4.6 Implementation Schedule and Construction Plan

4.6.1 Construction Plan and Schedule

The implementation schedule for the whole project is given in Fig. 4.6. The implementation of the whole project is divided into four phases. Phase 2 is further subdivided into two stages. The area to be developed in each phase is summarized as shown below:

	Area		Schedule of Construction From	To
Phase - 1	3,000 ha	(7,143 fedds)	Apr. 1980	Dec. 1981
Phase - 2				
Stage - 1	3,200 ha	(7,619 fedds)	Apr. 1981	Jun. 1983
Stage - 2	3,200 ha	(7,619 fedds)	Apr. 1982	Jun. 1984
Sub-total	6,400 ha	(15,238 fedds)		
Phase - 3	3,000 ha	(7,143 fedds)	Apr. 1983	Jun. 1986
Phase - 4	3,200 ha	(7,619 fedds)	Apr. 1984	Jun. 1986
Whole project	15,600 ha	(37,143 fedds)		

The time required for all construction work of the project is estimated at around eight (8) years including the time necessary for the preparatory works. The construction of the whole works could be completed by the end of June 1986. About time schedule was prepared based on the following assumption.

The number of workable days in a year for the earth-embankment is limited to only about 100 days due to rising water level of the White Nile (See Table 11.1 in ANNEX XI). About 320 days are assumed to be workable for the earth-moving work inside the polder, according to the rainfall data covering the period of past ten years. (See Table 11.2 in ANNEX XI) The workable days for concrete work are limited to about 260 days, excluding two months during the hottest season (April to May). One month is excluded from the workable days on account of the Ramadon every year.

i) Preparatory works

Prior to the commencement of the main construction works, it is necessary to complete such preparatory works as aerial photo mapping, detailed design, procurement of construction equipment and materials, land acquisition and buildings, etc. The topographic maps of 1/50,000 scale with 0.5-m contour lines revised in the feasibility stage are still not accurate to proceed the detailed design. Aerial shooting and subsequent mapping of the project area on a scale of 1/5,000 are required to be carried out before the commencement of the detailed design. Provided that the shooting is commenced in June 1978, the mapping will be completed in March 1979. Detailed design works including canal and road alignment survey as well as the preparation of tender documents will be commenced immediately upon completion of the mapping. The design work will be carried out stagewise. It is planned that administrative facilities such as the office, quarters and laboratories will be constructed in parallel with the engineering works.

The procurement of construction machinery, pump equipment and construction materials for the first phase will be started in August 1979 in due consideration of the anticipated manufacturing and delivery terms. Land acquisition should be made before the commencement of the main civil works.

ii) Major construction works

The construction of polder dike, main drainage canal and feeder channels for Phase-1 will be initiated concurrently in the middle of April 1980 when the area is free from flooding. Embankment materials for the polder dike will mainly be obtained from the excavated materials of the drainage canals and feeder channels. The dike will be completed within 5 months. The earthwork will be carried out mainly by bulldozers, backhoes, and excavators.

As soon as the major works of polder dike are completed, the construction of the main irrigation canal and main drainage canal will be commenced, and the construction of the drainage laterals, main roads and

farm roads will be carried out thereafter. The works for main irrigation canal and laterals for the first phase will be completed by the end of February and March 1981 respectively, those for the drainage laterals by the end of August 1981 and those for the main and farm roads by the end of April 1981.

Foundation work for the pumping station for the first phase scheme will be commenced in May 1980 and followed by the construction work. Installation of pump equipment will be carried out after they are delivered, and will be completed by the end of June 1981.

Phases 2, 3 and 4 will follow upon completion of Phase-1 under a similar schedule as shown in Fig. 4.7 (1)-(4).

iii) Onfarm development works

Onfarm works including the construction of onfarm irrigation ditches, drains, and onfarm roads as well as land preparation will take critical pass for the implementation so that the construction work will be carried out continuously from the beginning of May 1980 to June 1986. Onfarm works for the first phase will be completed by the end of December 1981.

Upon completion of the major civil works most of the earth moving equipment will be transferred for use in the construction of onfarm facilities for both Phases 3 and 4 which will be completed by the end of June 1986 accordingly.

iv) Processing and storage facilities

The construction of buildings for rice processing plant and storage for the first phase scheme will be started in September 1980. Installation of rice mill equipment and other facilities will be carried out after the completion of the buildings and will be completed by the end of August 1981. Those of Phases 2, 3 and 4 will be installed stagewise according to the progress of the major civil works.

4.6.2 Construction Quantities, Materials and Equipment

The volume of major construction work and the quantity of materials required for the construction work and summarized in Tables 4.2 and 4.3. The number of major construction machinery required by the contractors is roughly estimated as listed in Table 4.4.

V. COST ESTIMATE

V. COST ESTIMATE

5.1 Project Cost Estimates

The total project cost, including physical and price contingencies is estimated at £s.82.65 million, US$ 210.76 million equivalent at the official conversion rate. It includes the initial farm investment comprising the procurement cost of farm machinery and farming inputs required for the initial operation of the project. The foreign currency component among the total cost is estimated at 65 percent.

The item-wise costs invested are brokendown as below.

(Unit: £s 10^3)

Description	Foreign Component	Local Component	Total
(1) Base Cost			
i) Civil Works	20,170	12,414	32,584
ii) Processing, Storage and Office Facilities	9,240	4,951	14,191
iii) Initial Farm Investment	4,633	39	4,672
(Sub-total)	(34,043)	(17,404)	(51,447)
(2) Contingencies			
i) Physical contingency	4,416	2,364	6,780
ii) Price contingency	15,461	8,962	24,423
(Sub-total)	(19,877)	(11,326)	(31,203)
Total	53,920	28,730	82,650

5.2 Production Cost

The production cost comprises the following four categories; i) farming expenditure, such as cost for farm inputs, O & M cost of farm machinery and depreciation cost of farm machinery, ii) O & M cost of irrigation & drainage facilities, iii) O & M cost of processing facilities, iv) administration cost.

The production cost at the full operation stage of the project is summarized as below:

(Unit: £s 10^3)

Description	Foreign Component	Local Component	Total
1. *Farming expenditures*			
i) Farm inputs	3,881	-	3,881
ii) O & M cost of farm machinery	-	1,337	1,337
iii) Depreciation cost of farm machinery	979	10	989
(Sub-total)	(4,860)	(1,347)	(6,207)
2. O & M cost of irrigation and drainage facilities	-	2,439	2,439
3. O & M cost of rice mill	485	2,349	2,834
4. Administration cost	-	422	422
Total	5,345	6,557	11,902

The total production cost for whole project is estimated at £s.11.902 million, US$ 30.35 million equivalent; the cost on a per ha basis amounts to £s.763, US$ 1,946 equivalent. The local and foreign currency components among the cost is estimated at 55%, 45%, respectively.

VI. ORGANIZATION AND MANAGEMENT

VI. ORGANIZATION AND MANAGEMENT

6.1 General

Present irrigation projects in the Sudan are operated and maintained by various kinds of organizations and systems under the control of the Ministry of Irrigation and H.E.E. as follows:

i) Individual farmers produce crops using mainly his family labour.

ii) Landowners manage irrigation farming as private pump scheme owners using hired labourers.

iii) Mechanized estate farms manage irrigation farming using hired labourers.

iv) Public corporation manages irrigation farming in which tenants share the products in certain portion.

v) Agricultural cooperatives manage irrigation farming themselves,

Extension services are provided by the Department of Agricultural Extension of MAFN. Agricultural credit is provided by the Bank of Sudan and agricultural inputs are distributed through the Sudan Gezira Board. Although some cooperation exists between the representatives of the various organizations involved, the functionaries are directly, responsible to their departmental superiors. No timely decisions can be made on the spot resulting in serious damage in crop production sometimes.

In order to ascertain the responsibilities for the management of the project, it is proposed that an efficient organization is established for the construction of the project, operation and maintenance of irrigation and drainage system, rice cultivation, rice processing, and the sale of agricultural products. The proposed organization is outlined in the organization chart in Annex XV and summarized below.

6.2 Project Organization

The project would be administered by a semi-autonomous project organization (Project Executing Organization) which will be controlled and supervised by the Project Coordination Committee. The Project Executing Organization will be responsible for the construction of the project as well as the operation and maintenance of the project. The functions of the Organization will be as follows: (see details in Annex XV)

i) Supervision of the construction of the irrigation and drainage facilities, road network, protection dike, rice mills and their related facilities, and offices and quarters.

ii) Procurement of machinery and equipment required for the project.

iii) Operation and maintenance of the irrigation and drainage facilities, road network and dike.

iv) Operation and maintenance of farm machinery and equipment.

v) Operation of farming including inputs supply.

vi) Operation and maintenance of the rice mills and related facilities.

vii) Operation and maintenance of the workshops and related facilities.

viii) Procurement of the farm inputs.

ix) Storage, processing and marketing of the products.

x) Accounting and administrative affairs.

For executing the project, the Organization will consist of four departments and two units, namely Department of Personnel and General Affairs, Department of Finance and Commercial Affairs, Department of Agricultural Production, Department of Engineering, Planning Unit and Advisory Unit under the management of the project manager (see Fig. 6.1).

For the efficient management of the project area of 15,600 ha, the project area will be divided into five schemes with an average area of 3,100 ha. A scheme manager will be assigned for the management of each scheme. Each scheme is subdivided into several field operation

units of 400 ha. each. A field operation master is assigned for each field operation unit. He manages all the production process from land preparation through harvesting in the field operation unit.

6.2.1 Department of Engineering

This department will be divided into three sections, Construction, O & M and Mechanical Engineering sections. The Construction section will be abolished after the completion of the construction works. Functions and staffs required for each section are summarized as follows:

i) Function

Construction Section

- Design and supervision of construction works of irrigation and drainage facilities, on-farm facilities, road network and protection dike.
- Supervision of construction of processing facilities
- Supervision of construction of offices, workshops and quarters

O & M Section

- O & M of irrigation and drainage system
- Control of irrigation water supply
- Maintenance works on buildings

Mechanical Engineering Section

- Management of workshops
- Repair and maintenance of farm machinery and processing facilities

ii) Staff required/1

Profession	Required Number
Director	1
Irrigation Engineer	5
Civil Engineer	4
Architect	3
Construction Machinery Engineer	4

/1 The numbers of staffs given here are the maximum numbers required during construction and full operation stage.

Assistant Engineer	10
Field Overseer for Construction	36
Canal Rider	44
Surveyor	20
Mechanic of Construction Machinery	5
Mechanic	5
Electrician	5
Regular Employee for Repair	62
Others	1
Total	205

6.2.2 Department of Agricultural Production

This department will be divided into two sections, Agricultural Operation and Processing sections. Functions and staffs required for each section are summarized as follows:

i) Agricultural Operation Section

This section will carry out all farming operations from land preparation to harvesting by machinery, plant protection, fertilizer application and seed multiplication. This section will also handle research work for rice and training of the farming staff at the pilot farm which will be established near the project area in the near future.

ii) Processing Section

This section will handle the operation and management of rice mill and the storage of paddy and milled rice.

iii) Staffs

Staffs required at the full operation stage are as follows:

Profession	Required Number
Director	1
(Agricultural Operation Section)	
Field Agriculturist	65
Farm Machinery Engineer	15
" Operator	234
" Assistant Operator	468
Field Truck Driver	156

Farm labor	156
Others	1
(Processing Section)	
Plant Manager	5
Foreman	5
Engineer	5
Operators of Rice Mill	60
Mechanic	15
Labor	180
Others	1
Total	1,368

6.2.3 Department of Finance and Commercial Affairs

This department will be divided into three sections, Finance, Accounting and Logistic & Marketing sections. Finance section will be responsible for financing and repayment of the loan. Accounting section will be in charge of all money affairs associated with the project construction, operation and maintenance works of the whole project. Logistic and Marketing section will be responsible for the procurement of all inputs including farm machinery, storage and supply of farm inputs, purchasing spare parts, etc. and will be engaged in the marketing activities of rice including transporting the rice from the project site to Port Sudan. The staffs required for this department are as follows:

Profession	Finance section	Accounting section	Logistic & Marketing section	Total
Director				1
Accountant	3	8	4	15
Administrative Officer	-	-	6	6
Agro-economist	-	-	1	1
Clerk	2	2	12	16
Driver	-	-	36	36
Others	1	2	3	6
Total	(6)	(12)	(62)	81 (80)

6.2.4 Department of Personnel and General Affairs

This department will be responsible for the general affairs and the administrative work of the project. Welfare services for all employees will also be provided by this department. The staff requirement at the full development stage is as follows:

Profession	Required Number
Director	1
Administrative Officer	14
Driver	5
Others	11
Total	31

6.2.5 Planning Unit

This unit will be responsible for the following functions.

i) Formulation of overall yearly plan for the whole area.
ii) Formulation of overall budget plan for the whole area.
iii) Studies for finding out the best way of controlling the production cost.
iv) Evaluation and follow-up of the project.
v) Economic and social studies about the effect of the project.

Staff required for this unit would be as follows:

Profession	Required Number
Agro-economist	3
Statistician	1
Others	1
Total	5

6.2.6 Staffing and Expatiate Assistance

Many large scaled infrastructures will be constructed in the project. A qualified foreign consultant firm will have to be employed on the stage of detailed design and construction supervision to carry out smooth implementation of the project. The consultant will be employed from stage to stage, according to the construction schedule.

Because of the shortage of the personnel experienced in rice cultivation, some specialists will have to be recruited from abroad for the assistance and guidance for the purpose of successful implementation of the project. They will work for the project from the commencement of partial operation (1981) to the attainment of proposed target yield (1990). Afterwards, they will be replace by local advisory staffs. The experts to be recruited in the project are as follows,

Speciality	No. of personnel
Irrigation Engineering	3
Civil Engineering	2
Construction Machinery	1
Farm Machinery	3
Rice Mill	2
Rice Agronomy	4
Total	15

They belong to the advisory unit.

VII. MARKETING AND PRICE

VII. MARKET AND PRICE

7.1 Marketing

Domestic demand for rice in 1976/77 was 23,000 tons of milled rice, while its total production was 12,000 tons. According to the Six-Year Development Plan, total production of rice will be increased to about 57,000 tons in 1982/83, while domestic demand would be about 43,000 tons in the same year. Self-sufficiency in rice would be attained in 1981/82 (see details in Annex XVI).

Production of rice of about 110,000 tons from the project at the full development stage (year of 1990) would then find outlets within the Arab countries. Import of rice in the Arab countries has steadily increased recently, which totaled about 550,000 tons in 1975. According to the population forecast in those countries, the total population in 1987 will increase to 1.4 times of the 1976 level. Provided that the import of rice increases in proportion to the population increase, the total amount of rice to be imported would be more than 770,000 tons in those countries (see details in Annex XVI).

7.2 Price

The prices of rice have substantially fluctuated in recent years. The price in 1977 shows a slightly downward trend in the world market. Forecasted prices of rice in 1977 constant dollars and in current dollars in the international market projected by IBRD are given in Table 7.1, respectively together with actual data in the past.

The economic and financial mill gate price of rice which will be produced by the Gasaba Project will be estimated to be £s.176.0/ton and £s.233.1/ton, respectively on the basis of the international market prices projected by the IBRD, taking associated costs such as loading and port charges, storage and insurance costs, and transportation costs from the project area to Port Sudan into consideration. The details are given in Table 7.2.

VIII. PROJECT EVALUATION

VIII. PROJECT EVALUATION

8.1 Economic Evaluation

Economic feasibility of the project is analized by calculating internal rate of return on the basis of the estimated economic costs required for the implementation of the project and economic benefits derived from the project. Sensitivity analysis is also made in regards to the changes in the project cost, production of rice and price of rice for testing the sensitivity of the project feasibility. For the economic analysis, the project life is assumed to be 50 years after the project enters into the full operation stage.

8.1.1 Economic Project Cost and Production Cost

For the estimation of the economic project cost and production cost, the following adjustment are made to the assumptions made for the estimation of the financial costs of the project.

a) Compensation costs for land acquisition are excluded
b) Price contingency is excluded
c) Shadow exchange rate of £s. 1=US$2.0 is applied
d) Import taxes on the imported materials are excluded

Economic project cost is estimated to be £s. 61.170 million which consists of £s. 41.400 million of the foreign currency component and £s. 19.770 million of the local currency component as shown below.

(Unit: £s. 10^3)

Discription	Foreign component	Local component	Total
Civil Works	20,581	12,414	32,995
Processing, Storage and Office Facilities and Workshops	11,035	4,951	15,986
Initial Farm Inverstment	5,076	39	5,115
(Sub-total)	(36,692)	(17,404)	(54,096)
Physical Contingency	4,708	2,366	7,074
Total	41,400	19,770	61,170

The annual disbursement schedule of the project cost is given in Table 8.1.

The economic production cost includes all the annual expenses required for the rice production namely,

i) Farming expenditures
   - Cost for fertilizers and agro-chemicals,
   - O & M cost of farm machinery,
   - Depreciation cost of farm machinery,

ii) O & M cost of rice mills,

iii) O & M cost of irrigation and drainage facilities, and

iv) administration cost

The said cost at the full operation stage is estimated to be £s.5.612 million which consists of £s.2.800 million of the foreign currency component and £s.2.812 million of the local currency component. The details of the production cost are shown in Annex XVIII.

8.1.2 Net Incremental Value of the Project

(1) Net value without the project

Out of 20,000 ha of the project area, about 250 ha is cultivated by manual labor at present. Vegetables and fruits are grown in about 210 ha and rice is grown in about 40 ha. The gross value and production cost of these crops are estimated to be about £s.61,000 and £s.48,000, respectively, through farm survey. The net valve without the project is estimated to be about £s.13,000, by deducting the production cost from the gross value.

The area of the cultivated land in the project area has remained almost constant for ages[/1] mainly because the land is cultivable only for limited period of time, April through June. The productivity of the land also has not changed significantly in recent years.

It is most likely that the total production of the land will remain

/1 Obtained through the farm survey done by the JICA Survey Team.

unchanged in the future. The net value without the project, therefore, is likely to remain constant.

Animal production forms another important cash source for the farmers and nomadic grazers in the project area. As mentioned in the Chapter 3.6.2, the number of animals owned by the farmers is estimated at about 140,000 heads through farm survey, while the number owned by nomads is not confirmed.

The acreage of wild grass land which is available for grazing in the project area is about 9,000 ha or 45 % of the project area. After the project implementation, the project area will be changed into paddy field of 15,600 ha. The amount of rice straws will considerably exceed that of wild grass through twice rice cultivation proposed in the project area. The nutrient compositions of wild grass and straw are very close each other (see Annex-XVIII).

The grazing sector in the project area will be completely compensated by substituting wild grass by rice strow. The production value without the project, which will be derived from the grazing in the project area, will not be taken into account for economic evaluation.

(2) Net value with the project

At the full operation stage, 156,000 tons of paddy or 109,200 tons[/1] of milled rice will be produced by the project. The gross value of the production is estimated to be £s.19.219 million[/2]. The net value of the project is estimated to be £s.13.607 million by deducting the production cost from the gross value.

(3) Net incremental value of the project

Net incremental value of the project is obtained by deducting the net value without the project from the net value of the project. Net incremental value of the project is estimated to be £s.13.594 million.

/1 Milling rate is 0.7.

/2 109,200 tons x £s.176/ton

The value and production cost mentioned above are summarized as follows,

(Unit: £s.10^3)

		with project	without project	Incremental
i)	Gross value	19,219	61	19,158
ii)	Production cost	5,612	48	5,564
iii)	Net value	13,607	13	13,594

8.1.3 Economic Feasibility and Sensitivity Analysis

(1) Internal rate of return (IRR) and Benefit Cost Ratio

As shown in Table 8.2, an economic cash flow statement is prepared to calculate IRR based on the economic annual disbursement schedule (Table 8.1). The useful life of 50 years for the project is assumed from the year when the project enters the full operation stage. IRR is estimated at 17.6 %. The figure indicates that the project is economically feasible. The benefit cost ratio (B/C) under various discount rates are as follows.

Discount Rate	B/C
4 %	2.1
6 %	1.9
8 %	1.6

The evaluation is also made subject to the condition that rice produced in the project will be locally consumed and non parboiling mill system be subsequently introduced. Then IRR is calculated at 25.3 % (see ANNEX XVIII). In this case, the project is economically more feasible than in case of the export, which is a basic strategy of the project.

(2) Sensitivity analysis

As shown in the following table, sensitivity test is made in regards to the project cost, productivity of rice and the price of rice. The details of the analysis are shown in Fig. 8.1. The results of the

analysis indicate that the economy of the project is equally sensible to the decrease in the productivity and to the price descent of rice. The economy of the project is slightly less feasible to the increase in the project cost than the other two factors.

	Change in the project cost	Change in the production of rice	Change in the price of rice	IRR (%)
1)	0	0	0	17.6
2)	+10 %	0	0	15.4
3)	+20 %	0	0	13.7
4)	0	-10 %	0	15.5
5)	0	-20 %	0	13.0
6)	0	0	-10 %	15.5
7)	0	0	-20 %	13.0
8)	+10 %	-10 %	0	13.2

8.2 Financial Evaluation

Financial evaluation of the project is made from the viewpoint of the project executing organization which is responsible both for the construction and the operation and maintenance of the project. Loan repayability of the project is analyzed for the loans under specific conditions.

8.2.1 Net Income

(1) Gross income

The gross income of the project executing organization is derived from exporting milled rice abroad. The total production of paddy by the project at the full operation stage will 156,000 tons or 109,200 tons of milled rice/1. The gross income is estimated to be £s. 25.455 million/2.

(2) Production cost

Production cost consists of farming expenditures/3, operation and maintenance cost of irrigation and drainage facilities, operation and maintenance cost of rice mills and administration cost. The estimated production cost of the project at the full operation stage is £s. 11.902 million.

(3) Net income

Net annual income of the project is obtained by deducting production cost from gross income i.e., (£s. 25.455 million - £s. 11.902 million). It is estimated to be £s. 13.553 million.

8.2.2 Cash Flow Statement and Anticipated Loan

As shown in Table 8.3, cash flow statement of the project is prepared on the basis of the project cost and its annual disbursement schedule (see Table 17.10 in ANNEX XVII).

/1 Milling rate is 0.7.

/2 109,200 tons x £s. 233.1/ton

/3 Include the cost for farm inputs, operation and maintenance cost of farm machinery and depreciation cost of farm machinery.

To cover the deficits of the project cost during the construction period, the amount of £s. 64.985 million must be made a loan from international monetary fund. The repayment capability of the project is analyzed for the loans with assumed conditions. The following two cases are assumed to cover the deficits in the net balance of the project during the construction period.

Case A Ten percent of interest rate and 30 years of repayment period including 8 years of grace period.

Case B Eleven percent of interest rate and 40 years of repayment period including 8 years of grace period.

Cash flow statements for above two cases are given in Table 8.4 and in Table 8.5. As seen in the Tables, the project is capable of repaying the loans in both cases. Hence, the project is sound from the financial viewpoint as well as the economic viewpoint.

Furthermore, the loan repayability of the project is also comparatively tested in the case of the local consumption of produced rice in the project area. In this case, the project is capable of repaying the loans in the following cases and financially more feasible.

Case a 12 percent of interest rate and 20 years of repaying period including 8 years of grace period, and

Case b 15 percent of interest rate and 40 years of repaying period including 8 years of grace period.

8.3 Socio-economic and Macro-economic Aspect

8.3.1 Socio-economic Aspect

Besides the direct effects of the project evaluated in the preceding sections, favourable socio-economic effects can be expected from the realization of the project. Employment opportunity in the region will be increased through the project implementation both during construction stage and operation stage. Considerable number of construction workers and machine operators will be employed during the construction of the project. In the operation stage, about 1,500 regular staffs and labourers and about 900 man-months of seasonal labourers will be employed. Since unemployment and underemployment are prevalent in the region, creation of the employment opportunity through the project will contribute to the welfare of the people in the region. Additional income gained through the increased employment opportunity by the project will increase the aggregate demand in the regional economy and will stimulate the economy.

A great number of animals are grazing in the project area during the low water season of the White Nile. Some of them are owned by the farmers in the surrounding area of the project area. Others are owned by nomads who seasonally stay in the project area. The number of the animals owned by the farmers around the project area is about 140,000 and that animals owned by nomads is not obtainable.

The gross acreage of the project land is about 20,000 ha. The acreage of wild grass land which is available for grazing in the project area is about 9,000 ha, or about 45% of the project area.

After the project implementation, the project area will be changed into paddy field of 15,600 ha. The total production of rice straw would be about 94,000 tons from the first crop and about 140,000 tons from the second crop, respectively. Total digestive nutrient of wild grass which is the key factor of nutrient composition is 40.6% and that of rice straw is 37.8%. They are very close to each other. Figures for other components are also about the same. The total amount of the straw produced through twice rice cultivation will substantially exceed that of wild grasses

grown in the project area. About 20% of the straw produced from the whole project area would be returned to the soil to increase the fertility of the land. Total amount of rice straw available for animals would be about 190,000 tons annually which can be made available throughout the year by providing some simple storage facilities. The amount of rice straw which will be produced as by-product in the project area exceeds the amount of wild grass which grows in the flood land only during the non-flood spring season. If rice straw is used to feed the animals, the supply of feed for the animals will be much improved and fattening effect can be expected.

In the Gasaba rice production project a considerable amount of insecticides will be used every year for the production of rice. It is expected that the application of insecticides for the production of rice will be very helpful in wiping out the anopheles mosquite to reduce the cases of malaria in and around the project area.

8.3.2 Macro-Economic Aspect

The Six-Year Plan intends to stimulate the agricultural sector further by aiming at the full exploitation of the huge agricultural potential of the country. One of the basic strategies of the Six-Year Plan for the agricultural sector is to attain self-sufficiency in these products in the first stage and to export such products by increasing the production in the second stage. Rice is considered as one of these items. According to the Plan, self-sufficiency of rice will be attained in 1981/1982 fiscal year. After that year, the surplus will be exported.

The construction of the Gasaba Project will be started in 1979 and completed in 1986. The rice production will partially be commenced in 1981 and expanded later. The production in 1987 will reach the level of about 142,000 tons of paddy or 99,000 tons of milled rice, which will fully satisfy the local demand. Surplus rice produced thereafter will be exported abroad and will contribute to the foreign exchange earnings.

The Gasaba Project is characterized as a pioneer scheme for the expansion of rice production in the Sudan. Though rice is produced

domestically at present in the Sudan, total production and the yield is very low. While, by the Gasaba Project, about 100,000 tons of milled rice will be produced. The production level and the yield will be raised sharply. Transfer of knowledge of rice production and the improvement of agricultural system for rice are essential. Once the Gasaba Project is implemented successfully, it would be easier to implement similar rice production projects successfully.

Expansion of the agricultural production including rice production in the Sudan will help the neighbouring Arab countries which do not possess enough agricultural potentital to cover the domestic demand for agricultural products.

TABLE

Table Member List of Japanese Feasibility Study Team

Advisory Committee, JICA:

Mr. T. Tauchi	Chief of the Committee Ministry of Agriculture and Forestry
Mr. K. Kamijoh	Irrigation Advisor Ministry of Agriculture and Forestry
Mr. K. Kurosawa	Agronomy Advisor Ministry of Agriculture and Forestry

Consultants (Nippon Koei Co., Ltd.):

Mr. H. Yamamoto	Team Leader
Mr. S. Matsuhima	Agromony
Mr. S. Yano	Irrigation and Drinage Planning
Mr. K. Kobayashi	Agro-machinery
Mr. I. Akizuki	Drainage Design
Mr. K. Goto	Irrigation Design
Mr. S. Homma	Pedology
Mr. M. Akagawa	Agro-economy
Mr. K. Minagawa	Soil Mechanic
Mr. S. Shindo	Topographic Survey
Mr. K. Wakatsuki	Architecture

Table 3.1 Soil Groups in Higher Categories

(GROUP)	ORDER	SUB-ORDER	GREAT SOIL GROUP	SUB-GROUP
I	Vertisols	Torrerts 1)	Typic Torrerts	Peleustollic-Torrerts
II	Do	Do	Do	Do
III	Entisols	Aquents 2)	Fluvaquents	Vertic-Fluvaquents
IV	Do	Fluvents 3)	Udifluvents	Vertic-Udifluvents

Note: 1) Torrerts are the Vertisols which develop under the arid and/or semi-arid climatic conditions. They are classified into Grumusols defined by the U.S.D.A. standard in 1938 and modified in 1951.

2) Aquents are the wet Entisols. They are considered Low Humic Gley soils in the 1938 U.S.D.A. classification and modified in 1949.

3) Fluvents are the Entisols formed in recent waterdeposited sediments. They were called Alluvial soils in the 1938 classification defined by U.S.D.A.

Table 3.2 Soil Groups in Lower Categories

(GROUP)	SUB GROUP	SOIL FAMILY	EXTENT AREA (ha)
I	Peleustollic Torrerts	- Very fine clayey, mixed, hyperthermic, deeply cracked soils	5,240 (26.2%)
II	Do	- Very fine clayey, mixed, thermic, shallowly cracked soils	9,640 (48.2%)
III	Vertic Fluvaquents	- Very fine clayey, mixed, thermic soils	3,920 (19.6%)
IV	Vertic Udifluvents	- Very fine clayey, mixed, thermic soils	1,200 (6.0%)
		TOTAL	20,000 (100 %)

Note: 1) Cracking conditions are tentatively classified into (a) deeply cracked - cracking depth deeper than 60 cm and (b) shallowly cracked - cracking depth shallower than 60 cm.
2) Earth temperature regime is assumed on the basis of the air temperature at Kosti Station, 50 km far from the Gasaba plain.

Table 3.3 Land Classes and Their Proportional Extent

Land class	Area (ha)	Proportional extent (%)
Class S2: Moderately suitable land	13,180	65.9
Class S3: Marginally suitable land	3,920	19.6
Class Sc: Conditionally suitable land	1,200	6.0
Class N_1: Currently unsuitable land	1,700	8.5
Total	20,000	100.0

Table 3.4 Main Features of Climate (1)

Station: ED-DUEIM

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean or (Total)
Monthly Mean Rainfall in mm /1	0	0	0	3	11	24	86	115	46	11	0	0	(296)
Numbers of Rainy Days /1	0	0	0	0	1	3	7	8	5	2	0	0	(26)
Monthly Mean Temperature /2 in °C - Maximum	32.1	33.3	37.3	40.0	41.1	39.6	36.0	34.0	35.9	37.9	35.9	32.7	36.3
Monthly Mean Temperature /2 in °C - Mean	24.3	25.2	28.6	30.9	32.7	32.0	29.7	28.4	29.3	31.6	28.3	25.0	28.7
Monthly Mean Temperature /2 in °C - Minimum	16.4	17.1	19.8	21.7	24.2	24.4	23.4	22.7	22.7	23.2	20.7	17.2	21.1
Monthly Mean Relative Humidity /2 in %	38	34	29	26	32	49	65	73	67	52	39	40	45
Monthly Mean Wind Speed in m/sec /3	1.8	2.7	2.7	2.7	2.7	2.2	2.2	2.2	2.2	1.3	1.8	1.8	2.2
Prevailing Direction /3	NE	NE	NE	NE	NE	SW	SW	SW	SW	NE	NE	NE	-
Monthly Mean Piche Evaporation /2 in mm	14.0	15.7	18.2	19.7	18.8	16.0	10.9	7.7	9.1	12.5	14.9	13.9	14.3

/1 1902 - 1975 (74 years)
/2 1941 - 1970 (29 years)
/3 1941 - 1970 (10 years)

Source: Sudan Meteorological Service

Table 3.4 Main Features of Climate (2)

Station: KOSTI

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean or(Total)
Monthly Mean Rainfall in mm /1	0	0	1	2	16	44	110	140	66	18	1	0	(398)
Numbers of Rainy Days /2	0	0	0	0	3	6	12	14	7	4	0	0	(46)
Monthly Mean Temperature /1 in °C - Maximum	32.8	34.7	37.5	40.7	40.6	38.1	34.5	32.5	34.4	37.3	36.1	33.2	36.0
Monthly Mean Temperature /1 in °C - Mean	24.7	26.1	28.8	31.7	32.8	31.5	28.9	27.5	28.5	30.1	28.5	25.3	28.7
Monthly Mean Temperature /1 in °C - Minimum	16.6	17.5	20.1	22.6	25.0	24.9	23.3	22.5	22.5	22.9	20.9	17.4	21.4
Monthly Mean Relative Humidity /1 in %	36	29	23	22	31	45	60	71	64	47	35	36	42
Monthly Mean Sunshine Hours /3 in hrs	10.3	10.5	10.1	10.3	9.9	8.5	7.2	7.0	8.3	9.6	10.3	10.4	9.4
Monthly Mean Sunshine Hours /3 in %	90	90	84	83	66	66	56	56	68	79	88	92	77
Monthly Mean Wind Speed in m/sec /3	2.7	2.7	2.7	2.2	2.2	2.7	2.7	2.2	2.2	1.8	2.7	2.7	2.7
Prevailing Direction /3	N	N	N	N	N	SSW	SSW	SSW	SSW	N	N	N	-
Monthly Mean Piche Evaporation /1 in mm	12.7	14.6	17.1	18.2	16.0	13.1	7.9	5.0	6.0	9.9	12.8	12.1	12.1

/1 1941 - 1975 (35 years)

/2 1941 - 1970 (30 years)

/3 1941 - 1970 (10 years)

Source: Sudan Meteorological Service

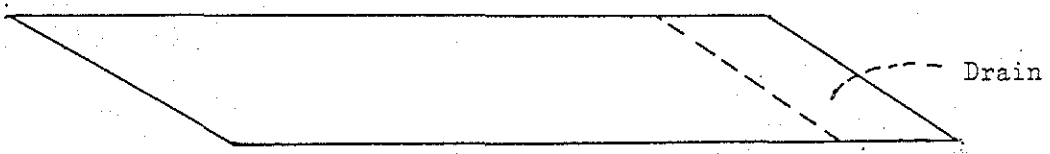
Table 4.1(1) Irrigation Water Requirement (1st Crop)

	Dec.	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.
Cropping Calender														
1. Consumptive Use of Water														
(1) Crop Coefficient (kc)				0.83	1.02	1.16	1.23	1.26	1.20	1.04	0.81			
					0.83	1.02	1.16	1.23	1.26	1.20	1.04	0.81		
						0.83	1.02	1.16	1.23	1.26	1.20	1.04	0.81	
(2) Average Crop Coefficient				0.83	0.93	1.00	1.14	1.22	1.23	1.17	1.02	0.93	0.81	
(3) Potencial Evapotranspiration(mm)				114	114	126	126	129	129	122	122	111	111	
(4) Consumptive Use of Water(2)x(3)(mm)				95	106	126	144	157	159	143	124	103	100	
2. Percolation (mm)				7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
3. Effective Rainfall (mm)				-	-	-	-	-	1.6	0.5	0.7	7.2	5.0	
4. 1 + 2 - 3 (mm)				102.5	113.5	133.5	151.5	164.5	164.9	150.0	130.8	103.3	102.5	
5. Crop Intensity to Total Area				1/6	3/6	5/6	1	1	1	1	5/6	3/6	1/6	
6. Pre-irrigation Requirement (mm)	20	20	20	15	15	15	-	-	-	-	-	15/2	15/2	15/2
7. Net Water Requirement (mm) 4 x 5 + 6	20	20	20	32	72	126	152	165	165	150	109	67	32	15
8. Diversion Water Requirement (mm) 7 /0.7/1	29	29	29	46	103	180	217	236	236	214	156	96	46	21

/1: Irrigation efficiency

/2: Pre-irrigation requirement for 2nd crop

Table 4.1(2) Irrigation Water Requirement (2nd Crop)

	Jul.	Aug.		Sep.		Oct.		Nov.		Dec.		Jan.	Feb.
													
1. Consumptive Use of Water													
(1) Crop Coefficient (kc)	0.82	0.98	1.12	1.21	1.26	1.25	1.16	1.01	0.79				
		0.82	0.98	1.12	1.21	1.26	1.25	1.16	1.01	0.79			
			0.82	0.98	1.12	1.21	1.26	1.25	1.16	1.01	0.79		
(2) Average Crop Coefficient	0.82	0.90	0.97	1.10	1.20	1.24	1.22	1.14	0.99	0.90	0.79		
(3) Potential Evapotranspiration(mm)	92	80	80	92	92	93	93	111	111	107	107		
(4) Consumptive Use of Water(2)x(3) (mm)	75	72	78	101	110	115	113	127	110	96	85		
2. Percolation (mm)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5		
3. Effective Rainfall (mm)	23.4	28.3	29.3	18.1	3.1	2.0	0.3	-	-	-	-		
4. 1 + 2 - 3 (mm)	59.1	51.2	56.2	90.4	114.4	120.5	120.2	134.5	117.5	103.5	92.5		
5. Crop Intensity to Total Area	1/6	3/6	5/6	1	1	1	1	1	5/6	3/6	1/6		
6. Pre-irrigation Requirement (mm)	15	15	15	-	-	-	-	-	-	-	-		
7. Net Water Requirement 4 x 5 + 6	25	41	62	90	114	121	120	135	98	52	15		
8. Diversion Water Requirement (mm) 7 /0.7/1	36	59	89	129	163	173	171	193	140	74	21		

/1: Irrigation efficiency

Table 4.2 Volume of Construction Work

No.	Works	Unit	Quantity
1.	Clearing and stripping	ha	4,600
2.	Excavation common	m^3	14,047,000
3.	Embankment	"	13,538,000
4.	Backfilling	"	54,000
5.	Concrete for structure	"	19,900
6.	Concrete pipe	m	13,720
7.	Gate and hoist	ton	360
8.	Reinforcing bar	ton	1,530
9.	Laterite pavement	m^3	551,000
10.	Land levelling	"	3,900,000
11.	Installation of pump	Nos.	14

Table 4.3 Construction Materials

No.	Item	Unit	Quantity
1.	Portland cement	P.C.S.(50kg/p.c.s)	131,600
2.	Reinforcing bar	ton	1,530
3.	Structural steel	"	110
4.	Gate and hoise	"	360
5.	Gravel for concrete	m^3	17,900
6.	Sand for concrete	"	9,000
7.	Laterite materials for road	"	551,000
8.	Fuel	kℓ	26,000
9.	Lubricant	ton	740

Table 4.4 Construction Machinery

No.	Machinery	Description	Required Number
1.	Bulldozer	21 ton	20
2.	"	15 "	10
3.	"	15 "	2
4.	Rake dozer	22 "	3
5.	Backhoe	1.2 m^3	18
6.	"	0.6 "	12
7.	Tractor shovel	2.2 "	10
8.	"	1.4 "	8
9.	Dragline	0.8 "	20
10.	"	0.6 "	10
11.	Clamshell	0.8 "	1
12.	Motor scraper	21 "	3
13.	"	11 "	10
14.	Motor grader	11 ton	5
15.	"	7 "	10
16.	Tyre roller	20 "	8
17.	"	14 "	5
18.	Crawler crane	25 "	1
19.	Diesel hammer	2.5 "	1
20.	Truck crane	10 "	1
21.	"	5 "	2
22.	Concrete plant	30 m^3/hour	1
23.	Aggregate plant		1
24.	Screening plant		1
25.	Agitator truck	6 m^3	2
26.	"	3 "	2
27.	Dump truck	11 ton	30
28.	Ordinary truck	11 "	10
29.	"	6 "	5
30.	Fuel tanker	10 kℓ	4
31.	Grease car	6 ton	2
32.	Water tanker		2
33.	Generator with diesel engine		5
34.	Drainage pump		10
35.	Miscellaneous equipment (Welder, Concrete mixer, Concrete vibrator, Compresser, etc.)		L.S.

Table 7.1 Forecasted Prices of Rice /1

(I) In 1977 Constant Dollars (US$/ton)

Average			Actual				Partially Estimated	Projected			
1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985
447.5	269.7	271.7	297.5	668.3	396.3	273.7	270.0	305.6	344.5	390.2	390.1

(II) In Current Dollars (US$/ton)

Average			Actual				Partially Estimated	Projected				
1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985	1987 /2
198.1	140.0	158.9	144.0	542.0	363.0	254.5	270.0	330.0	400.0	485.0	680.0	778.5

/1 Thai Bangkok F.O.B., 5 % broken.

/2 Forecasted on the basis of the recent price trend.

Source: "Price Projects of Major Primary Commodities", IBRD, June 1977

Table 7.2 Price of Rice (Export)

(I) Economic Price

International Market Price	US$390.1/t
Applying Shadow Exchange Rate £s 1 = US$ 2	£s195.1/t
Loading, Port Charge	£s3.8/t
Storage and Insurance Costs	£s2.6/t
Transportation Cost from Mill Gate to Port Sudan /1	£s12.7/t
Economic Price of Rice at Mill Gate	£s176.0/t

(II) Financial Price /2

International Market Price	US$778.5/t
Applying Effective Exchange Rate £s 1 = US$ 2.55	£s305.3/t
Loading, Port Charge	£s14.4/t
Storage and Insurance Costs	£s9.8/t
Transportation Cost from Mill Gate to Port Sudan	£s48.0/t
Financial Price of Rice at Mill Gate	£s233.1/t

/1 From project area to Khartoum by trailer
From Khartoum to Port Sudan by train

/2 At full operation stage

Table 8.1 Annual Disbursement Schedule of Economic Project Cost

(Unit: £S10^3)

Item	Total Cost	1979	1980	1981	1982	1983	1984	1985	1986
Civil Works									
1) Construction Works	29,934	-	3,928	5,644	5,235	4,781	4,998	3,982	1,366
2) Engineering services & Administration	3,061	367	870	236	474	569	293	168	84
3) Physical contingency	4,955	47	709	891	859	801	800	629	219
Sub-total	37,950	414	5,507	6,771	6,568	6,151	6,091	4,779	1,669
Processing, Workshop, Office and Related facilities									
1) Processing facilities	14,240	-	2,848	-	2,848	2,848	2,848	2,848	-
2) Workshop & shade	503	-	82	-	175	82	82	82	-
3) Office & related facilities	1,243	395	212	212	212	212	-	-	-
4) Physical Contingency	1,604	41	315	22	325	315	293	293	-
Sub-total	17,590	436	3,457	234	3,560	3,457	3,223	3,223	-
Initial Farm Investment									
1) Agricultural machinery	5,115	-	656	393	1,049	656	656	1,705	-
2) Physical Contingency	515	-	66	40	106	66	66	171	-
Sub-total	5,630	-	722	433	1,155	722	722	1,876	-
Total	61,170	850	9,686	7,438	11,283	10,330	10,036	9,878	1,669

Table 8.2 Economic Cash Flow Statement

(Unit: £s.10^3)

Year	Year in order	Cash inflow			Cash outflow			
		Project Benefit			Project Cost			
		Sales of Rice	Benefit of without project	Total inflow	Irrigation Facilities	Processing, Workshop, Office & Related Facilities. Farm Machinery	Production cost	Total outflow
1978	1	-	-	-	-	-	-	-
79	2	-	13	-13	414	436	129	979
80	3	-	13	-13	5,507	4,179	147	9,833
81	4	1,164	13	1,151	6,771	667	719	8,157
82	5	2,933	13	2,920	6,568	4,715	1,149	12,432
83	6	5,714	13	5,701	6,151	4,179	2,096	12,426
84	7	8,225	13	8,212	6,091	3,945	2,904	12,940
85	8	10,756	13	10,743	4,779	5,099	3,603	13,481
86	9	15,683	13	15,670	1,669	0	4,874	6,543
87	10	17,536	13	17,523	-	0	5,071	5,071
88	11	18,264	13	18,251	-	668	5,071	5,739
89	12	18,818	13	18,805	-	393	5,071	5,464
90	13	19,219	13	19,206	-	1,081	4,972	6,053
91	14	19,219	13	19,206	-	668	4,972	5,640
92	15	19,219	13	19,206	-	668	4,972	5,640
93	16	19,219	13	19,206	-	1,717	4,972	6,689
94	17	19,219	13	19,206	-	0	4,972	4,972
95	18	19,219	13	19,206	-	18	4,972	4,990
96	19	19,219	13	19,206	-	668	4,972	5,640
97	20	19,219	13	19,206	-	451	4,972	5,423
98	21	19,219	13	19,206	-	1,099	4,972	6,071
99	22	19,219	13	19,206	-	686	4,972	5,640
2000	23	19,219	13	19,206	-	2,872	4,972	7,844
01	24	19,219	13	19,206	-	1,717	4,972	6,689
02	25	19,219	13	19,206	-	2,186	4,972	7,158
03	26	19,219	13	19,206	-	2,186	4,972	7,158
04	27	19,219	13	19,206	-	2,854	4,972	7,826
05	28	19,219	13	19,206	-	2,579	4,972	7,551
06	29	19,219	13	19,206	705	1,081	4,972	6,758
2007	30	19,219	13	19,206	-	668	4,972	5,640
08	31	19,219	13	19,206	1,265	668	4,972	6,095
09	32	19,219	13	19,206	-	717	4,972	6,689
10	33	19,219	13	19,206	705	18	4,972	5,695
11	34	19,219	13	19,206	856	0	4,972	5,828
12	35	19,219	13	19,206	-	725	4,972	5,697
13	36	19,219	13	19,206	236	411	4,972	5,619
14	37	19,219	13	19,206	63	1,099	4,972	6,134
15	38	19,219	13	19,206	142	686	4,972	5,800
16	39	19,219	13	19,206	122	686	4,972	5,780
17	40	19,219	13	19,206	-	1,717	4,972	6,689
18	41	19,219	13	19,206	-	0	4,972	4,972
19	42	19,219	13	19,206	-	0	4,972	4,972
20	43	19,219	13	19,206	-	2,854	4,972	7,826
21	44	19,219	13	19,206	-	393	4,972	5,365
22	45	19,219	13	19,206	-	3,267	4,972	8,239
23	46	19,219	13	19,206	-	2,854	4,972	7,826
24	47	19,219	13	19,206	-	2,854	4,972	7,826
25	48	19,219	13	19,206	-	3,921	4,972	8,893
26	49	19,219	13	19,206	-	0	4,972	4,972
27	50	19,219	13	19,206	-	58	4,972	5,030
28	51	19,219	13	19,206	-	686	4,972	5,658
29	52	19,219	13	19,206	-	411	4,972	5,383
30	53	19,219	13	19,206	-	1,099	4,972	6,071
31	54	19,219	13	19,206	-	668	4,972	5,640
32	55	19,219	13	19,206	-	668	4,972	5,640
33	56	19,219	13	19,206	-	1,717	4,972	6,689
34	57	19,219	13	19,206	-	0	4,972	4,972
35	58	19,219	13	19,206	-	0	4,972	4,972
36	59	19,219	13	19,206	-	668	4,972	5,640

Table 8.3 Cash Flow Statement (Financial)

(Unit: £s 10^3)

Year	Year in Order	Cash Inflow: Project Benefit: Total Inflow/1	Cash Outflow: Project Cost: Irrigation Facilities	Cash Outflow: Project Cost: Processing, Workshop, Office & Related Facilities and Farm Machinery	Cash Outflow: Production Cost	Total Outflow	Net Balance
1979	1	-	3,578	377	145	4,100	-4,100
80	2	-	12,908	4,367	178	17,453	-17,453
81	3	1,148	9,655	848	823	11,326	-10,178
82	4	3,032	6,621	5,709	1,545	13,875	-10,843
83	5	6,225	6,782	5,641	2,965	15,388	-9,163
84	6	9,431	7,022	5,638	4,687	17,347	-7,916
85	7	12,963	4,291	7,596	6,408	18,295	-5,332
86	8	19,827	1,043	574	9,198	10,815	9,012
87	9	23,226	-	-	11,119	11,119	12,107
88	10	24,190	-	1,036	11,119	12,155	12,035
89	11	24,924	-	609	11,119	11,728	13,196
1990	12	25,455	-	1,686	10,913	12,599	12,856
91	13	"	-	1,036	"	11,949	13,506
92	14	"	-	1,036	"	11,949	13,506
93	15	"	-	2,661	"	13,574	11,881
94	16	"	-	-	"	10,913	14,542
95	17	"	-	35	"	10,948	14,507
96	18	"	-	1,036	"	11,949	13,506
97	19	"	-	720	"	11,633	13,822
98	20	"	-	1,720	"	12,633	12,822
99	21	"	-	1,071	"	11,984	13,471
2000	22	"	-	4,619	"	15,532	9,923
01	23	"	-	2,661	"	13,574	11,881
02	24	"	-	3,548	"	14,461	10,994
03	25	"	-	3,548	"	14,461	10,994
04	26	"	-	4,584	"	15,497	9,958
05	27	"	-	4,157	"	15,070	10,385
06	28	"	1,347	1,686	"	13,946	11,509
07	29	"	-	1,036	"	11,949	13,506
08	30	"	2,413	1,036	"	14,362	11,093
09	31	"	-	2,661	"	13,574	11,881
2010	32	"	1,347	35	"	12,295	13,160
11	33	"	1,663	-	"	12,576	12,879
12	34	"	-	1,147	"	12,060	13,395
13	35	"	484	644	"	12,041	13,414
14	36	"	149	1,720	"	12,782	12,673
15	37	"	294	1,071	"	12,278	13,177
16	38	"	333	1,036	"	12,282	13,173
17	39	"	-	2,661	"	13,574	11,881
18	40	"	-	-	"	10,913	14,542
19	41	"	-	-	"	10,913	14,542
2020	42	"	-	4,584	"	15,497	9,958
21	43	"	-	609	"	11,522	13,933
22	44	"	-	5,232	"	16,145	9,310
23	45	"	-	4,584	"	15,497	9,958
24	46	"	-	4,584	"	15,497	9,958
25	47	"	-	6,243	"	17,156	8,299
26	48	"	-	-	"	10,913	14,542
27	49	"	-	111	"	11,024	14,431
28	50	"	-	1,071	"	11,984	13,471
29	51	"	-	644	"	11,557	13,898
2030	52	"	-	1,720	"	12,633	12,822
31	53	"	-	1,036	"	11,949	13,506
32	54	"	-	1,036	"	11,949	13,506
33	55	"	-	2,661	"	13,574	11,881
34	56	"	-	-	"	10,913	14,542
35	57	"	-	-	"	10,913	14,542
36	58	"	-	1,036	"	11,949	13,506

/1 The inflow is derived by the sale of rice.

Table 8.4 Cash Flow Statement for Loan Repayment (Case A)

(Unit: £s 10^3)

Year	Year in Order	Cash Inflow			Cash Outflow			Cash Surplus	Accumulated Surplus
		Sales of Rice	Loan 1/	Total	Project & Production Cost	Loan Repayment	Total		
79	1	-	4,100	4,100	4,100		4,100	0	
1980	2	-	17,453	17,453	17,453		17,453	0	
81	3	1,148	10,178	11,326	11,326		11,326	0	
82	4	3,032	10,843	13,875	13,875		13,875	0	
83	5	6,225	9,163	15,388	15,388		15,388	0	
84	6	9,431	7,916	17,347	17,347		17,347	0	
85	7	12,963	5,332	18,295	18,295		18,295	0	
86	8	19,827		19,827	10,815		10,815	9,012	9,012
87	9	23,226		23,226	11,119	11,267	22,386	840	9,852
88	10	24,190		24,190	12,153	"	23,422	768	10,620
89	11	24,924		24,924	11,728	"	22,995	1,929	12,549
1990	12	25,455		25,455	12,599	"	23,866	1,589	14,138
91	13	"		"	11,949	"	23,216	2,239	16,377
92	14	"		"	11,949	"	23,216	2,239	18,616
93	15	"		"	13,574	"	24,841	614	19,230
94	16	"		"	10,913	"	22,180	3,275	22,505
95	17	"		"	10,948	"	22,215	3,240	25,745
96	18	"		"	11,949	"	23,216	2,239	27,984
97	19	"		"	11,633	"	22,900	2,555	30,539
98	20	"		"	12,633	"	23,900	1,555	32,094
99	21	"		"	11,984	"	23,251	2,204	34,298
2000	22	"		"	15,532	"	26,799	-1,344	32,954
01	23	"		"	13,574	"	24,841	614	33,568
02	24	"		"	14,461	"	25,728	-273	33,295
03	25	"		"	14,461	"	25,728	-273	33,022
04	26	"		"	15,497	"	26,764	-1,309	31,713
05	27	"		"	15,070	"	26,337	-882	30,831
06	28	"		"	13,946	"	25,213	242	31,073
07	29	"		"	11,949	"	23,216	2,239	33,312
08	30	"		"	14,362	"	25,629	-174	33,138
09	31	"		"	13,574		13,574	11,881	45,019
2010	32	"		"	12,295		12,295	13,160	58,179
11	33	"		"	12,576		12,576	12,879	71,058
12	34	"		"	12,060		12,060	13,395	84,453
13	35	"		"	12,041		12,041	13,414	97,867
14	36	"		"	12,782		12,782	12,673	110,540
15	37	"		"	12,278		12,278	13,177	123,717
16	38	"		"	12,282		12,282	13,173	136,890
17	39	"		"	13,574		13,574	11,881	148,771
18	40	"		"	10,913		10,913	14,542	163,313
19	41	"		"	10,913		10,913	14,542	177,855
2020	42	"		"	15,497		15,197	9,958	187,813
21	43	"		"	11,522		11,522	13,933	201,746
22	44	"		"	16,145		16,145	9,310	211,056
23	45	"		"	15,497		15,497	9,958	221,014
24	46	"		"	15,497		15,497	9,958	230,972
25	47	"		"	17,156		17,156	8,299	239,271
26	48	"		"	10,913		10,913	14,542	253,813
27	49	"		"	11,024		11,024	14,431	268,244
28	50	"		"	11,984		11,984	13,471	281,715
29	51	"		"	11,557		11,557	13,898	295,613
2030	52	"		"	12,633		12,633	12,822	308,435
31	53	"		"	11,949		11,949	13,506	321,941
32	54	"		"	11,949		11,949	13,506	335,447
33	55	"		"	13,574		13,574	11,881	347,328
34	56	"		"	10,913		10,913	14,542	361,870
35	57	"		"	10,913		10,913	14,542	376,412
36	58	"		"	11,949		11,949	13,506	389,918

1/. Annual interest rate: 10 %, Repayment period: 30 years, Grace period: 8 years.

Table 8.5 Cash Flow Statement for Loan Repayment (Case B)

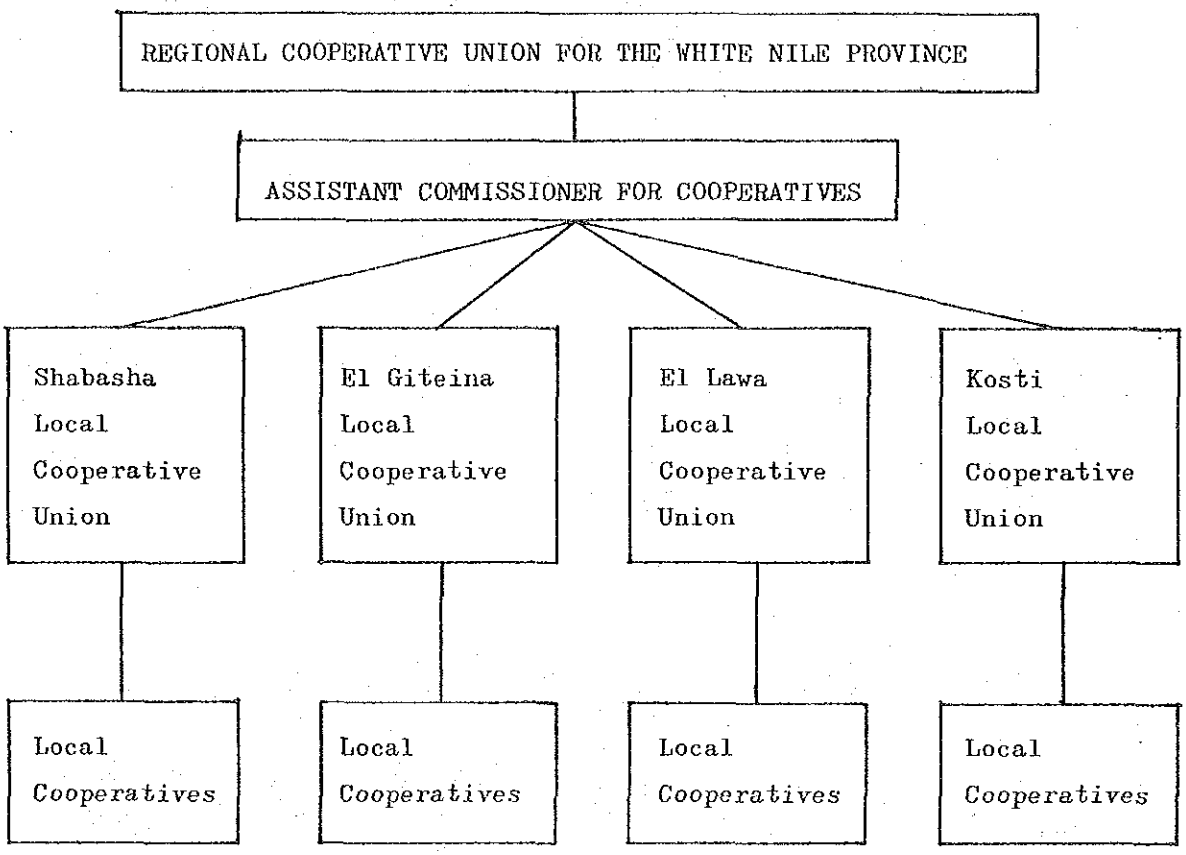
(Unit: ₤s 10^3)

Year	Year in Order	Cash Inflow			Cash Outflow			Cash Surplus	Accumulated Surplus
		Sales of Rice	Loan[1]	Total	Project & Production Cost	Loan Repayment	Total		
79	1	-	4,100	4,100	4,100		4,100	0	
1980	2	-	17,453	17,453	17,453		17,453	0	
81	3	1,148	10,178	11,326	11,326		11,326	0	
82	4	3,032	10,843	13,875	13,875		13,875	0	
83	5	6,225	9,163	15,388	15,388		15,388	0	
84	6	9,431	7,916	17,347	17,347		17,347	0	
85	7	12,963	5,332	18,295	18,295		18,295	0	
86	8	19,827		19,827	10,815		10,815	9,012	9,012
87	9	23,226		23,226	11,119	11,724	22,861	365	9,377
88	10	24,190		24,190	12,155	"	23,897	293	9,670
89	11	24,924		24,924	11,728	"	23,470	1,454	11,124
90	12	25,455		25,455	12,599	"	24,341	1,114	12,238
91	13	"		"	11,949	"	23,691	1,764	14,002
92	14	"		"	11,949	"	23,691	1,764	15,766
93	15	"		"	13,574	"	25,316	139	15,905
94	16	"		"	10,913	"	22,655	2,800	18,705
95	17	"		"	10,948	"	22,690	2,765	21,470
96	18	"		"	11,949	"	23,691	1,764	23,234
97	19	"		"	11,633	"	23,375	2,080	25,314
98	20	"		"	12,633	"	24,375	1,080	26,394
99	21	"		"	11,984	"	23,726	1,729	28,123
2000	22	"		"	15,532	"	27,274	-1,819	26,304
01	23	"		"	13,574	"	25,316	139	26,443
02	24	"		"	14,461	"	26,203	-748	25,695
03	25	"		"	14,461	"	26,203	-748	24,947
04	26	"		"	15,497	"	27,239	-1,784	23,163
05	27	"		"	15,070	"	26,812	-1,357	21,806
06	28	"		"	13,946	"	25,688	-233	21,573
07	29	"		"	11,949	"	23,691	1,764	23,337
08	30	"		"	14,362	"	26,104	-649	22,688
09	31	"		"	13,574	"	25,316	139	22,827
2010	32	"		"	12,295	"	24,037	1,418	24,245
11	33	"		"	12,576	"	24,318	1,137	25,382
12	34	"		"	12,060	"	23,802	1,653	27,035
13	35	"		"	12,011	"	23,783	1,672	28,707
14	36	"		"	12,782	"	24,524	931	29,638
15	37	"		"	12,278	"	24,020	1,435	31,073
16	38	"		"	12,282	"	24,024	1,431	32,504
17	39	"		"	13,574	"	25,316	139	32,643
18	40	"		"	10,913	"	22,655	2,800	35,443
19	41	"		"	10,913		10,913	14,542	49,985
2020	42	"		"	15,497		15,497	9,958	59,943
21	43	"		"	11,522		11,522	13,933	73,876
22	44	"		"	16,145		16,145	9,310	83,186
23	45	"		"	15,197		15,197	9,958	93,144
24	46	"		"	15,497		15,497	9,958	103,102
25	47	"		"	17,156		17,156	8,299	111,401
26	48	"		"	10,913		10,913	14,542	125,943
27	49	"		"	11,024		11,024	14,431	140,374
28	50	"		"	11,984		11,984	13,471	153,845
29	51	"		"	11,557		11,557	13,898	167,743
30	52	"		"	12,633		12,633	12,822	180,565
31	53	"		"	11,949		11,949	13,506	194,071
32	54	"		"	11,949		11,949	13,506	207,577
33	55	"		"	13,574		13,574	11,881	219,458
34	56	"		"	10,913		10,913	14,542	234,000
35	57	"		"	10,913		10,913	14,542	248,542
36	58	"		"	11,949		11,949	13,506	262,048

1. Annual interest rate: 11 %, Repayment period: 40 years, Grace period: 8 years.

FIGURE

Fig. 2.1 Organization Structure for Cooperative Unions



Source: Provincial Headquarters in Ed Dueim.

Fig. 3.1 Water Level of the White Nile

Station : Ed Dueim

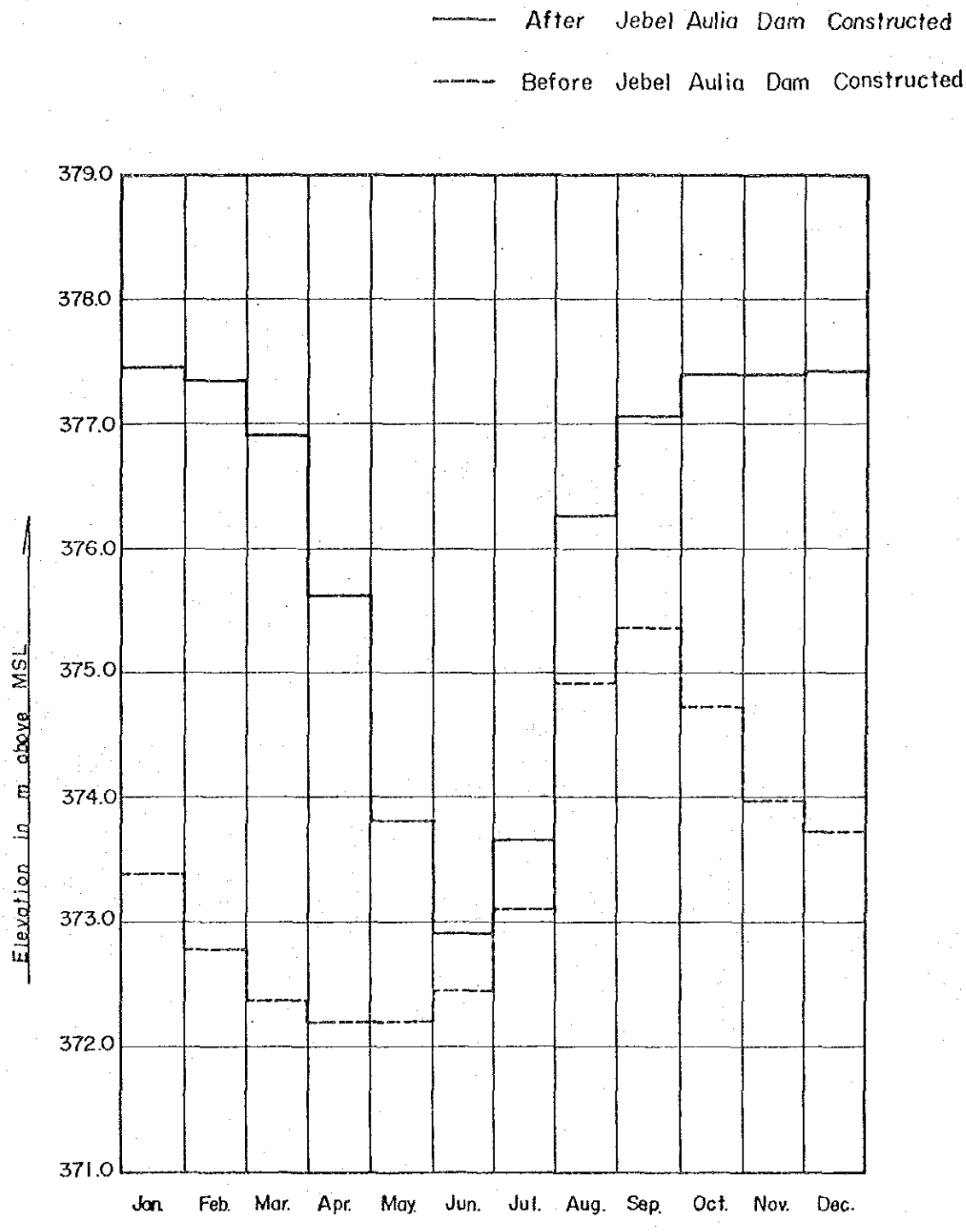
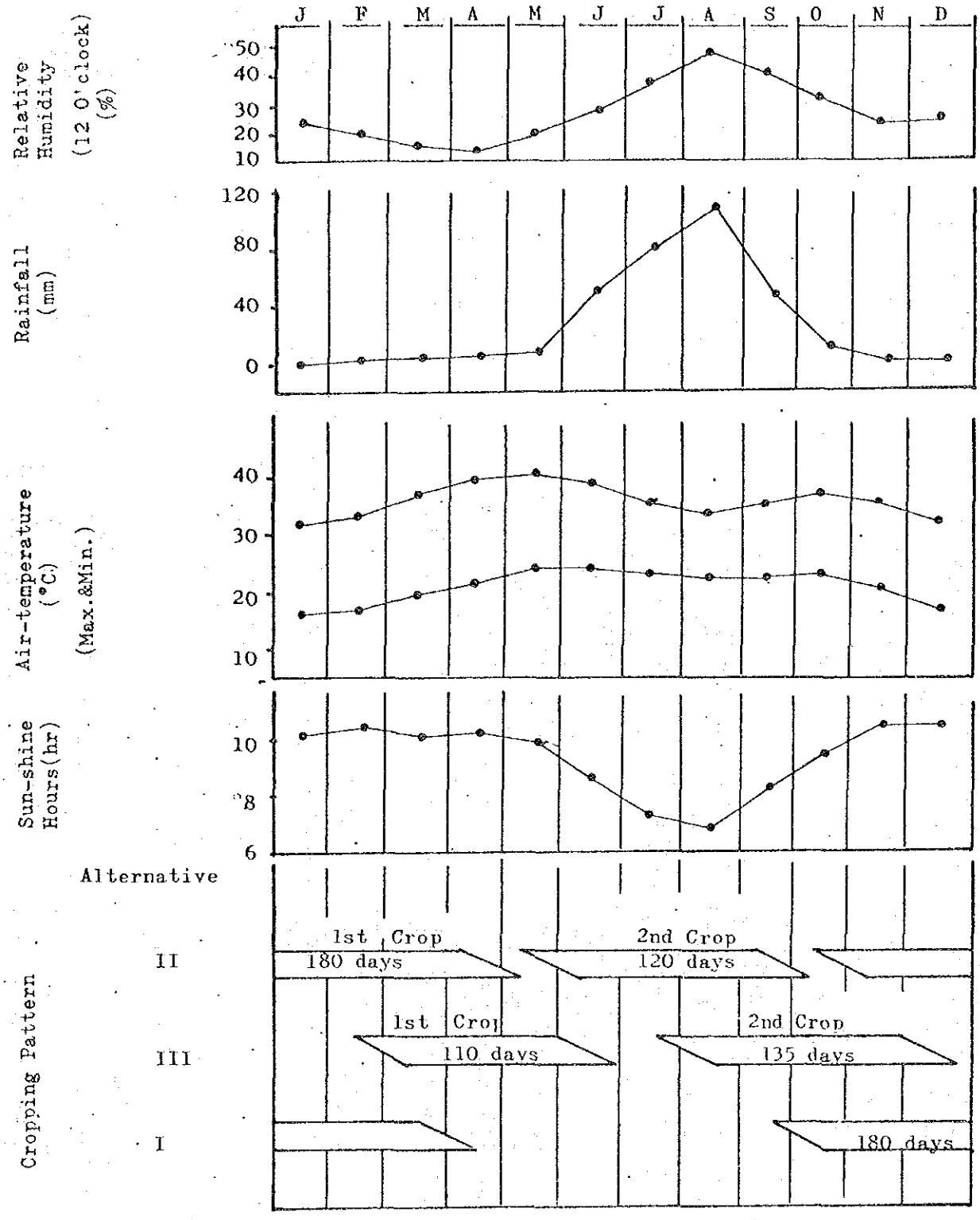
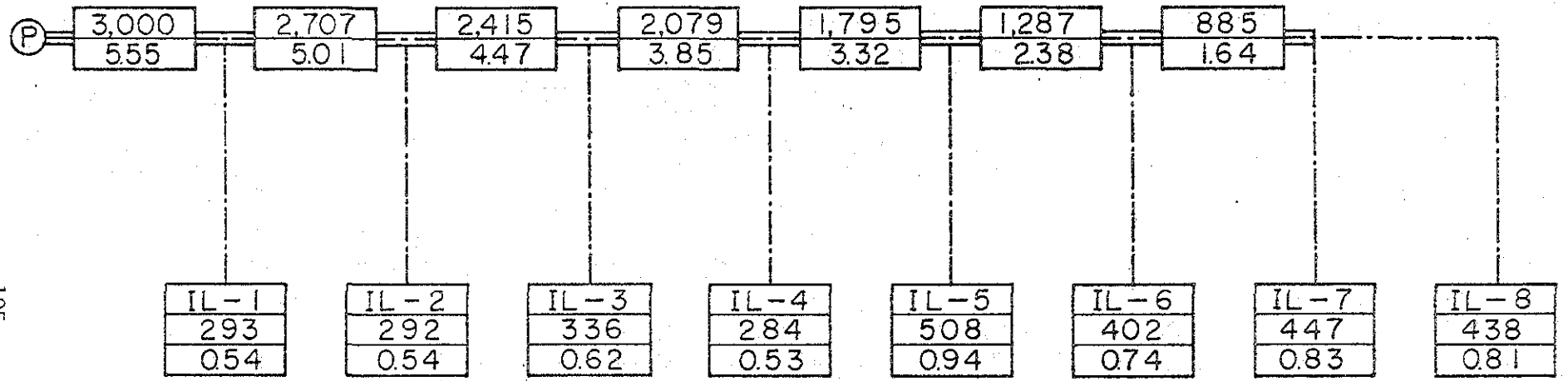


Fig 4.1 Meteorological Conditions and Cropping Pattern



Note: Relative humidity, Rainfall and Mean Air-remperature are the average values obtained at Ed Dueim over a period of 29 years, while Sun-shine hours are those observed at Kosti over a period of 14 years.

Fig. 4.2 (1) Irrigation Diagram for Tract - I



LEGEND

Name of Canal
Area (ha)
Discharge(m^3/sec)

Main Irrigation Canal

Irrigation Lateral

(P) Pump Station

Fig. 4.2 (2) Irrigation Diagram for Tract - 2

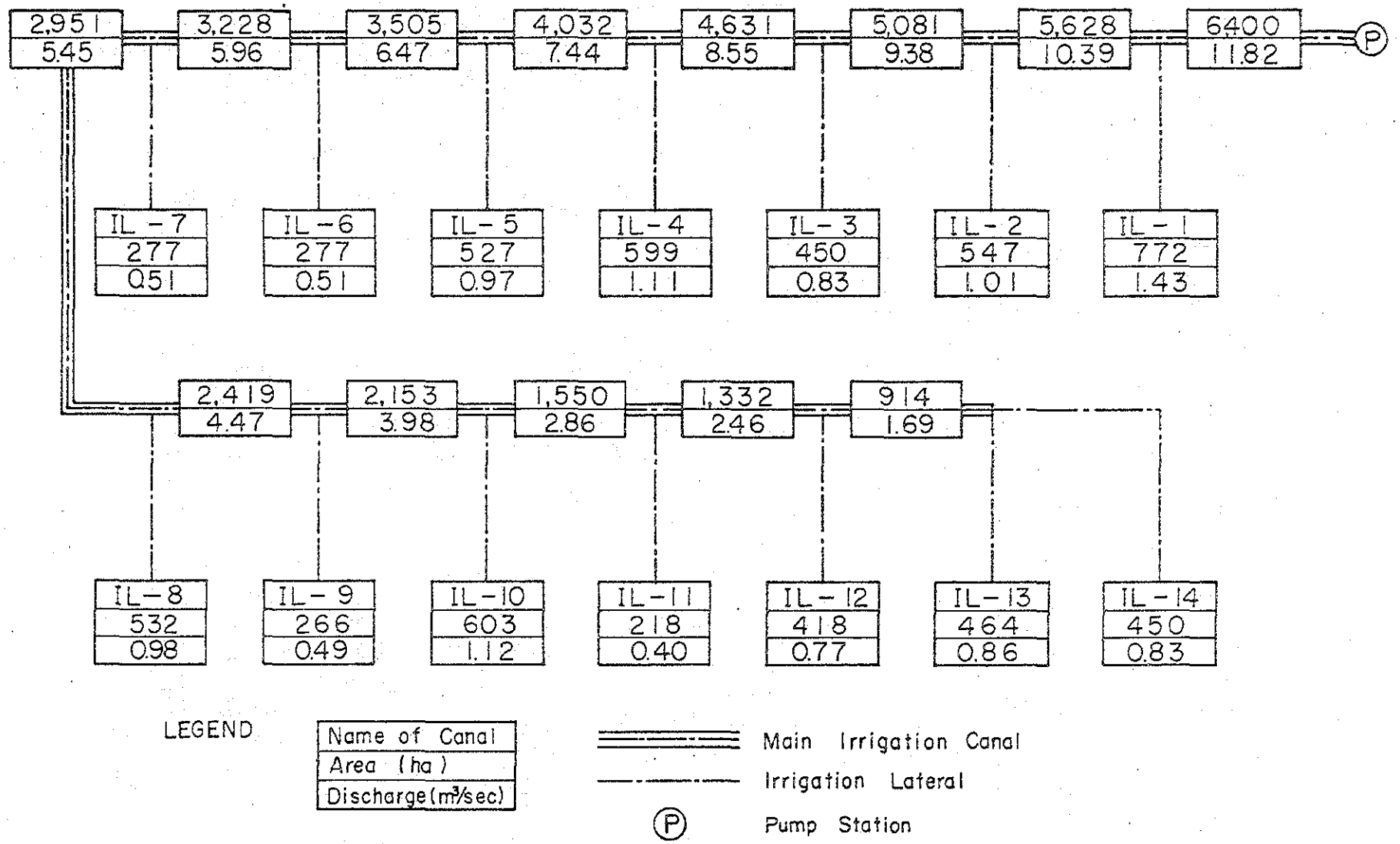


Fig. 4.2 (3) Irrigation Diagram for Tract - 3

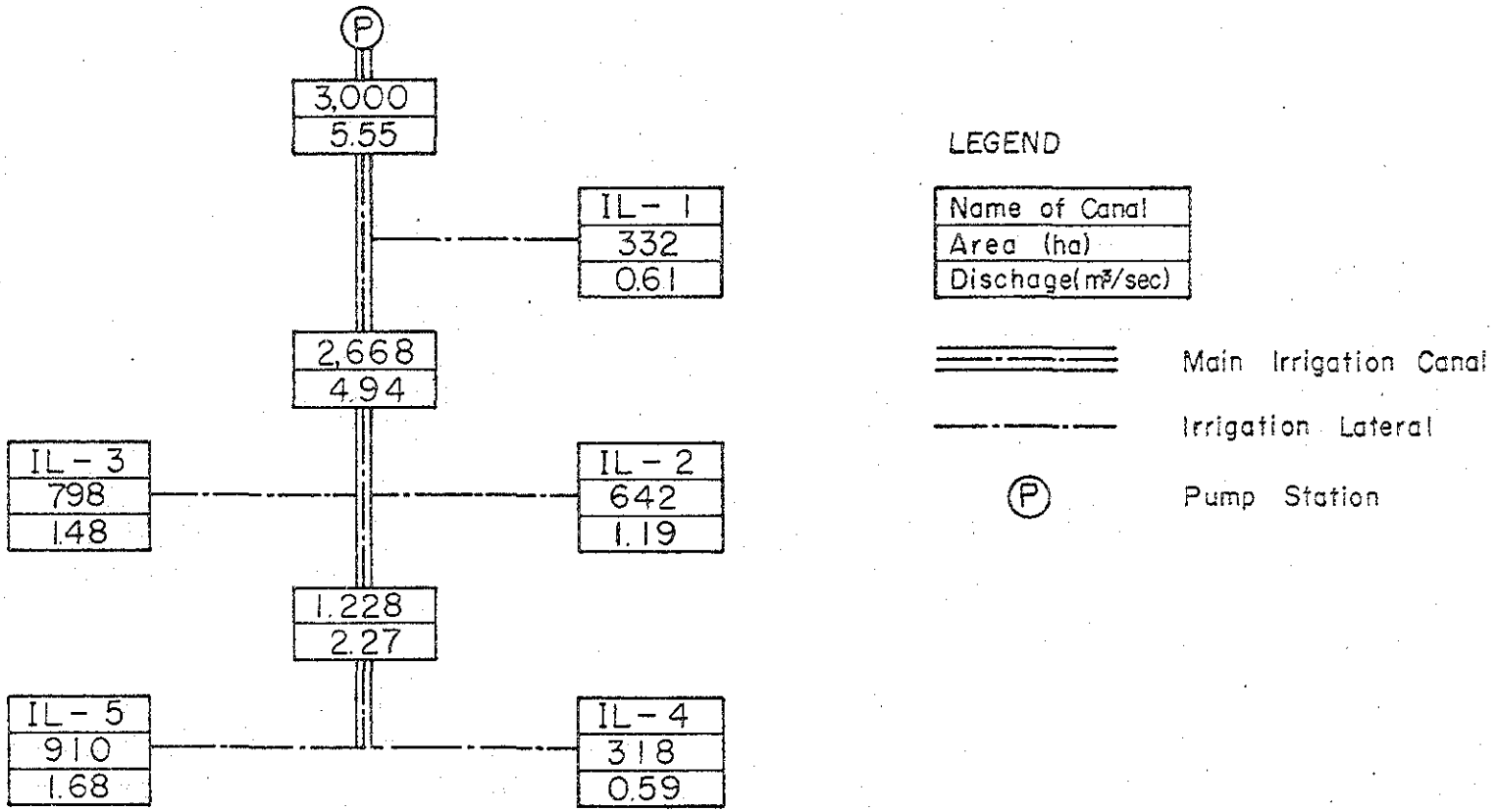
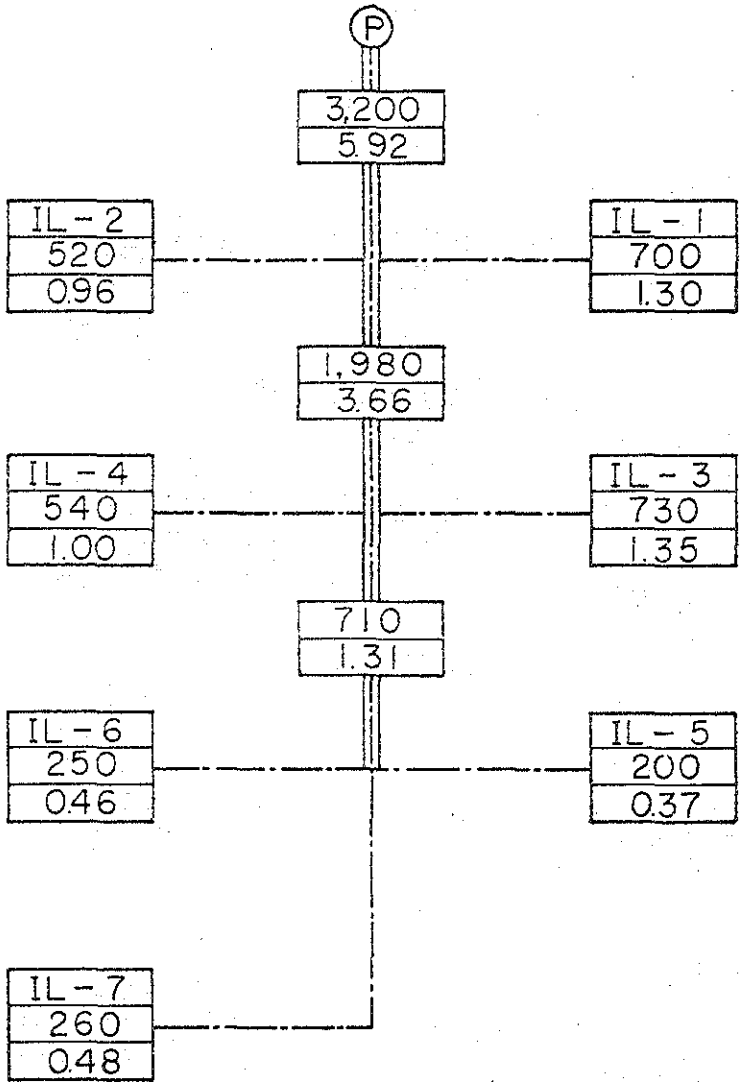


Fig. 4.2(4) Irrigation Diagram for Tract - 4



LEGEND

Name of Canal
Area (ha)
Dischage (m^3/sec)

Main Irrigation Canal

Irrigation Lateral

P Pump Station

Fig. 4.3 Canal & Road Section

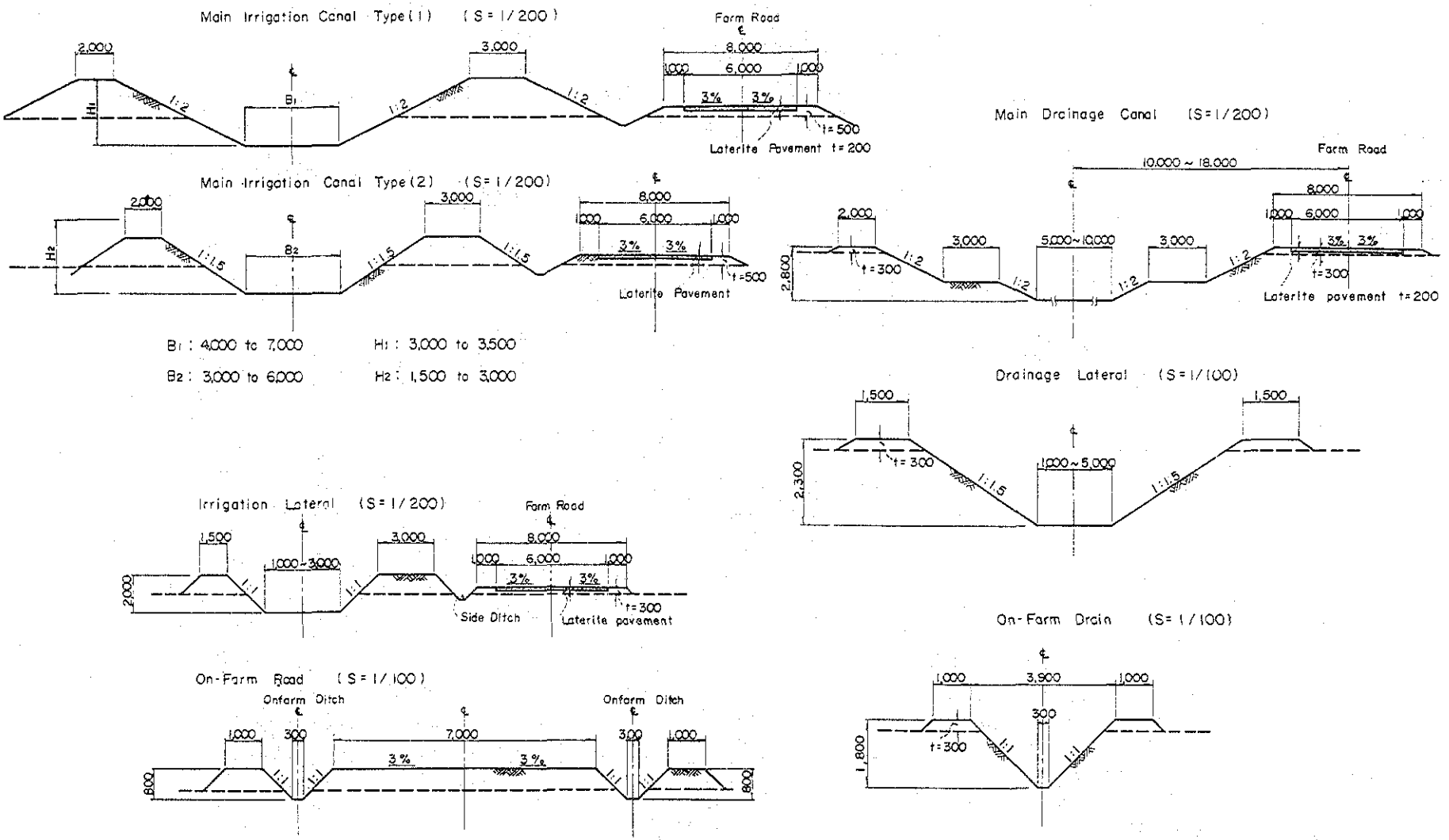


Fig. 4.4 Typical Cross Section of Polder Dike

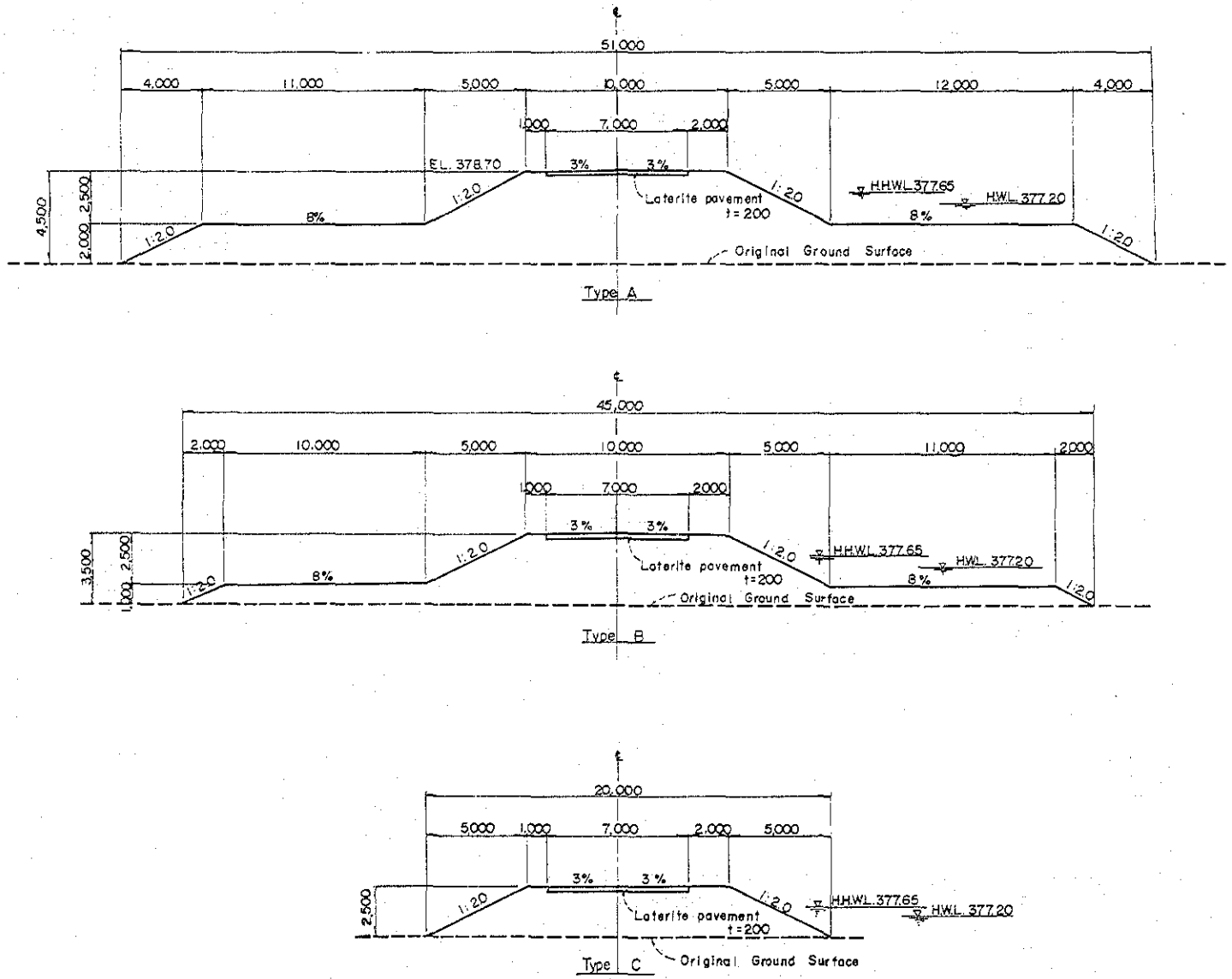


Fig. 4 . 5 Typical Layout of Farm Unit

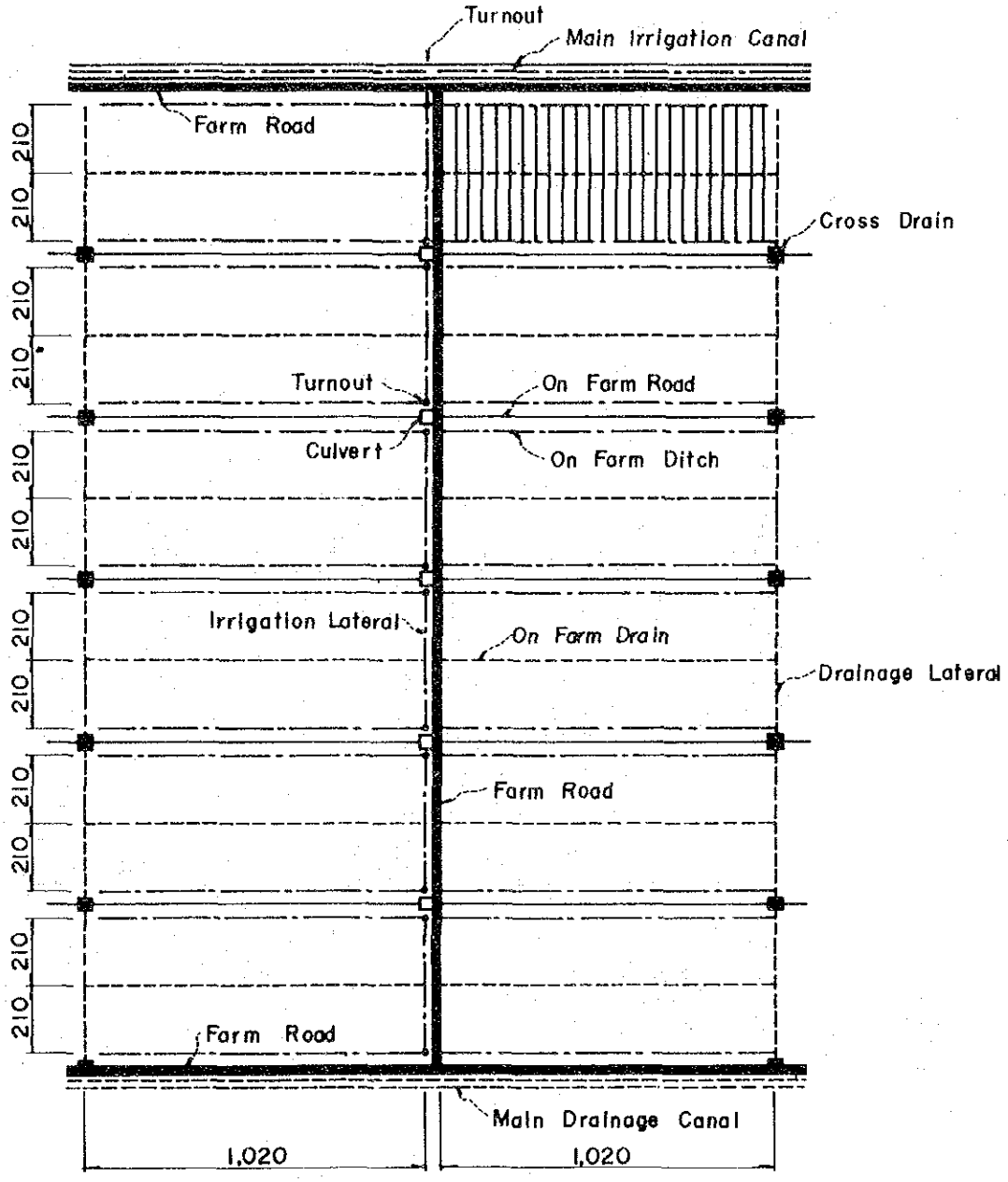


Fig 4.6 Implementation Schedule for Whole Project

Item	Unit	Quantity
1. Preparatory Works		
-1 Shooting and Mapping	ha	50,000
-2 Engineering Services	ha	15,600
-3 Procurement of Equipment	L.S.	——
-4 Land Acquisition	ha	95
-5 Administrative Facilities	Nos.	6
2. Major Construction Works		
-1 Dike	m	154,690
-2 Pumping Station	Nos.	4
-3 Main Irrigation Canal	m	51,790
-4 Irrigation Lateral	m	120,790
-5 Main Drainage Canal	m	73,300
-6 Drainage Lateral	m	103,240
-7 Main Road	m	51,700
-8 Farm Road	m	280,240
-9 Feeder Channel	m	100,050
-10 Miscellaneous Works	L.S.	——
3. On-Farm Development Works	ha	15,600
4. Rice Processing & Storage Facilities	Nos.	5
6. Pilot Farm	Nos.	1
7. Project Operation		
-1 Pilot Scheme	—	——
-2 Main Project	—	——

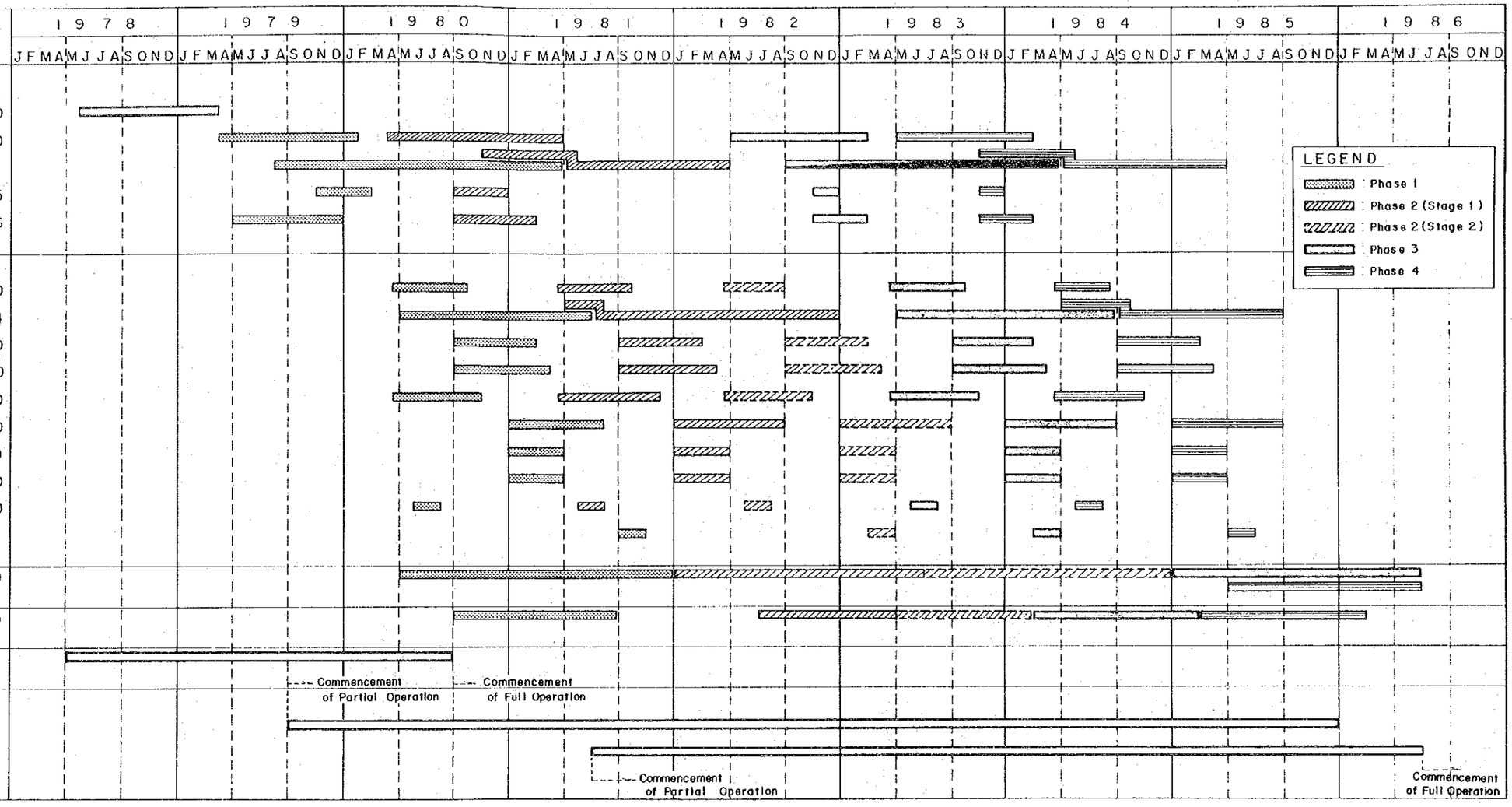


Fig 4.7(1) Construction Time Schedule for Phase 1 (Tract1)

Item	Unit	Quantity
1. Preparatory Works		
1.1 Engineering Services	LS	—
1.2 Procurement of Equipment	"	—
1.3 Land Acquisition	ha	32.9
1.4 Administrative Facilities	LS	—
2. Dike		
2.1 Stripping	ha	85
2.2 Embankment	m^3	1,422,200
2.3 Pavement	"	55,400
3. Pumping Station		
3.1 Inlet Channel	m^3	11,900
3.2 Foundation	"	2,200
3.3 Building	m^2	375
3.4 Pump Installation	Set	3
4. Main Irrigation Canal		
4.1 Stripping	ha	25
4.2 Excavation	m^3	56,400
4.3 Embankment	"	340,100
4.4 Related Structures	LS	—
5. Irrigation Lateral		
5.1 Stripping	ha	23
5.2 Excavation	m^3	9,400
5.3 Embankment	"	150,000
5.4 Related Structures	LS	—
6. Main Drainage Canal		
6.1 Stripping	ha	6
6.2 Excavation	m^3	915,600
6.3 Embankment	"	30,900
6.4 Related Structures	LS	—
7. Drainage Lateral		
7.1 Stripping	ha	8
7.2 Excavation	m^3	208,300
7.3 Embankment	"	57,900
7.4 Related Structures	LS	—
8. Main Road		
8.1 Stripping	ha	3
8.2 Embankment	m^3	15,300
8.3 Pavement	"	3,400
9. Farm Road		
9.1 Stripping	ha	51
9.2 Embankment	m^3	175,900
9.3 Pavement	"	66,500
10. Feeder Channel (Excavation)	m^3	1,488,000
11. On-Farm Development Works		
11.1 Land Leveling	ha	3,000
11.2 On-Farm Ditch	km	150
11.3 On-Farm Drain	"	75
11.4 On-Farm Road	"	63

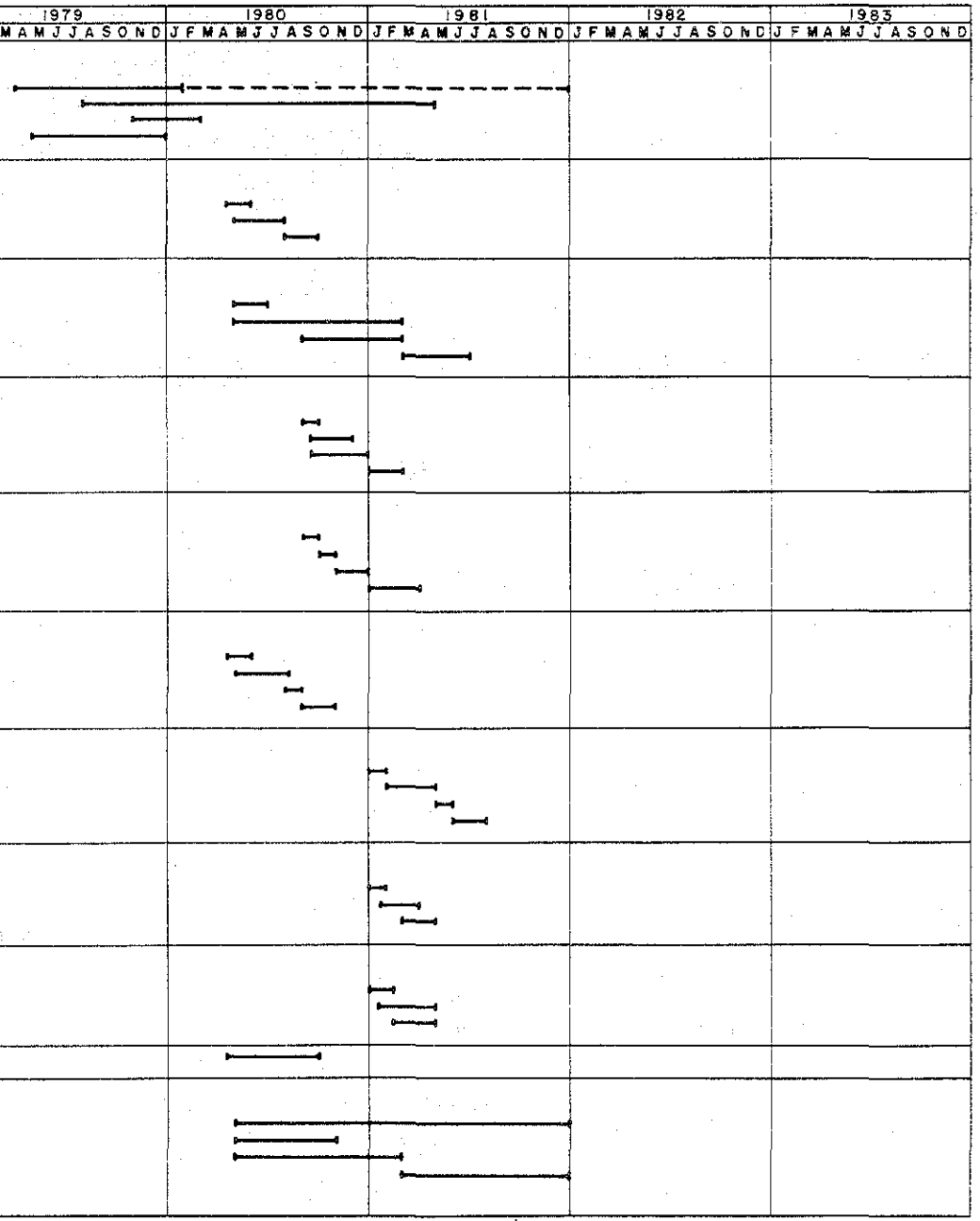


Fig 4.7(2) Construction Time Schedule for Phase 2 (Tract 2)

Item	Unit	Quantity
1. Preparatory Works		
1.1 Engineering Services	LS	—
1.2 Procurement of Equipment	"	—
1.3 Land Acquisition	ha	45.5
1.4 Administrative Facilities	LS	—
2. Dike		
2.1 Stripping	ha	134
2.2 Embankment	m^3	2,267,600
2.3 Pavement	"	85,600
3. Pumping Station		
3.1 Inlet Channel	m^3	15,400
3.2 Foundation	"	4,300
3.3 Building	m^2	525
3.4 Pump Installation	Set	5
4. Main Irrigation Canal		
4.1 Stripping	ha	54
4.2 Excavation	m^3	192,700
4.3 Embankment	"	714,200
4.4 Related Structures	LS	—
5. Irrigation Lateral		
5.1 Stripping	ha	56
5.2 Excavation	m^3	16,500
5.3 Embankment	"	530,600
5.4 Related Structures	LS	—
6. Main Drainage Canal		
6.1 Stripping	ha	16
6.2 Excavation	m^3	1,690,300
6.3 Embankment	"	31,600
6.4 Related Structures	LS	—
7. Drainage Lateral		
7.1 Stripping	ha	19
7.2 Excavation	m^3	6,451,000
7.3 Embankment	"	144,700
7.4 Related Structures	LS	—
8 Main Road		
8.1 Stripping	ha	31
8.2 Embankment	m^3	165,500
8.3 Pavement	"	36,700
9 Farm Road		
9.1 Stripping	ha	61
9.2 Embankment	m^3	209,300
9.3 Pavement	"	79,000
10. Feeder Channel (Excavation)	m^3	2,496,400
11. On-Farm Development Works		
11.1 Land Leveling	ha	6,400
11.2 On-Farm Ditch	km	320
11.3 On-Farm Drain	"	160
11.4 On-Farm Road	"	135

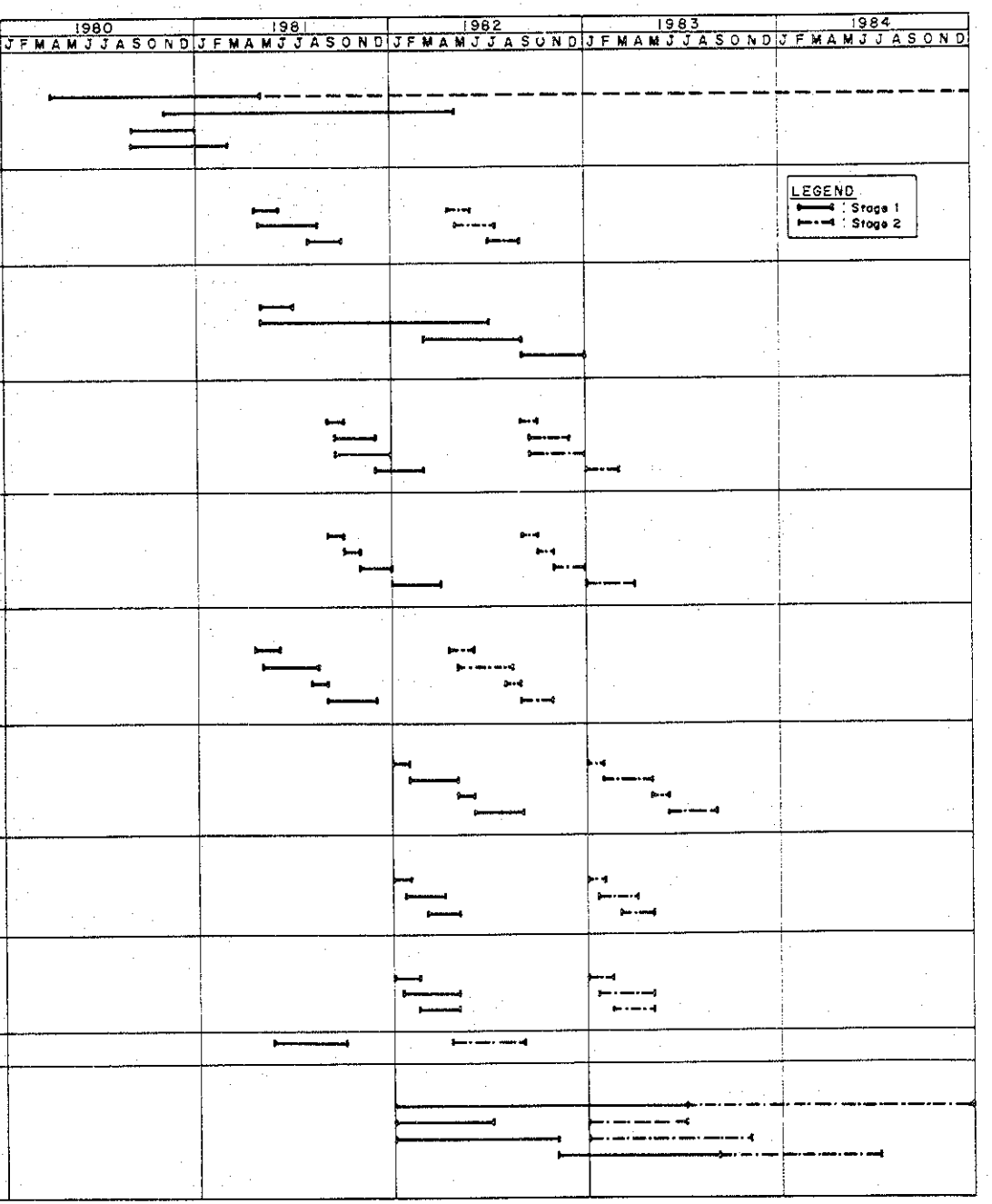


Fig 4.7(3) Construction Time Schedule for Phase 3 (Tract 3)

Item	Unit	Quantity
1. Preparatory Works		
1.1 Engineering Services	LS	—
1.2 Procurement of Equipment	"	—
1.3 Land Acquisition	ha	84
1.4 Administrative Facilities	LS	—
2. Dike		
2.1 Stripping	ha	76
2.2 Embankment	m^3	1,072,200
2.3 Pavement	"	40,800
3. Pumping Station		
3.1 Inlet Channel	m^3	9,500
3.2 Foundation	"	2,200
3.3 Building	m^2	375
3.4 Pump Installation	Set	3
4. Main Irrigation Canal		
4.1 Stripping	ha	8
4.2 Excavation	m^3	7,900
4.3 Embankment	"	189,400
4.4 Related Structures	LS	—
5. Irrigation Lateral		
5.1 Stripping	ha	28
5.2 Excavation	m^3	12,100
5.3 Embankment	"	184,400
5.4 Related Structures	LS	—
6. Main Drainage Canal		
6.1 Stripping	ha	5
6.2 Excavation	m^3	798,800
6.3 Embankment	"	35,900
6.4 Related Structures	LS	—
7. Drainage Lateral		
7.1 Stripping	ha	6
7.2 Excavation	m^3	226,600
7.3 Embankment	"	65,100
7.4 Related Structures	LS	—
8. Main Road		
8.1 Stripping	ha	11
8.2 Embankment	m^3	58,300
8.3 Pavement	"	12,900
9. Farm Road		
9.1 Stripping	ha	44
9.2 Embankment	m^3	150,500
9.3 Pavement	"	56,900
10. Feeder Channel (Excavation)	m^3	1,131,500
11 On-Farm Development Works		
11.1 Land Leveling	ha	3,000
11.2 On-Farm Ditch	km	150
11.3 On-Farm Drain	"	75
11.4 On-Farm Road	"	63

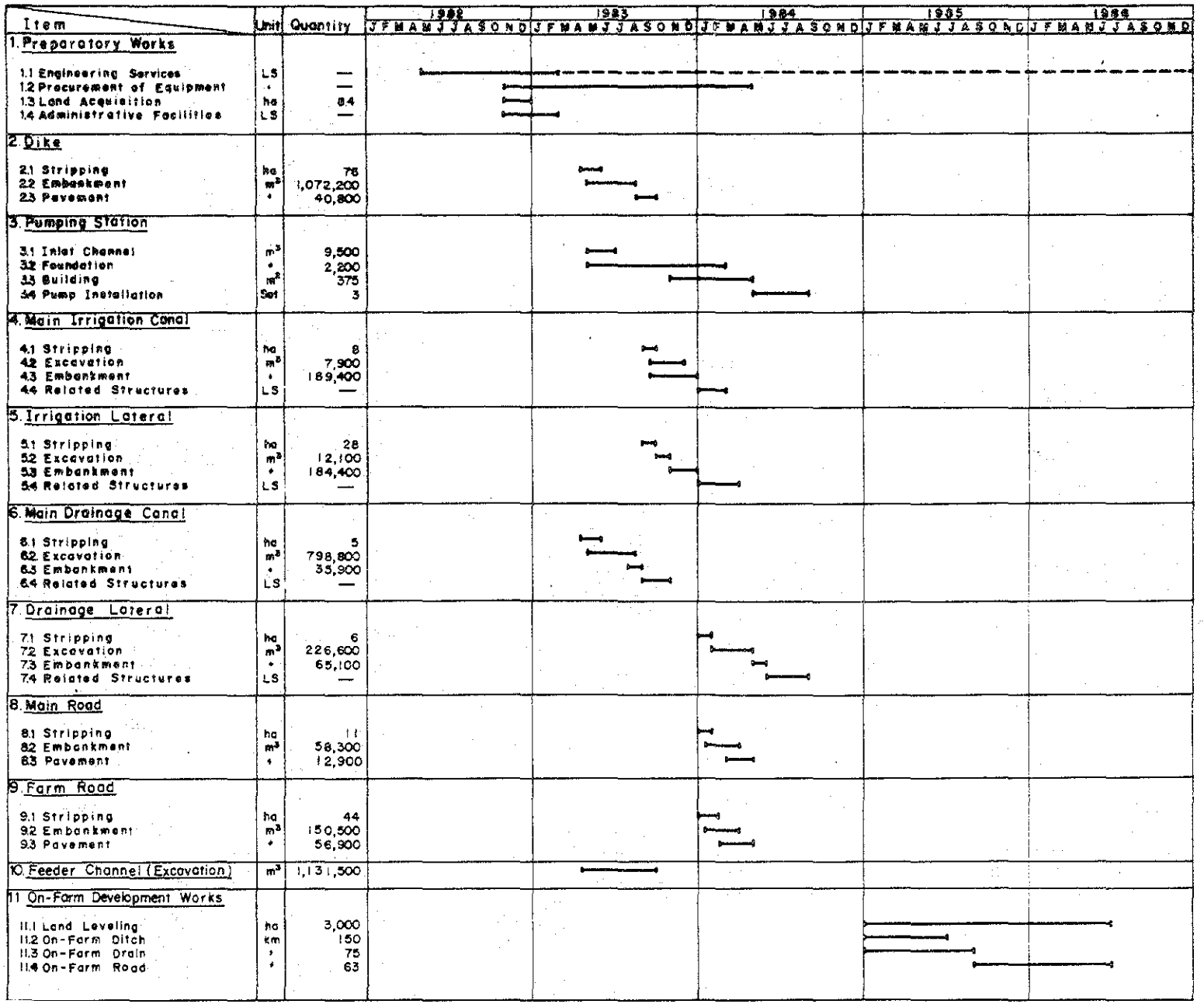


Fig 4.7(4) Construction Time Schedule for Phase 4 (Tract 4)

Item	Unit	Quantity
1. Preparatory Works		
1.1 Engineering Services	LS	—
1.2 Procurement of Equipment	"	—
1.3 Land Acquisition	ha	8.2
1.4 Administrative Facilities	LS	—
2. Dike		
2.1 Stripping	ha	72
2.2 Embankment	m^3	1,146,800
2.3 Pavement	"	37,800
3. Pumping Station		
3.1 Inlet Channel	m^3	9,500
3.2 Foundation	"	2,200
3.3 Building	m^2	375
3.4 Pump Installation	Set	3
4. Main Irrigation Canal		
4.1 Stripping	ha	7
4.2 Excavation	m^3	4,900
4.3 Embankment	"	213,600
4.4 Related Structures	LS	—
5. Irrigation Lateral		
5.1 Stripping	ha	38
5.2 Excavation	m^3	21,800
5.3 Embankment	"	298,900
5.4 Related Structures	LS	—
6. Main Drainage Canal		
6.1 Stripping	ha	6
6.2 Excavation	m^3	1,064,700
6.3 Embankment	"	45,800
6.4 Related Structures	LS	—
7. Drainage Lateral		
7.1 Stripping	ha	9
7.2 Excavation	m^3	263,200
7.3 Embankment	"	70,000
7.4 Related Structures	LS	—
8. Main Road		
8.1 Stripping	ha	17
8.2 Embankment	m^3	88,700
8.3 Pavement	"	19,600
9. Farm Road		
9.1 Stripping	ha	43
9.2 Embankment	m^3	148,000
9.3 Pavement	"	56,000
10. Feeder Channel (Excavation)	m^3	1,149,000
11. On-Farm Development Works		
11.1 Land Leveling	ha	3,200
11.2 On-Farm Ditch	km	160
11.3 On-Farm Drain	"	80
11.4 On-Farm Road	"	67

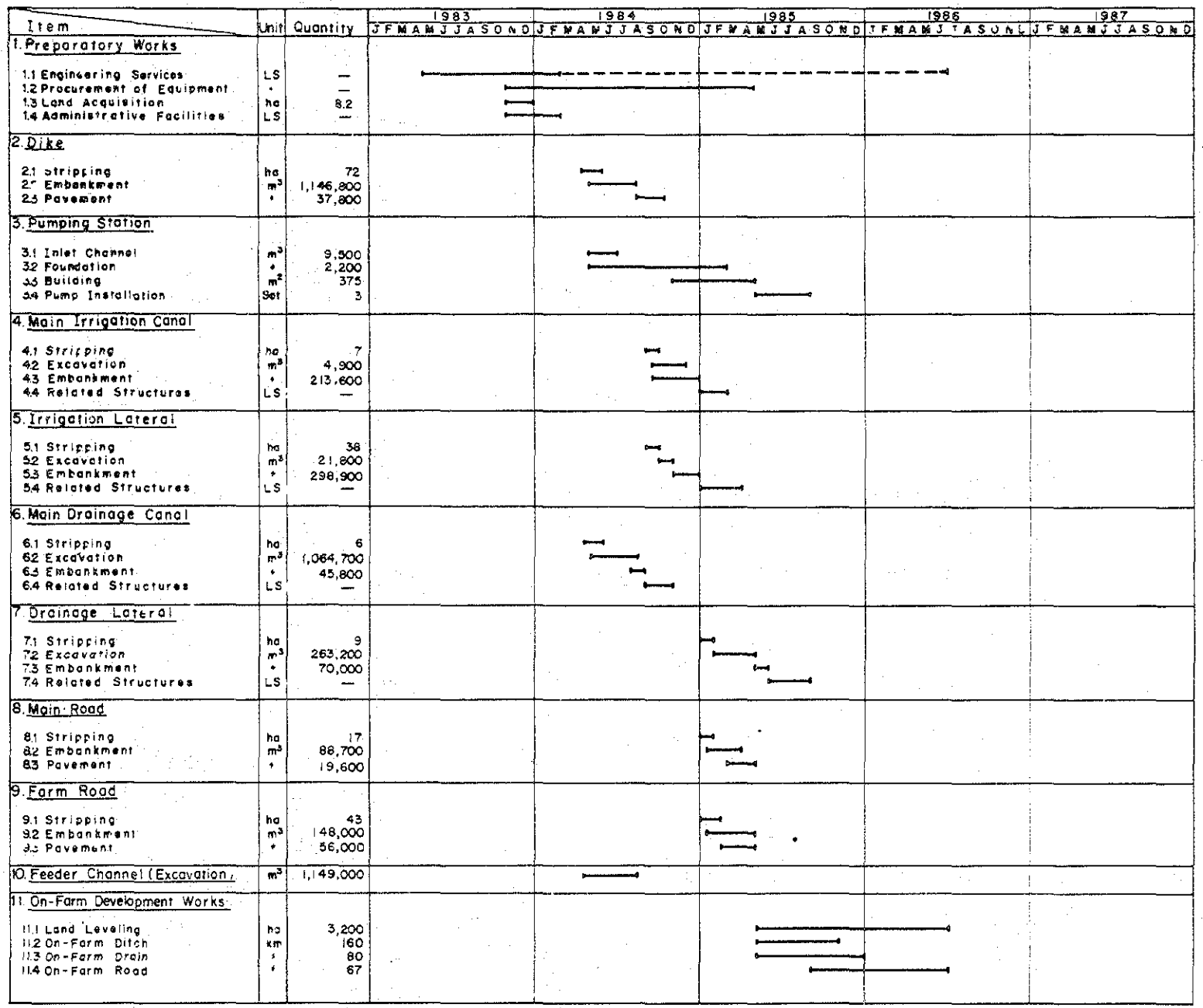
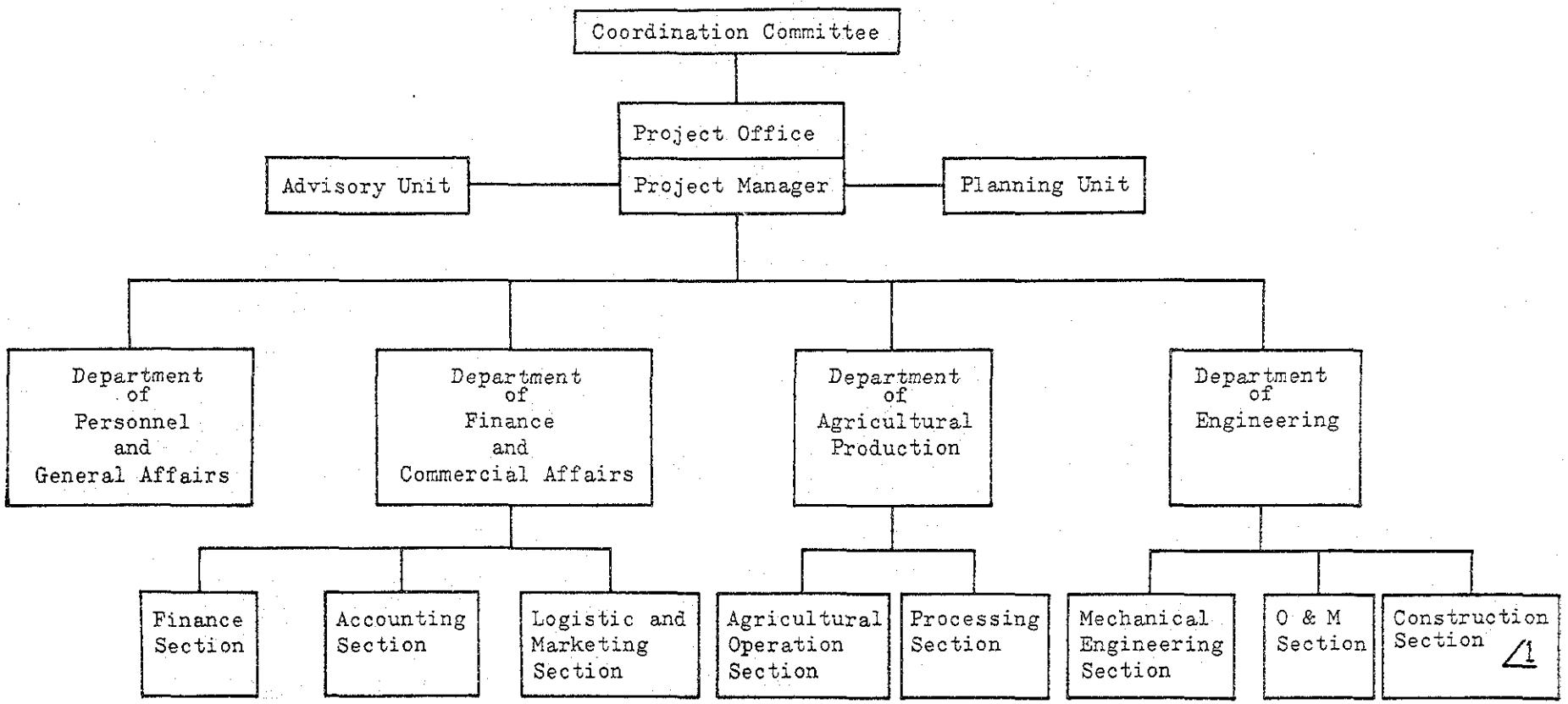
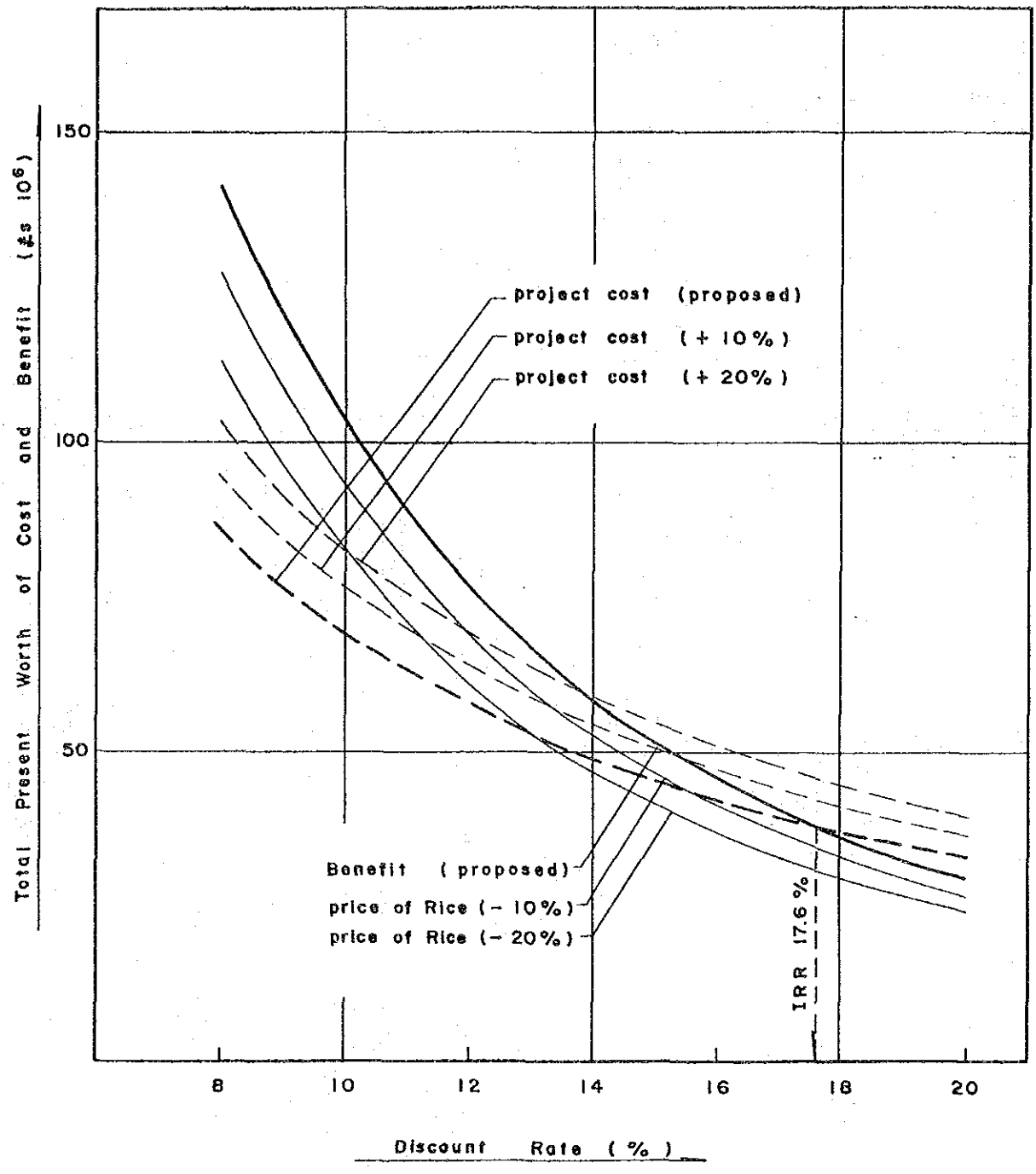


Fig. 6.1 Organization For The Executing Organization

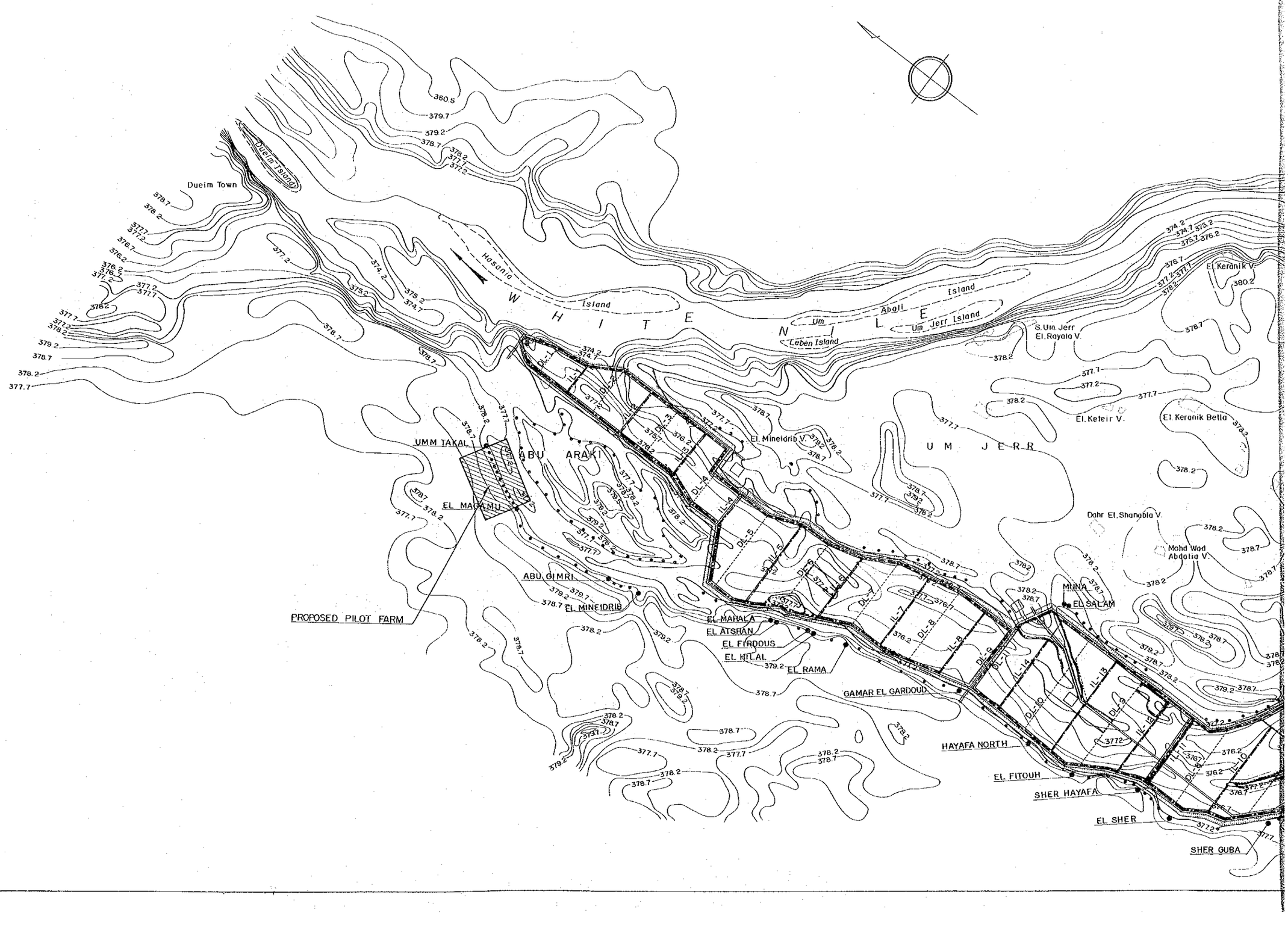


/1 Disappear in and after 1987

Fig. 8.1 Estimation of IRR for the Project



DRAWING


Dueim Island
Dueim Town
Hasania
Island
W H I T E
N I L E
Um Abgil Island
Um Jerr Island
Leben Island
S. Um Jerr
El. Rayala V.
El. Keranik V.
El. Keleir V.
El. Keranik Betla
U M J E R R
UMM TAKAL
ABU ARAKI
EL MAGAMU
ABU GIMRI
EL MINEIDRIB
El. Mineidrib V.
PROPOSED PILOT FARM
EL MAHALA
EL ATSHAN
EL FIRDOUS
EL HILAL
EL RAMA
GAMAR EL GARDOUD
Dahr El. Shangola V.
Mohd Wad Abdalla V.
MUNA
EL SALAM
HAYAFA NORTH
EL FITOUH
SHER HAYAFA
EL SHER
SHER GUBA
DL-1
DL-2
DL-3
DL-4
DL-5
DL-6
DL-7
DL-8
DL-9
DL-10
DL-9
IL-1
IL-2
IL-3
IL-4
IL-5
IL-6
IL-7
IL-8
IL-9
IL-10
IL-11
IL-12
IL-13
IL-14
IL-10

N I L E

Um Abgal Island

Leben Island

Um Jerr Island

S.Um Jerr

El.Rayala V.

El Kawa

El Keranik V.

El Nabara Island

Abu Hind V.

El Shouwal V.

Abu Lahm Is

El Dibeikin Is

Um Bagar Is.

Um Berbit Is

W H I T E

U M J E R R

El Mineidrib V.

El Keteir V.

El Keronik Betta

Dahr El Shangalo V.

Mohd Wad Abdalla V.

EL TAYEF

MUNA

EL SALAM

FALAH BOGO

ABU AGARIB

SULHA

KASHEMA

SAFA DAKAHLA

WAD SHAMAM

KARAMA

EL RAMA

GAMAR EL GARDOUD

HAYAFA NORTH

EL FITOUH

SHER HAYAFA

EL SHER

SHER GUBA

EL BAYAHA

RAWAD EL MUKTAR

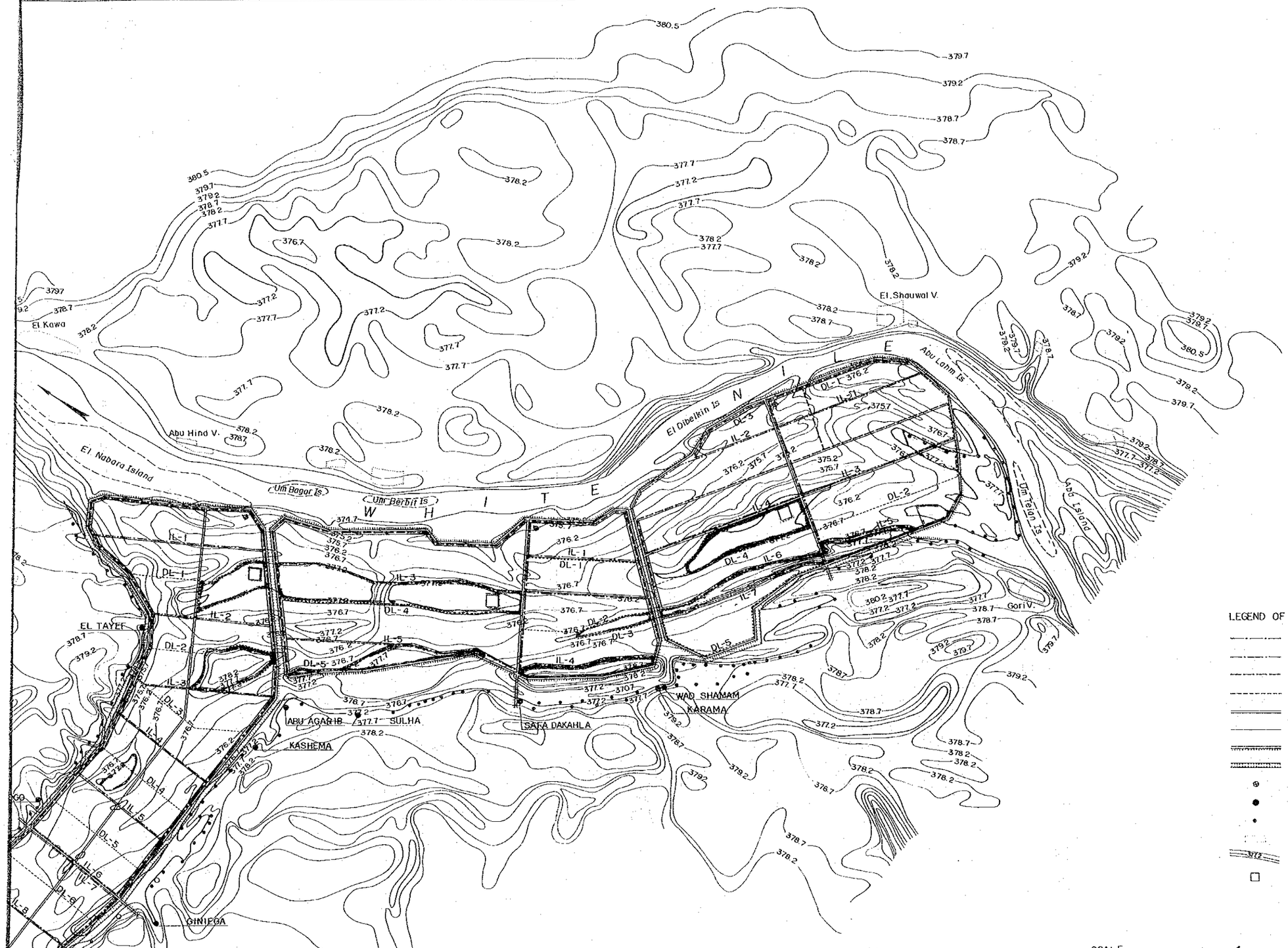
GINIEGA

PREPARED

CHECKED

SUBMITTED

DATE



LEGEND OF LAYOUT

- Main Irrigation Canal
- Irrigation Lateral (IL)
- Main Drainage Lateral
- Drainage Lateral (DL)
- Main Road
- Farm Road
- Polder Dike & Main Road
- Feeder Channel
- Proposed Pump
- Existing Pump (Public)
- Existing Pump (Private)
- Village
- Contours (m)
- Central Office & Branch Office

SCALE 0 1 2 3 4 5 km

PREPARED	THE DEMOCRATIC REPUBLIC OF THE SUDAN	TITLE OF DRAWING	APPROVED
CHECKED	MINISTRY OF AGRICULTURE, FOOD AND NATURAL RESOURCES	GENERAL LAYOUT	
SUBMITTED	RICE DEVELOPMENT PROJECT IN ABU GASABA BASIN	DWG. NO. 01 / JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO	DATE
DATE