the present level of agricultural technique in the area concerned

Therefore, the development project should be set on phase by phase.

3) It is necessary not only to propose the Whole Rhombe Swamp Area Agricultural Development Project (hereinafter referred to as "Whole Project") but also at present to show one of possible ideas as the First

Stage Development Project of Rhombe Swamp (hereinafter referred to as "First Project") as the first phase of the "Whole Project".

4) While proceeding with the "First Project", the Sierra Leone Government might try to promote both the spreading of modernized Agricultural techniques and other knowledge among the farmers and filling-up of the infrastructure such as schools, roads, bunds and so on in the crea concerned. Only with such governmental endeavours may the "Whole Project" become a possibility and a reality.

2) Whole Project

1) The objectives of the "Whole Project" will be:

i) To construct the irrigation and drainage system which enable the farmers to achieve the so-called double cropping of rice or rice and other crops in the arca concerned.

ii) To develop the modernized infrastructure such as roads, housing, education and so on, especially focused on the rural area.

2) The Procedure

The source of water resources for irrigation in dry seasons may be obtained by

i) Construction of dams or intakes at the upper reaches of the Little Scarcies river

ii) Rational utilization of inland swamps and leading the water from these into the riverine land

iii) Introduction of irrigation pumps

The "Construction of dams or intakes" is the most appropriate for the "Whole Project" because of the long-term maintenance and operating costs which are cheaper than those associated with the "Introduction of irrigation pumps". Once dams are constructed,

the development of hydro-electricity may be also anticipated.

3) The First Project

1) Selection of development site

Generally, the Rhombe Swamp Area is divided into three kinds of area.

i) Riverine lands

ii) Swamps Area

iii) Uplands

With consideration of the nature of the "First Project", the following conditions should be satisfied for the "First Project".

i) Existence of a large cultivated area

ii) Existence of a fairly heavy population in the area

iii) Existence of many farmers who have intentions of advancing their own agricultural techniques and also increasing their production.

iv) the possibility in future for the area to become one of the economic, education, market and transportation "cores" of the whole Rhombe Swamp Area

v) high priority attached +o the development of the area by the Sierra Leone Government.

2) The outline of the "First Project" might be as below

i) Objectives

a) To improve and construct the agricultural structure which enable the farmers double cropping with high level managements of irrigation and drainage water.

b) To educate the farmers high level agricultural knowledge in the whole Rhombe Swamp Area.

ii) Area and Location of the Project

The condition written before should be satisfied. In addition to this, the cost of the project should be suitable to the amount of money of the budget of the Sierra Leone Government. The details about the area and location of this project site should be made clear.

iii) Projects

The source of irrigation water during dry seasons may be obtained by the same resources referred already at the paragraph of the "Whole Project". However, considering the scale of total cost and small area of this project and taking into account the pilotting nature of the project, we prefer the introduction of pumps with diesel engines.

In addition to irrigation, consolidation of paddy field preparing for introduction of small agricultural machinery is also necessary.

II. Terms of Reference of Africa Development Bank on Rhombe Swamp Development Project

I. INTRODUCTION

1.01 The proposed study was submitted to the African Development Bank in March, 1975 for consideration and financing. The study aims at the development of the Rhombe Swamp Area along the Little Scarce River north of Freetown for rice production.

1.02 At present rice is grown only in the higher-lying riverian areas of the Rhombe Swamp Area. It is believed that the lower-lying areas could offer great potential for rice growing if adequate drainage and flood control measures were provided. The situation would be further improved with an additional provision of irrigation facilities.

1.03 The MRT Consulting Engineers Ltd conducted some hydrological and engineering studies in 1971/72 and concluded that from the engineering point of view drainage and irrigation are possible in the project area. However, the study would have to be re-examined and up-dated.

1.04 Other studies have been made, though not in detail, including vegetation survey, land-use survey, and topographical survey. Brief notes on some soil types and maps, serial photographs and other information relevant to the project are also available.

1.05 Notwithstanding, in order to justify the implementation of the project, a feasibility study should be undertaken to select the most suitable and favourable areas for the project, and to establish the technical (agronomic and engineering) and financial feasibility and the economic viability of the project.

1.06 It is intended to develop the project in phases with phase I implemented as a pilot scheme.

II. OBJECTIVES

2.01 The objectives of the study would be as follows:

i) To identify the most suitable areas in the Rhombe Swamp area for rice production, and to map plan out an area for project implementation and delineate an area from within such mapped plan out project area for a pilot scheme ;

respect to the total acreage to be included in the project. Make recommendations on the development of the project land in phases with phase I as a pilot scheme and state the physical, financial, economic and managerial criteria used for the development phasing. Describe development methods indicating machinery and other investment requirements and estimated costs.

v) Farm Production : Determine the number of farmers/farm families and groups that would participate in the project and describe the production techniques to be adopted. Make recommendations on paddy varieties to be used, the seed multiplication programme to be adopted, supply of farm inputs including farm machinery, and pest and disease control measures. Determine the cost of production.

vi) Extension Service : Examine the extension service system in the project area and describe an organisation and methods to be used to supervise the farmers and to train them in modern farming techniques.

vii) Agricultural Credit : Determine the credit requirements of project farmers and whether existing institutional arrangements are adequate to meet those requirements. Suggest methods of improvement, if necessary, of existing arrangements.

viii) Processing : Determine the requirements in processing facilities and prepare investment and installation schedules and cost estimates ; describe the processing organization and production methods.

ix) Marketing : Make yearly projections of rice yields and physical output and describe the organizational arrangements for the purchase, transport and marketing of the project output giving the estimated cost involved. Discuss the prevailing pricing policy of the Government and comment on the effects of any future price changes including farm-gate, import and export prices. Discuss the rice supply and demand situation of the country as a whole and comment on how they would affect the marketing of the project output.

x) Infrastructure : Examine the existing infrastructure eg. roads and agricultural tracks, in the project area and access their adequacy and the need to construct new ones. Give cost estimates of all new infrastructural constructions including maintenance costs. Indicate how they would be maintained during and after project implementation.

xi) Cost Estimates : Project costs should be grouped under a) Capital investment costs, for example land development, buildings, farm machinery and equipment, vehicles, plant and equipment, and infra-

ii) To determine the technical and financial feasibility of the project, and to identify the various project components and their integration to evolve a viable project ;

iii) To prepare a comprehensive plan for project development and its implementation in phases ;

and iv) To make recommendations on the organization and management of the project.

III. TERMS OF REFERENCE

The study should include, but not limited to, the following headings which should be discussed in detail :

3.01 General Situation in the Project Area

i) Climate including rainfall, temperature, relative humidity evaporation rates and wind velocities etc... ;

ii) Vegetation, topography and soils ;

iii) Population including growth, age distribution, farm families farm labour availability etc... ;

iv) Land tenure system ;

v) Crop production including production techniques, yields and total output, varieties and seed multiplication programmes, distribution of farm inputs and availability of farm machinery services, crop pests and diseases, marketing and processing facilities and extension services ;

vi) Infrastructure including road and agricultural track network, transport and communications, and availability of other social services eg. health centres, schools and drinking water.

3.02 The Project

i) Soil Survey : Make a semi-detailed soil survey to cover about 25,000 acres and prepare a soil map of a scale 1:16,000 ;

ii) Engineering Studies : Review the engineering and hydrological studies completed by the MRT Consulting Engineers Ltd. to confirm their findings and to establish if further details would be required for project implementation ;

iii) Designs : Prepare preliminary designs for flood control, drainage and irrigation systems and access roads. Indicate the phasing of the works and prepare cost estimates for each phase.

iv) Land Development : On the basis of the soil survey, determine the total area suitable for rice production and make recommendation with

structure and welfare ; and b) Recurrent costs including land preparation and other farm production input costs, maintenance costs, administrative costs etc... Provision should be made for both physical and price contingencies and all costs should indicate local, foreign exchange and total costs. Time schedules of investments and replacements of fixed assets should be prepared.

3.03 Organization and Management

Make recommendations with respect to the type of entity and management organization to implement the project showing the organizational structure in a chart. Examine the availability of local management and technical personnel and for what periods. Indicate the cost involved in such foreign assistance and the source of financing such costs. Prepare a staff requirement list up to full project development and indicate recruitment procedures and salaries.

3.04 Financial Analysis

Prepare in detail yearly pro-forma income and expenditure statement for the project, and a cash flow indicating sources and application of funds. Determine the financial rate of return to the project as a whole using a project life span of 20 years. Discuss the financial impact of the project on farmers' incomes and on Government revenue and expenditure.

3.05 Economic Analysis

Calculate the economic rate of return of the project using a project life span of 20 years, and subject the result to sensitivity analysis.

3.06 Justification

Justify project implementation on the basic of its technical and financial feasibility and economic viability. Discuss the economic and social benefits of the project.

3.07 Pilot Scheme

After establishing the feasibility and viability of the project as a whole the study shall advice on the ways and means of implementing a pilot scheme as phase I of the project and shall proceed to :

III Register of Names Concerned

The Republic of Sierra Leone

S.I. Koroma	Hon. 1st Vice President
A.F. Joe Jackson	Minister of Agriculture and Forestry
W.B. Muna	Permanent Secretary, Ministry of Agri. & Forestry
M.M. Bangura	Deputy Secretary, Ministry of Agri. & Forestry
Denys Schurer	Minister of Natural Resources
Peter Kuyumbeh	Permanent Secretary, Ministry of Development and Economic Planning
Tailor	Director, Economic, Technical Cooperation, Ministry of Foreign Affairs
Beatrice A. Hamilton	Deputy Director, "
Ibarhim S. Kanu	Officer, "
Denys Schwaar	Project Manager, UNDP Land Resources Survey Project
M. Sufian Kargbo	Project Co-Manager, "
A.R. Siafa	Chief Agriculturist, M.A.F.
H. Leslie Lymon	Senior Agricultural Engineer, M.A.F.
T.J. Shorunkeh-Sawyerr	Chief Fisheries Officer, M.N.R
D. Janakiram	Plant Breeder, Rice Research Station, Rokepr
Mohamed Kandeh	Soil Survey, Land Resources Survey Project

Joe Hamelberg	Irrigation Engineer, "
Ambrose J.I. Inilliams	Hydrologist, "
Paul S.F. Fomba	Agricultural Planning Officer, M.A.F.
J.P. Amara	Co-Project Manager, Seed Multiplication Project MAF
Seinya E. Harleston	Agr. Assistant Chief Agriculturist, MAF
J.G. Abdnlin	" "
M.I. Kermera	Senior Asst. Sec. (Project) "
T.J. Shorunkeh-Sawyerr	Chief Fisheries Officer M.N.R
A. Manarey	Officer Ministry of Development & Economic Planning
Sydney F. Beoku-Betts	Honorary Consul of Japan

The Republic of Ivory Coast

KARNGA	African Development Bank Head of Cooperation Department
AMEGAVIE	Senior Staff of Cooperation Dept.
ADJAOTTOR	Agro-economist
Kenji Yasuda	Ambassador of Japan to Ivory Coast
Michitsugu Nakano	Secretary of Embassy of Japan

Liberia

Sanni Djawudon	WARDA
Koichi Muraya	Ambassador of Japan to Liberia
Hiroshi Funakoshi	Counselor of Embassy of Japan
Yasuo Nakano	Secretary of Embassy of Japan

IV. Literature Collected

No.	Title	Source or Publisher
1	Land in siera Leone: A Reconnaissance Survey and Evaluation for Agriculture (Coloured maps and plates)	U.N.D.P. and F.A.O.
2	Land Resources Survey; Vegetation and Land Use in Siera Leone: A Reconnaissance Survey AG:DP/SIL/73/002 Technical Report	" "
3	Land Resources Survey; Vegetation and Land Use in Sierra Leone: A Reconnaissance Survey (coloured map) Technical Report 2	"
4	Land Resources Survey; Proceedings of the First National Remote Sensing Seminar on Land Resources Technical Report 3	"
5	Land Resources Survey; Review of Remote Sensing Techniques for Multi-Disciplinary Land Evaluation Purposes Technical Report 4	"
6	Land Resources Survey; Bush Fallow in Sierra Leone: An Agricultural Survey	"
7	Mise en Valleu des Marais de Rhombe (République de Sierra Leone)	Association pour le Development de la Piziculture on Afrique de L'Quest
8	Hydrological Year Book of Sierra Leone	Ministry of Energy and Power, Water Supply Division

No.	Title	Source or Publisher
9	1979 FAO Production Yearbook (Annuaire FAO de la Production, Anuario FAO de Producción)	F.A.O.
10	Rice Soils and Fertilizer Use in Sierra Leone	Rice Research Station
11	Land Resources Survey; Land in Sierra Leone a Reconnaissance Survey and Evaluation for Agriculture	U.N.D.P. and F.A.O.
12	Annual Report 1979 UNDP/FAO Iita Sierra Leone Rice Project (sil/76/008)	Rice Research Station
13	West Africa Rice Development Association Mangrove Swamp Rice Research Project Rice Research Station Rokupr; Research Report 1979	West Africa Rice Development Association
14	Annual Report Rice Breeding 1978-79	Rice Research Station
15	Plant Physiology 1978/79 Research Review	"
16	Proposal for the Phombe Swamp Feasibility book Study	Tate & Lyle Technical Services Ltd.
17	The Land Resources Survey Project of Sierra Leone 1975-80	FAO and UNDP
18	New Upland Rice Varieties for Sierra Leone Farmers Bulletin No.1	Rice Research Station, Ministry of Agriculture & Natural Resources
19	West Africa Rice Development Association Mangrove Swamp Rice Research Project Rice Research Station Rokupr: Research Report 1977	West Africa Development Association

No.	Title	Source or Publisher
20	National Development Plan 1974/75 - 1978/79	Permanent Secretary, Ministry of Development and Economic Planning
21	Rhombe Swamp Engineering Feasibility Study volume 2 Appendices	Ministry of Development
22	Rhombe Swamp Engineering Feasibility Study volume 3 Plan Supplement	"
23	Rhombe Swamp Engineering Feasibility Study volume 1 Main Report	"
24	Tide Tables 1981	Sierra Leone Government
25	Priority Project for Financing from OPEC	
26	Rice Statistics Yearbook (Abstracts)	West Africa Rice Development Association
27	Occasional Paper; Prospects of Self-Sufficiency in Rice in West Africa No.1	"
28	Occasional Paper; Types of Rice Cultivation in West Africa No.2	"
29	Rice Development Strategies WARDA/SD/79/8 Rice Policy in Sierra Leone	"
30	Rice Development Strategies WARDA/SD/79/9 Private & Social Profitability in Rice Production in Sierra Leone	"

No.	Title	Source or Publisher
31	Rice Development Strategies WARDA/SD/ 79/15 Prospects & Costs of Achieving Self-Sufficiency in Rice Production in West Africa by 1990	
32	The Political Economy of Rice in West Africa: A Summary of Principal Results	Food Research Institute, Stanford University and West Africa Rice Development Association
33	Gbinti S 1:50,000	Directors of Overseas Surveys
34	Rhombe Swamp Project S 1:50,000	
35	Rice Statistics Yearbook (Abstracts)	West Africa Rice Development Association
36	Review and Planned Programmes of the Agricultural Sector	The Ministires of Agriculture & Forestry and Natural Resources
37	Agricultural Statistical Survey of Sierra Leone 1970/71	Central Statistics Office
38	National Development Plan 1974/75 - 1978/79	Ministry of Development and Economic Planning Central Planning Unit
39	Estimates of Revenue and Expenditure 1980 - 81	Government of Sierra Leone