Forest Area

The Land Capability Study (1976) shows that some forest land is best suited for agriculture, and that some State land is only suited for forestry. The Forest Department is attempting to release the former and reserve the latter as the opportunity arises. An overall land use policy would introduce planning into this activity, possibly permitting greater yield of timber to be obtained by various measures on land not now needed for agriculture and by an early planting of land only suitable for forestry (see Table V-15).

Production, Exports and Prices

Table V-16 presents some basic data on the production of logs and wood products between 1970 and 1978. The rapid rise in production of logs over the nine years, from 181 million Hft in 1970 to 360 million Hft/1 is evident. The decline in 1977 and 1978 in the production of plywood was caused by fire at one mill and major overhaul at another. Although the percentage contribution of the forestry sector to GDP has declined since 1970, the real value of earnings from the sector has been steadily increasing. Log export volume doubled during this period, while real prices of tropical logs have increased by more than 9 per cent per annum since 1972.

3.3 AGRICULTURE IN AND AROUND THE PROJECT AREA

With regard to the agricultural production in the project area, little can be mentioned except cultivation of rattan and paddy in a small scale. However, the overall picture of agricultural activities in and around the Kinabatangan River Basin will be described.

3.3.1 Present Land Use

A study on the land use of the Kinabatangan District/2 was conducted in 1970. According to that report, which was based on an interpretation of aerial photographs, as much as 97.6% of the Kinabatangan District was under forest, including scrub forest, swamp and wetland forest, covering a greater part of the hilly and mountainous area as well as the coastal area. On the other hand, agricultural land including the area under shifting cultivation was only 0.38% (17,405 acres = 6,962 ha) in 1970. When this is compared with the size of the cropped area which was identified as (23,624 acres = 99,561 ha) as late as 1979, the land use pattern of the Kinabatangan District would be presumed to have remained almost unchanged since 1970 and, such as this District is lagging behind as the least developed district in Sabah (refer to Table V-17).

/1 : 1 cubic meter = 27.7362 Hoppus cubic feet
/2 : The Kinabatangan District is almost the same in area as the Kinabatangan River Basin.

3.3.2 Agricultural Setting

Compared to its forest production, agricultural activities in the District have so far been extremely restrained in spite of the availability of a vast land area of good soil conditions, mainly due to a lack of infrastructure and labour. Agricultural activities undertaken in this area may be broadly categorized as follows:

1) Estate farming;
2) Primitive shifting cultivation;
3) Small holding subsistence-cum-marketing farming known as 'mixed horticulture', and
4) Government-sponsored minor schemes for improvement of the above 2) and 3).

However, in terms of the size of the land and technology put under respective use, estate farming and shifting cultivation represent the characteristic features of the Kinabatangan agriculture and the contrasts between the two are quite remarkable.

Estate Farming

The large scale estates are usually operated by private entrepreneurs who employ local labourers for cultivation of farm products, specifically, the permanent crops such as rubber, oil palm and cacao, under high level modern production techniques and estate management.

Estate products are primarily for export, and the typically extensive agricultural method is being adopted for the cultivation of the selected crops because of the weather and land conditions combined with general shortage of labour.

The estate farming extending over 8,817 acres (3,527 ha) in 1970 has been expanded to 14,730 acres (5,960 ha) within a decade (refer to Tables V-17 and V-18).

Shifting Cultivation

Shifting cultivation is generally practised by the native farmers by clearing forest lands and swamp-forests in order to grow hill paddy (upland paddy) and other food crops purely for their own subsistence purposes. Most of the clearings are scattered along or close to the banks of the major rivers and their principal tributaries.

The 1970 survey classified 5,744 acres (2,325 ha) in the Kinabatangan District as shifted cultivation, accounting for the second most extensive method of agricultural land utilization next only to estate farming. Even in 1979, shifting cultivation would have covered an area second in size to that under oil palm cultivation.

However, the area actually planted at one time or another is very small, about 15% of the above, that is 5,744 acres. It is assumed that nearly 80% of the shifting cultivation area is under forest and 5% in the deforested State land.

Mixed Horticulture

Mixed horticulture is carried out by the small holders who cultivate subsistence crops for their own consumption and some cash crops for the local market as supplements. The crops usually cultivated by such small holders, often along the rivers, are made up of upland paddy, vegetables, maize, cassava, sweet potatoes, etc., while fruit trees such as coconuts or papaya are grown in and around homesteads.

The area which was classified under the mixed horticulture amounted to 2,810 acres (1,140 ha), the fourth largest category of land utilized for agriculture, in 1970.

Minor Scheme

The Minor Scheme is a kind of agricultural development program aimed at resettling the shifting cultivators and/or petty local farmers through development of land, building of houses, provision of seed or seedling, fertilizers, etc., and electricity and other facilities all subsidized by the Department of Agriculture. About 12 acres (4.8 ha) of land in alotted per settling household. The organization of these minor schemes is directly undertaken by the State Government. The area consisting of these minor schemes occupied 888 acres (395 ha) which corresponds to 3.8% of the total farmland in the Kinabatangan District in 1979 (refer to Table V-18).

Apart from the Minor Scheme, there are on-going major schemes organized by the Sabah Land Development Board, the Co-operative Scheme under the Co-operative Department, and the joint farming of small holders being organized by the Rural Development Corporation under the Chief Minister Department. However, the progress thereof to data has not been reported in detail as yet for this District.

3.3.3 PRESENT CROPPING

According to the estimated cropped area of Kinabatangan District in 1979, the main crops are oil palm, coconuts, rubber, cacao, fruit trees, paddy and vegetables (refer to Table V-18). Their cropped areas are as follows:

Cropped Area

1) Oil Palm - occupying 12,457 acres (5,041 ha) or 52.7% of the agricultural land - is leading all other crops. It is planted on private estates or through the land development schemes in the newly opened-up areas. Oil palm plantations are generally scattered extensively along roads in the hilly areas above 50 feet (15 meters above M.S.L.) to avoid inundation by the flood waters of the Kinabatangan River.

2) Coconut - grown along the Kinabatangan River or sometimes in the Kampong areas usually by small holding farmers for family and/or local consumption and export; coconuts occupy some 2,251 acres 9911 ha) or 9.5% of the agricultural land.

3) Rubber - with a total land area of 1,383 acres (560 ha), rubber occupies 5.9% of the agricultural land in cultivated permanent crop.

4) Cacao - rapidly rose within a comparatively short period to the position of the fourth most extensively cultivated permanent crop being planted on fertile soils in the hilly area exclusive of the oil palm fields. It occupies 1,074 acres (435 ha) which equals 4.5% of the total land under agricultural use.

5) Fruit trees - citrus, durian, rambutan, mango, mangosteen, etc., are commonly grown in a limited scale usually around the Kampong areas for the villagers' family consumption. Banana, coffee, pineapple and others are grown in more or less a similar fashion. Their combined cultivated area comes to 1,086 acres (440 ha), accounting for 4.6% of the agricultural land (refer to Table V-18).

6) Paddy - hill paddy or upland paddy is universally cultivated in the shifting cultivation area as well as around the Kampong areas for local consumption; it occupies an area of 3,200 acres (1,300 ha) or 13.5% of the total agricultural land. The area under rainfed wet paddy cultivation along the rivers, however, is very limited.

7) Maize, cassava, sweet potatoes, vegetables, groundnuts, etc. - Cassava is grown on the largest area, 1,275 acres (510 ha) or 5.4%, of the agricultural land, being followed by maize (373 acres = 151 ha). Excluding casava, other crops combinedly occupy 803 acres (325 ha) which is only 3.4% of the total agricultural land.

Present Cropping Pattern

Annual crops such as maize, cassava, vegetables, groundnuts, sweet potatoes, etc., can be grown all through the year. Hill paddy is sown directly in the shifting cultivation field or upland field between August and October to be harvested during January and March, while wet paddy is sown in the nursery in/around September to be transplanted in October and usually harvested in January and February (refer to Fig. V-3).

Crop Diversification

Agricultural diversification has been one of the principal agricultural policies since Sabah achieved her independence in 1963, and the perennial crop diversification program, which seeks to quickly establish oil palm and cacao as major crops of the State, has been implemented since the 1970's. As a result, oil palm area was expanded by three times within 10 years between 1970 and 1979, and cacao was planted on more than 1,000 acres (400 ha) within five years ending in 1979. The area under cacao is expected to continuously expand in the next few years thanks to the favourable prices ruling in the international market. As far as the other crops are concerned, there has been no significant change in area in the past ten years (refer to Table V-19).

3.3.4 Agricultural Production

In the absence of reliable statistics on the crop yield in Sabah, estimation of crop yield has been made on the basis of the information available from the Department of Agriculture. According to these data, most of the crop yields in the Kinabatangan District seem to be a little lower than the State averages. This would be attributable to the smallness in scale of farming combined with primitive technology as far as annual crops and fruit trees are concerned, and immaturity of tree crops such as oil palm and cacao which occupy the predominant position in the District agriculture (refer to Table V-20).

3.3.5 Animal Husbandry

The Department of Veterinary Services has a district office in Sandakan, which covers the Kinabatangan District. Livestock farming is concentrated in the neighbourhood of Sandakan where marketing facilities are available. In the Kinabatangan District, there is no commercial livestock farming, and the animal husbandry as such has little practical appeal as long as game like wild boar and deer are abundant and near at hand simply to be caught through hunting. The population of the domestic animals in the District is estimated as shown in Tabe V-21.

3.3.6 Inland Fishery

The inland fishery industry gives additional nutrition to the people's diet and also provides side-jobs for the small-scale farmers. The Government maintains fish breeding stations for distributing fish fry; one is located in the Sandakan Residency and another is currently being planned. The official statistics say that there are 264 fish-ponds covering 107.5 acres (43.52 ha) in the Sandakan Residency. More than 20,500 fish fry were distributed in the Residency including the Kinabatangan District in 1979. The species of the fry are Lampan Jawa, Common Carp, Big Head, Silver Carp, Grass Carp and Tilapia.

3.3.7 Forestry

The major sector of economic and industrial activities in the Kinabatangan River Basin pertains to the extraction of forest resources and some processing of timber. The Kinabatangan River Basin is covered by the Lamag and Sandakan South Forest Districts, the Lamag Forest District being more extensive. In 1978, 23% of the total forest reserve area and more than one-fourth of the commercial forest in the State of Sabah were in Lamag Forest District in the Kinabatangan River Basin (refer to Table V-22).

Figures concerning extraction of timber in the area are available as per Table V-23. According to the statistics, the production of timber has been continuously declining since 1973, and it is feared if a serious insufficiency of forest resources may be felt in the near future. Most of the timber is for export.

4. AGRICULTURAL SERVICE

4.1 MINISTRY OF AGRICULTURE AND FISHERY

The Ministry of Agriculture and Fishery is responsible for rendering agricultural services for the farmers in Sabah. Main activities of the organizations concerned are as follows:

The Ministry of Agriculture and Fisheries (MAF) is supported by six implementing agencies:

1) Department of Agriculture
2) Department of Fisheries
3) Department of Veterinary Service and Animal Industry
4) Department of Drainage and Irrigation
5) Sabah Rubber Fund Board
6) Sabah Paddy Board

Major functions and/or responsibility of each organizations are as follows:

1) Department of Agriculture	-Agricultural research, extension service and manpower development;
	-Plant protection and Pest and Disease control.
	-Propagation of planting materials;
	-Land development, rehabilitation and soil conservation.
	-Functional farmers institution.
2) Department of Fisheries	-Fishery research, extension service and manpower development
	-Aquaculture development
	-Production of fish fry and stock seeds
3) Department of Veterinary Services and Animal Industry	-Livestock and pasture research; extension service and manpower development
	-Animal health, quarantine and disease control
	-Livestock multiplication
4) Department of Irrigation and Drainage	-Drainage and Irrigation
	-Hydrological Investigation
	-River Conservancy
	-Flood Mitigation/Control

5) Sabah Rubber Fund Board	-New planting and replanting of moribund rubber
	-Rubber processing and purchasing
	-Production and improvement of planting material
	-Land rehabilitation
6) Sabah Paddy Board	-Administration of the Paddy Input Credit Subsidy Scheme
	-Paddy production, ploughing and extension service
	-Production and distribution of paddy seeds

4.2 DEPARTMENT OF AGRICULTURE (DOA)

Prior to 1946, there was no independent Department of Agriculture as such in Sabah. Agriculture was made one of the responsibilities of the Conservator of Forest. However, in November 1946, an independent Department of Agriculture was set up to be responsible for Crop Agriculture, Animal Husbandry and Veterinary Services, Marine and Freshwater Fisheries and Drainage and Irrigation. Over the years independent departments have been established to look after each of these functions and the role of the Department of Agriculture has become more specialized i.e. dealing only with Crop Agriculture (see Fig. V-4).

Basically, the Department has three functions, namely:

1) Regulatory e.g. plant quarantine, land insection, approving development plans, etc.

2) Service e.g. Soil survey, analytical services, extension services, training etc.

3) Development

Presently the Department is one of the agencies under the Ministry of Agriculture and Fisheries and from the implementation point of view, the activities of the Department are being carried through the 3 branches:

1) Agricultural Research

2) Extension

3) Agricultural Education and Training

The following research stations/sections are set up to carry out the specific research and to provide the related services as may be required.

1) Agricultural Research Centre, Tuaran

The Centre conducts research and provides services in the disciplines of Plant Pathology, Plant Entomology, Plant Physiology, Soil and Plant Analysis, Paddy and Food Crop Agronomy and Chemistry.

The Plant Protection Division (which includes Plant Pathology and Entomology) also provides advisory services to the farming community. For prompt action by the Division in the event of disease or pest outbreak, the respective District Agricultural Officers should be contacted.

The Soil Division undertakes soil survey and soil analysis which is presently restricted to only Govrnment agencies.

2) Cacao Research Station

The Cacao Research Station at Quoin Hill, Tawau, has facilities for research on cacao agronomy and cacao breeding. The Station is also one of the main suppliers of proven high yielding hybrid cacao seeds in the country.

Cacao seeds are sold to the general public at a reasonable price. For the order of these seeds, the nearest Agricultural office in the respective districts can be contacted.

3) Agricultural Research Station, Ulu Dusun

The main emphasis of this Station in Sandakan is put on the research of oil palm Agronomy and Breeding. However, it has expanded its scope to include research on coconut, fruit trees and cacao progeny trials.

Through years of untiring research, the Station is now the only producer of proven oil palm seeds in the State. The seeds are sold to interested planters in Sabah.

4) Agricultural Research Station, Tenom

This Station at Lagud Sebrang, Tenom started off as the Second Cacao Research Station in Sabah. It conducts intensive research on Cacao Agronomy. The Station will also supplement the Cacao Research Station at Tawau in the production of proven cacao seeds.

The expansion of the Station has also included research on Food Crop Agronomy in its programme.

5) Plant Quarantine Section

This Section is responsible for the following services:

- To issue plant import permit for the importation of plants or planting materials into Sabah
- To issue Phytosantitory certificate for the export of plants or planting materials

4.3 DRAINAGE AND IRRIGATION DEPARTMENT (DID)

The Drainage and Irrigation Department was established as a independent department in January, 1967. Prior to this it functioned as a section of the Hydraulic Branch of the Public Works Department. The Department, under the Ministry of Agriculture and Fisheries, has 10 district Branch Offices throughout the State. It works very closely with the Sabah Paddy Board and the Agriculture Department (see Fig. V-5).

4.3.1 Policy

The basic policy of the Drainage and Irrigation Department is to contribute towards raising the State's production of rice and other agricultural crops to higher levels; and also to improve the socio-economic status and income of the large number of small farmer in the rural areas.

4.3.2 Functions

The functions of the Department may be briefly summarized as follows:

1) To provide improved irrigation facilities to existing paddy areas so as to increase rice yields

2) To develop new areas for rice cultivation

3) To construct drainage schemes to improve the production of agricultural crops other than rice

4) To maintain and operate completed drainage and irrigaiton schemes

5) To improve and maintain rivers, including river clearing and training, dredging, canalization and deviation works

6) To undertake flood mitigation works in the rural and agricultural areas

7) To collect essential hydrological data to meet present and future requirements in the field of water resources development and management, and to disseminate such information to interested parties

8) To develop flood forecasting and flood warning techniques and methods

4.4 SABAH PADDY BOARD

The Sabah Paddy Board was established on 2nd February, 1968 under the Agriculture Produce Ordinance No. 23 of 1963 to facilitate the production of sufficient rice for the State's needs and to improve the standard of living of paddy farmers in Sabah. However, the Board will be phased out and its functions handed over to National Rice and Paddy Board (LPN) from 1982 (see Fig. V-6).

4.4.1 Policy

1) To improve the conditions of paddy cultivation through the conservation and proper utilization of natural and avilable human resources and introduction of appropriate modern methods of cultivation

2) To improve the economic position and consequently the standard of living of the paddy farmers

3) To increase the production of paddy in the state so as to achieve rice self-sufficiency as early as possible

4.4.2 Functions

1) To consider methods of actively encouraging paddy farmers to improve their yield by the use of improved varieties, double-cropping and fertilizers and to provide funds which would be required for their implementation

2) To assist farmers by providing Credit subsidies, to improve their paddy cultivation techinque

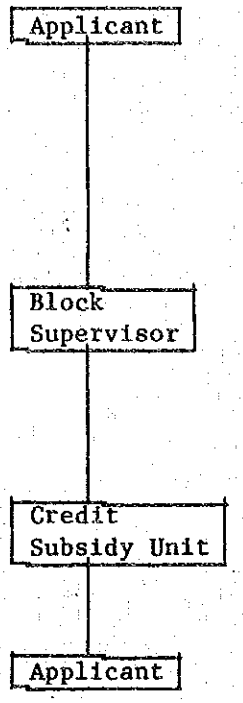
3) To advise on the priorities in improving irrigation in the exisiting producing area

4) To invite in experts, if necessary, from overseas to demonstrate improved techinques

5) To consider priorities in opening new land suitable for paddy cultivation to increase production in the long run

6) To establish a fund for the implementation of the above measures

4.4.3 Services Provided and Procedures for Obtaining Services



Applicants must fill in the Application Form No. C.S. 11 in duplicate. Forms are obtainable from the Block Supervisors, the officers of the Sabah Paddy Board. Application must be made at least two months before the planting season.

The Block Supervisor will advise and assist the applicants in completing the forms. One copy of the form will be submitted to the Credit Subsidy Unit through the Block Supervisor, and the other copy to be retained by the applicant for future reference.

Applications will be processed by the Credit Subsidy Unit. It normally takes about one month to process the applications.

Successful applicants will be given several coupons entitling them to obtain planting materials and services and other agricultural inputs.

5. LAND DEVELOPMENT PLAN

In this chapter, a study will be made of the area to be released from the flooding effects through dam construction, and those portions thereof which are appropriate for agricultural development will be identified. Also, a formulated approach for (1) cleaning and leveling of the said area which is targeted for paddy cultivation; at present it is almost entirely left as jungle/secondary forest, and (2) for construction of irrigation, drainage, farm road network and other required agricultural infrastructure for materializing double cropped paddy cultivation will be presented in below.

5.1 DESIGN BENEFIT AREA

5.1.1 General Description of Flood Prone Area

The implementation of a flood control scheme through construction of the Balat dam will release 107,000 ha in its downstream from the effects of habitual flooding (Fig. V-7 and Table V-24). The proposed dam is designed to safely pass a maximum discharge of flooding with a return period of 20 years, without causing flood damage to downstream areas. Details regarding the said flood control scheme are contained in the "Flood Control" Sector.

In Table V-25 and Fig. V-8, the present flood prone area is classified according to soil type. As is clearly indicated in the Table, said area includes approximately 42,000 ha of tropical peat.

Table V-26 and Fig. V-9, on the other hand, indicate classification of the flood prone area on the basis of the existing land use plan. The greater portion of the State land (49,700 ha) shown in Table V-26 corresponds to the area classified as tropical peat in Fig. V-8.

5.1.2 Benefit Area

Determination of Benefit Area

As depicted in Fig. V-7, the present flood prone area can be broadly categorized into three sections: (1) 45,500 ha consisting predominantly of peaty soil and some waste area; (2) 55,000 ha consisting of largely peat-free soil appropriate for agricultural development; and (3) protection green belt comprising 6,500 ha.

The protection green belt itself will consist of minimum 100 m wide belt of jungle along both banks of the river which will be excluded from the area to be developed for agriculture. Preserved in its original state, said belt of

jungle on both banks will serve to minimize damage to cultivated area from river course shifting and flood water flow which may occur even after dam construction.

As indicated in Fig. V-7, the suitable land for agricultural development lies largely upstream from Batu Puteh, and immediately astride the river between Batu Puteh and Bilit. The unsuitable land, on the other hand, is located on the left side of the river between Batu Puteh and Bilit, and downstream from Sukau. Said unsuitable land consists chiefly of peaty soil, being subject to increased salinity from the Sulu Sea water during low flow periods of the Kinabatangan River in the dry season, and as such is not appropriate for irrigated agriculture.

The upper basin of the S. Tenegang Besar, which joins the Kinabatangan River south of Bilit, has also been excluded from the development area. Although said area does not feature with peaty soil, it exhibits numerous creeks and is rather distantly located from the irrigation water source (Kinabatangan River); those factors led to the decision to omit such from the development area. The upper S. Tenegang Besar basin has both current and future potential for rattan development and, accordingly, holds promise as a possible substitute area for the on-going rattan development project being implemented by SAFODA.

Net Irrigable Area

The proposed development area of 55,000 ha was selected on a 1/50,000 scale topographic map. It can be assumed, therefore, that further necessity exists to exclude from development consideration the elevated spots and the deep swampy areas that do not appear within the proposed development area delineated on the 1/50,000 scale map. The study of such areas for exclusion will be implemented subsequent to preparation of the more precise and the smaller scaled topographical maps of the project area. Accordingly, for interim planning purposes, roughly 20% of the proposed development area will be considered as subject to eventual exclusion from cultivation due to unfavorable topographical characteristics. This leaves approximately 44,000 ha as feasible for agricultural development.

Roads, canals and other infrastructures (area of which is estimated at 8% of the total proposed area) necessary to successfully realize the envisaged level of agricultural development will be included in the 20% area to be excluded from cultivation.

5.2 PREPARATION OF LAND FOR CULTIVATION

The steps required to prepare the targeted 55,000 ha of the current flood prone area for cultivation will be discussed in below.

5.2.1 Jungle Reclamation

Jungle Reclamation in Sabah State

Jungle reclamation in Sabah State can be broadly categorized into (i) that for cultivation of crops for export such as oil palm, cacao, rubber, etc., and (ii) that for paddy development in conjunction with the Government's goal of self-sufficiency in rice. Reclamation of the first type is implemented principally under the direction of the Federal Land Development Authority (FELDA), Sabah Land Development Board (SLDB), and Sabah Forest Development Authority (SAFODA), while the latter is carried out chiefly by the Department of Irrigation and Drainage (DID) and the Paddy Board.

DID itself is engaged principally in the improvement of irrigation facilities chiefly relevant to development of the existing paddy field, while the Paddy Board concentrates its efforts on reclaiming new land for paddy cultivation.

The introduction of large scale, technologically modern farming practices for paddy agriculture in Sabah State has begun only recently with the Trusan Sapi Project which is the only citable precedent of this type of approach in the State. The said project area is located on the low, flat swampy area in the Labuk River basin stretching 80 km to the west from Sandakan and, as of 1980, approximately 800 ha had been developed for cultivation. Jungle clearing, root removing, levelling and bunding work for the project was conducted under the direction of the Paddy Board, while DID assumed responsibility for construction of irrigation and drainage systems, including pump station.

Jungle Reclamation

Land preparation work of the Trusan Sapi Project proved extremely difficult, being finally implemented in a successful manner by the third contractor engaged for the job. As the area coming under the proposed Project consists of low and flat swampy land covered by secondary jungle quite similar to the Trusan Sapi Project area, the Trusan Sapi Project provides a useful reference in planning land preparation measures in this study.

Principal work items necessary to convert 800 ha of jungle into cultivable paddy field per annum are set out below. It must be borne in mind, however, that as the construction period excludes the heavy rainy season, and work items need to be implemented only during 6 to 7 months of a year.

Work item

Jungle clearing:

Cut, Push, Laydown Trees
Stacking
Burning
Root Removing
Restacking
Reburning

Land Levelling

Major machinery required for the above works are as below:

Construction Machinery

Dozer (125 HP LGP)
Dozer (140 HP LGP)
Excavator (75 HP)
Chain saw

With sufficient budget, equipment, manpower and the participation of an adequately experienced supervisor for the required work items, a conversion rate from jungle to paddy field may be accelerated 5 - 10 times greater than 800 ha per annum as proposed in the above.

5.2.2 Field Preparation Work

Blocking

As indicated in Fig. V-10, the proposed paddy development area (hereinunder referred to as "development area") has been sectioned into 23 irrigation blocks. Using a 1/50,000 scale topographical map as a basis, the blocking configuration was determined with due consideration to the alignment of the existing river, rough conceptualization of the proposed irrigation scheme, as well as other relevant factors. Each individual block encompasses an average irrigable area of 1,900 ha.

Field Structure

As a large scale, mechanized paddy cultivation is envisaged for the development area, each irrigation block has been accorded the field structure basically outlined in Figs. V-11 and V-12. The said structural framework will comprise such components as indicated below:

Field Structure	Area (ha) Gross	Net irrigable
Irrigation Block (average 4 Farm Units)	2,400	1,900
Farm Unit (24 Farm Lots)	514	480
Farm Lot (25 Farm Parcels)	21.4	20
Farm Parcel	-	0.8

Each of the above structural components will contain the necessary farm roads, as well as irrigation and drainage facilities to materialize mechanized paddy cultivation. Based on the roads and canals envisaged for a typical field structure, the overall road and canal network for the entire development area is indicated in Fig. V-13. The density of the road and canal network is given in Table V-27.

Criteria such as an interval between roads, road width, etc. for the said road network were determined on the basis of the capacity of farm machinery to be introduced. The configuration of the irrigation and drainage network was designed from the viewpoint of maximizing water management efficiency and labour requirement reduction.

5.3 IRRIGATION SCHEME

5.3.1 Irrigation Water Requirement

Under the guidance of the Federal DID, the Sabah DID adopted, as discussed in the Interim Report, an irrigation water requirement of 2.336 litre/s/ha. The National Water Resource Study /1, however, recommends the pan evaporation method be to calculate the irrigation water requirement /2. This method has been applied for estimation of the irrigation water requirement in this study.

Irrigation requirement computations have been made on a semi-monthly basis, and the calculation procedure for 1978 is indicated in Table V-28, while Table V-29 presents the average semi-monthly diversion water requirement over a 10 - year period.

Through the discussions with Federal DID, it was decided to adopt a basic year for planning the irrigation water requirement with a return period of 5 years. Necessary meteorological data were obtained from Kuamut Station, which possesses long term records of meteorological conditions representative of the entire project area. 1978 was utimately decided as the basic year for planning upon careful study on effective rainfall, diversion water requirements, gross annual water requirements, etc. as indicated in the data for the past 10 years from 1970 - 1979.

/1 : A study team was dispatched by Japan International Cooperation Agency (JICA) under the technical cooperation program to Federal DID.

/2 : Sectoral Report PF, Irrigation Water Demand, National Water Resources Study, Malaysia, Dec. 1980, JICA (Draft)

Based on the requirements in the selected basic year the design diversion water requirement for planning the facility capacity was calculated at 1,772 litre/sec/ha. /1

As all the irrigation canals are to be earth canals, an irrigation efficiency of 0.55 was adopted as proposed in the above mentioned JICA Report.

Other design criteria include the following:

Land preparation water	:	150 mm
Inundation water after sowing	:	100 mm
Percolation	:	2 mm/day

5.3.2 Water Source

In principal, the Kinabatangan River is intended to serve as the sole source of irrigation water towards the development area. Technically speaking, however, there are some exceptions. Exception No. 1 is a regional dependence on the tributaries for irrigation some portions of the proposed irrigation blocks which are situated at a considerable distance from the Kinabatangan River; diversion from the tributaries will be made from such points where the back water effect from the Kinabatangan main course is still present. Exception No., 2 is that the specific flow discharge towards the catchment area in the upper portion of the tributaries which are passing through the development area is estimated at 1.5 m^3/sec/100 m^2 during periods of low flow; this has been ignored in this study because there are no discharge records to confirm it.

For reference, the irrigation requirements towards the irrigation blocks which are situated along the tributaries and the estimated low flow discharge of the relevant tributaries are given in Table V-30.

/1 : Unit facility capacity has been determined as below based on the diversion requirement for land preparation (April 4, 1978) for 46 days. Furthermore, for the purpose of computation, open water evaporation was calculated at 0.9 x pan evaporation (=66.8 mm/15 days), and the effective rainfall was computed at 36.1 mm/15 days.

$$\frac{1}{0.55} \times \frac{\frac{150 \text{ mm}}{46 \text{ days}} + \frac{45}{46} \times 4{,}453\text{mm/day} + 2\text{mm/day} - 1.2\text{mm/day})}{8{,}640}$$

$$= 1{,}772 \text{ litre/s/ha}$$

5.3.3 Diversion Method

Essentially 3 diversion methods are conceivable for the development area: (1) direct diversion from a dam (hereinunder referred to as "dam irrigation"), (2) diversion from headworks, and (3) pump irrigation from the Kinabatangan River (hereinunder referred to as "pump irrigation").

Details concerning the headworks plan are given in the "Hydro Power" sector. Even if the headworks were to incorporate the dual function of afterbay for the proposed hydro power generation, construction cost is considered as excessive and the plan has been eliminated from consideration.

A cost comparison analysis of dam irrigation and pump irrigation approaches indicated the approporiateness of pump irrigation for the development area. Comparison was made on the basis of annual cost, including depreciation cost, and operation and maintenance cost components. Respective annual costs are given below:

Dam irrigation	:	US$21.7 million
Pump irrigation	:	US$4.9 million

Details regarding the estimated costs for the above two approaches are presented in Table V-31.

5.3.4 Irrigation Plan

General Description of Irrigation Plan

From the topographic features and the present flood conditions, the proposed development area can be broadly categorized as below:

1) Lokan Area

The Lokan area is characterized by both hilly and relatively level terrain, with the latter also exhibiting considerable undulation. The increase in water level due to flooding is large. The area comprises 9 irrigation blocks with a total net irrigation area of 15,630 ha.

2) Lamag Area

Topographical and flood conditions existing in the Lamag area are a blend of those occuring in the above discussed Lokan area and the Koyah area to be described below. The area consists of 7 irrigation blocks and a total net irrigation area of 18,160 ha.

3) Koyah Area

The Koyah area is of mainly level topography, with less rises in water level due to flooding than that occuring upstream. The area encompasses 7 irrigation blocks and a total net irrigation are of 10,210 ha.

The total number of irrigation blocks included in the above 3 areas (total: 44,000 ha) is 23. Although said blocks are largely delimited by natural topographical features (i.e. Kinabatangan River, major tributaries, hills, etc.), factors such as irrigation block configuration, diversion point, canal gradient, pump type, etc. were also carfully considered in demarcating irrigation blocks. As a result, block areas range from 860 to 4,240 ha in size (average: 1,900 ha). The maximum diversion requirement for each block is indicated in Fig. V-14 as a flow diagram.

In addition to the fact that the magnitude of block area offers advantages in terms of water management when compared to other existing DID projects, division of the proposed development area into a number of small units will reduce the construction time required per block, thereby allowing for realization of project benefits at an earlier allowing for overall construction period.

Diversion Facilities

It has been mentioned in the previous section that the pump irrigation was selected as diversion method because of its economic superiority. An inclined mixed flow pump was subsequetly chosen as the pump type. The principal reasons for adopting this type of pump are (1) an inlined pump is more economical to operate than other types and (2) Sabah DID utilizes only this type of pump for its projects due to its easy operation and maintenace.

Although the pumping stations constructed by DID are generally equipped with one stand-by pump set, this project rather proposes to set up the single pumped stations subject to keep stockpiles of the reserve pump sets with respective diameters in the central work-shop.

On the basis of study of economical aspects and appropriate water management, 3 - 4 numbers of pumps 500 - 900 mm in dia. are to be installed at each station. The location of the pumping stations have been generally selected based upon proximity to the hill foot in order to design the most economical gravity irrigation system.

Pumping station and outlet structure, which are separated by less than 1 km, are connected by a conveyance canal consisting of steel pipeline. In order to protect the pipeline from siltation, one set of small size dredger (200mm dia) will be placed on stand by status at the central work shop for maintenance work.

The drawing of a typical pumping station is given in Fig. V-15 and the main features of each station are shown in Table V-32.

Irrigation Canal Network

Recently, Sabah DID has been generally designing irrigation canals lines with concrete blocks, according to the recommendation provided by Federal DID. Although the lined canal has various advantages, all irrigation canals in this Project except conveyance canals are designed as earth canals for reasons of economy. If concrete block lined canals are adopted for the Project, approximately US$90 million would be additionally required.

Some of the design criteria have been determined as follows, using as reference, the manual on Irrigation Conveyance System, 1980, Federal DID.

Name of Canal	Roughness coefficient	Bank slope	Canal gradient	Standard discharge (m^3/sec)
Main canal	0.025	1:1.5	1/8,000	0.85 - 4.2
Secondary canal	0.025	1:1.5	1/5,000	0.85
Tertiary canal	0.025	1:1.0	1/3,000	0.038

Layout of the irrigation network is shown in Fig. V-13, and is designed mainly based on topographic conditions. Generally all main and secondary canals are designed to run alongside gravel metalled farm roads, and tertiary canals alongside non-metalled on-farm roads.

Irrigation Related Structures

All irrigation facilities required for the Project are listed in Table V-33 and the typical layout drawings are shown in Fig. V-16. These preliminaly layouts almost fully depend on the said manual and the current design practices adopted by Sabah DID.

5.4 DRAINAGE SCHEME AND ROAD NETWORK

5.4.1 General Description of Drainage Scheme

Although the proposed development area will be released from habitual flooding through dam construction, construction of an appropriate drainage system remains a prerequisite for achieving target yields as envisaged by the project.

As indicated in Figs. V-11, V-12 and V-13, the envisaged drainage network is made up of the following types of canals:

Type of canal	Catchment area (ha)
Main canal	over 514
Lateral drain	514
Sub-lateral drain	43

5.4.2 Design Drainage Discharge

Upon consultation with Federal DID and in due consideration of economical factors, a daily rainfall with a return period of 5-year was selected as a basis for calculation of the design drainage discharge. Utilizing the records at the Kuamut Meteorological Station, said design rainfall was determined at 144.8mm/24 hrs.

The design discharge was accordingly derived from the following design criteria:

	Run-off coefficient	Drainage Period (hrs)	Discharge/1 (litre/s/ha)
External area	-	-	5.0
Main (Existing minor streams)	0.65	48	5.45
Lateral drain	0.50	24	8.4
Sub-lateral drain	0.65	24	10.9

5.4.3 Drainage Canals

Utilizing a 1/50,000 topographic map of the project area, the configuration for the drainage canal network was formulated on the basis of topographical factors, and the design criteria set out below. All drainage canals are to be earth canals.

/1: Discharge of 5.0 litre/s/ha for external area has been estimated from specific discharge for entire basin, and other discharge values were estimated based on the following formula:

$$Q = 2.78 \times 10^{-3} \times \frac{A.R.C.}{T}$$

where:

A: Area (1.0ha) C: Run-off coefficient

R: Rainfall (144.8mm) T: Drainage period

Canal type	Canal gradient	Bank slope	Roughness coefficient
Existing canal improvement	1/10,000	1 : 1.5	0.03
Lateral drain	1/8,000	1 : 1.5	0.03
Sub-lateral drain	1/5,000	1 : 1.5	0.03

5.4.4 Drainage Facilities

All drainage facilities for the Project are listed in Table V-33, and the typical layout drawings are illustrated in Fig. V-17. Layout drawings have been prepared based on the standard procedures applied by Sabah DID.

5.4.5 Roads and Bridges

A general description of the road network design is presented in Section 5.3.3 (2). Layout drawings are provided in Figs. V-11, V-12 and V-13 and required quantities are listed in Table V-33.

5.5 OPERATION AND MAINTENANCE OF IRRIGATION FACILITIES

Equipment required for operation and maintenance of the irrigation and drainage facilities are listed in Table V-34. The cost of annual operation and maintenance of said facilities is US$80/ha, or 1.75% of the total investment cost for the Project. Although this amount is slightly higher than the international average for similar type projects, it is still considered to be within acceptable limits. Details petaining to said operation and maintenance costs are given in Table V-35.

6. AGRICULTURAL PRODUCTION PLAN

6.1 PROPOSED AGRICULTURAL DEVELOPMENT AREA

Based upon the review of soil survey and land capability reports, the project area is selected out of the total study area in the existing flood plain.

The project area, at present, is swampy and is considerably flat. It is mostly covered with secondary forest on the alluvial and peat soils. Only about one percent or less of the land is being cultivated.

55,000 ha has been delineated on the agricultural development area. Excluding unsuitable area such as small hilly terraces scattering in the swamp and also the sites for major irrigation and drainage systems, protection green belts and on-farm facilities, the net cultivable area of 44,000 ha is selected in the agricultural development area. Beside this alluvial soils area of 44,000 ha, there exists the peat soil area of 45,500 ha.

Total agricultural development area	55,000 ha
Net cultivable area	44,000 ha
(Alluvial soil area	44,000 ha)
Peat soil area	45,500 ha

The pedological and topographical conditions in the alluvial soil area (Soil groups 2 and 3) are generally favourable for agricultural production. However, the peat soils are generally acidic and some very acidic, and the yield of crops are usually poor.

6.2 PROPOSED CROPPING PATTERN

6.2.1 Selection of Crops

There are several factors as described below which need to be taken into consideration when suitable crops are to be selected for intensive cultivation as the key products for agricultural development (see Table V-36).

1)	Flood condition	A flood of 20-year return period
2)	Soils and land capability	Fertility and slopes
3)	Weather conditions	Rainfall distribution and others
4)	Productivity	Production cost and net returns
5)	Labour requirement	Labour shortage and easy mechanized operations
6)	Marketability of products	Domestic and international

Annual crops are to be selected on the ground that 1) the area may be affected by floods of 20-year probability even after the completion of the proposed dam, which would annihilate such tree crops as oil palm and cacao, and 2) the Kinabatangan River Basin has extensive terrace land outside the project area with better drainage, which is more suitable for tree crops.

Paddy for alluvial soils

Among annual crops, paddy is the optimum choice for the alluvial soil because 1) it is one of the few areas in which large scale mechanization for irrigation farming would be possible owing to its vast plain, 2) rice has comparatively high demand and stable market value and 3) the State Government has strong intensions for food self-sufficiency.

Upland crops for peat soils

As for the peat soil area, mechanized farming of such upland crops as maize and/or soy bean is conceivable. However, at present, such cultivation does not seem likely to contribute to offsetting the development cost including that of dam construction.

According to a rough calculation, B/C ratio will be only 0.73 at 12% discount rate and 0.81 at 8% of discount rate. Therefore, for the time being, it is better to exclude the peat soil area of 45,500 ha from the development area (see Tables V-37, V-38 and V-39).

6.2.2 Selection of Variety

At present, two varieties of MR-7 and IR-42 could be recommended. These varieties will be re-examined for further selection and confirmation and, moreover, other improved varieties may as well be newly introduced in the future through the experiments at the project site.

Recently a rice disease called "Penyakit Merah" or "Tungro Virus" has been rampant and ravaging in various paddy growing areas of Sabah, particularly Tuaran, Papar and Keningau. Yield losses up to 100% were reported in the 1979 main-season. All existing varieties released so far including Jaya are susceptible to this desease.

This disease problem undoubtedly calls for priority attention of the paddy scientist. In this context it is commendable that the Tuaran Paddy Division has succeeded in selecting and identifying two new paddy varieties which, among all desirable qualities, possess good resistance to "Penyakit Merah". These are MR 7 and IR 42 which the Sabah Department of Agriculture feels most timely to release to the farmers for planting. The release of these two varieties will no doubt alleviate, if not completely overcome, the present "Penyakit Merah" problem. The following is a detailed description of MR 7 and IR 42.

MR 7 (MARDI RICE NO. 7)

1) Parentage

MR 7 is the first of MARDI new strains of rice which has been bred specially for foliar and panicle blast resistance. Resistance from the donor parent, Tadukan, has been incorporated into Jaya, which has good cooking and eating qualities as well as excellent agronomic traits but is susceptible to blast desease. Tadukan has consistently shown a high level of resistance to blast over the past decade in many countries including Malaysia. The variety, however, is a low yielder and has poor plant type.

The cross between Jaya and Tadukan was made by MARDI in the off-season of 1970 followed by two successive back-crosses of the first of F_1 generation to Jaya. After 5 generations of selection and purification, twelve lines were selected and evaluated over two seasons for yields and growth performance. This was followed by adaptability trials of four of the selections in various locations. Finally, MR 7 was selected as a potential variety. Adaptability trials carried out for MR 7 on several locations in Sabah have shown that the yield and the agronomic traits were good.

2) General Characteristics

MR 7 is a short maturation variety (115-130 days) with very slight seasonal variation. Thus it is very suitable for double-cropping areas. It is a suitable variety for areas with average to good soil type where water management is satisfactory. In these areas the yield range would be between 4 to 7 tons per hectare.

This variety is highly resistant to foliar and panicle blast, resistant to "Penyakit Merah" and only moderately susceptible to bacterial leaf blight.

In terms of grain cooking and eating qualities, MR 7 is comparable to Jaya which is highly acceptable to farmers and consumers.

- Parentage	C4-63 (Jaya)^3/Tadukan
- Maturation	115-130 days from sowing
- Culm height	75 cm - 85 cm
- Lodging	resistant
- Habit	flag-leaf erect to slightly droopy; medium broad leaves
- Leaf Colour	medium dark green
- Leaf senescence	medium
- Grain size	
a) Length	8.9 mm
b) Width	2.4 mm
- Grain shape	long slightly bold
- Grain quality	good
- 1000 grain weight	24.2 grams
- Threshability	easy
- Milling recovery	65 - 70%
- Yield range	4.7 tons per hectare (700 - 1200 gantangs per acre)
- Fertilizer response	moderately to highly responsive to nitrogen
- Disease reaction	
1) Penyakit Merah	resistant
2) Blast	highly resistant
3) Bacterial leaf blight	moderately suceptible
- Pest	susceptible to brown plant hopper (Nilaparvata sp.) and rat (Rattus sp.)
- Others	purplish pigmentation on leaf sheath during early plant growth

IR 42 (IRRI RICE NO. 42)

1) Parentage

IR 42 is the result of a multiple cross between IR 1561-288-1-2, IR 24, Oryza nivara and CR 94-13. The initial crossing was between Oryza nivara and IR 24. The first of F_1 generation from this cross was then back-crossed three times with IR 24. The resultant progeny was further crossed with IR 1561-288-1-2. Finally, the F_1 generation from this second cross was crossed with CR 94-13, and the progeny obtained was IR 42.

Adaptability trails were carried out for IR 42 on several localities in Sabah and the yield and the agronomic traits were observed to be good.

2) General Characteristics

IR 42 has a high yield potential at low levels of nitrogen. It is a relatively tall variety with culm height of 85 cm and it is non-lodging. It has a maturation period of 130-140 days with normal leaf senescene and low sterility. It is very suitable for general planting in single-croppng areas or for main-season planting only of double-croping area. It is resistant to "Penyakit Merah", blast and bacterial leaf blight. The grains are medium bold in shape and the eating quality is fairly acceptable.

- Parentage	IR 1561-288-1-2/IR 244 Oryza nivara/CR 94-13
- Maturation	130-140 days
- Culm height	80 - 90 cm
- Lodging	resistant
- Habit	flag-leaf erect; narrow leaves
- Leaf Colour	dark green
- Leaf senescence	medium to late
- Grain size	
1) Length	8.1 mm
2) Width	2.4 mm
- Grain shape	medium bold
- Grain quality	fairly acceptable
- 1000 grain weight	20.9 grames

- Threshability	moderately difficult
- Milling recovery	65 - 70%
- Yield range	5-7.5 tons per hectare (850 - 1300 gantangs per acre)
- Fertilizer response	slightly responsive to fertilizer
- Disease reaction	
1) Penyakit Merah	resistant
2) Blast	resistant
3) Bacterial leaf blight	resistant
- Pest	susceptible to leaf rollers (Hesperia sp.)

6.2.3 Recommendable Cropping Pattern

Proposed cropping patterns are studied mainly from the agronomic point of view, meteorological conditions and irrigation water consumption.

The present paddy cultivation in Sabah is mostly practiced from August/September to January/February as the main season and from May/April to September/October as the off-season on the West Coast (see Table V-40).

The project area on the East Coast has a little different rainfall distribution compared to the West Coast. The harvesting operations by combines should preferably avoid rainfall. In this connection, the harvesting season has selected in March and April for main season crop (2nd crop), and August and September for off-season crop (1st crop).

Thus, the 1st crop will take place during the season of mid-April and May to mid-August and September (about 120 days). The 2nd crop will be grown during the period of October and mid-November to March and mid-April (about 150 days) (see Fig. V-18).

In the trial growing at Bukit Garam Pilot Farm, the main season crop from June/July to January/February has been successfully grown in 1980/81.

However, the yield was damaged by a big flood in January 1981. Learning from the flood experience, an off season crop from June/July to November was implemented successfully in 1981 (see Table V-41).

Therefore, the above-mentioned cropping pattern could be recommended for the future production programme in the project area.

6.3 PROPOSED FARMING PRACTICES

For rice cultivation recommended in the future crop production programme, full mechanized farming is proposed in due consideration of the very hard soil conditions, suitability of paddy for mechanical farm operation, necessity of labour force saving, etc. (see Table V-42, V-43, V-44 and V-45).

6.3.1 Land Preparation

At the middle of April, land preparation will be started by use of the tractor with mounted disc plough having 4 bottoms. The soil saturation with pre-irrigation will be practiced to advance the ploughing. In this work, some crawler type tractor will also be required to a certain extent where the soils are very hardly consolidated.

Harrowing will be required at least twice after the ploughing in order to make the land level. Disc harrow attached to the tractor will be used for this practice. The crawler type tractor with dozer brande will be helpful for this work, particularly in the area where the soils are very consolidated. In this work schedule, the rice straw will be incorporated into the soil for improving the soil conditions.

Following the harrowing works, temporary ridges will be prepared by use of the ridger and the field plot will be divided into 2 or 3 small sub-plots, in order to achieve final land levelling for better water management and protection of young seedling against wavelets.

Application of the basic fertilizers will be practiced by use of the broadcaster attached to the tractor. After the basic fertilization, rotar - harrowing by rotarvator and/or final land levelling by land leveller will be carried out for preparation of a good seed bed. This is a very important practice particularly to ensure not only a good water spreading but also to promote the uniform germination of seeds as well as the growing of small seedlings.

As for the second cropping of rice, the land preparation will be carried out immediately after the harvesting of the first crop. All the practices are the same as the programme for the first crop mentioned above.

6.3.2 Seeding

At present, there are three types of rice cultivation methods broadly characterized by the seeding practice. One is the ordinary transplanting method in which seedlings are prepared at the nursery bed and thereafter are transplanted into the main field. This method is being widely practiced in the world and it is generally accepted that the yield

can be expected to be higher as compared with that of the direct sowing method, particularly in poor field conditions, while a large labour force is required for the transplanting of seedlings. Recently, transplanting machinery (so-called transplanter) have been developed in Japan and are popular among farmers. However, those still have a narrow suitability with the field conditions.

The second is also the transplanting method which has been recently developed in Japan. Seedlings are prepared by use of the seedling boxes and thereafter those seedlings are broadcasted at random spaces. In this method, labour requirement for transplanting is saved substantially and yield can be expected more than that by transplanting method. However, it will require rather big initial investment for preparation of seedling boxes.

The third is the direct sowing method. This method can be easily mechanized with less labour requirement than others. While, it is required to prepare the land levelling with more rigorous conditions as compared with that for others. The yield by this method is less than others in general, but it can be expected to be nearly the same as others only when germination of seeds is successfully achieved, weeds are well controlled and lodging of plants is nicely prevented.

Generally, the following seedling methods on direct sowing are practiced depending on the soil and field conditions.

1) Drill seeding on dry field conditions,
2) Broadcasting of seeds on dry field conditions, and
3) Broadcasting of seeds under submerged field conditions.

The method 3) is not recommendable in the objective area, in due consideration of the soil conditions. The seed germination will be largely restricted by clay coating in case of the method 3) due to very fine clayey soils in the objective area. Besides, under submerged conditions, trafficability and workability of farm machinery will be low in efficiency and, in certain extent, it will be difficult to use the machinery because the ground contact pressure decreases to less than 3 kg/cm^2, according to our field observation.

The following are the summary of comparison on the different conditions in each method.

Different Conditions in Each Method

Planting methods	Labour requirement /1 (man-day/ha)	Expected yield
Ordinary transplanting method	60	5.2
Transplanting method with broadcastable seedlings	20	5.0
Direct seeding method	1	4.2

Taking into account the merits and demerits as seen in the above table, the direct seeding method in the dry field is mainly proposed in this production programme, but in some cases broadcast transplanting method is also recommendable.

Operation of the seeding practice is such that the seeds will be sown in shallow depth by the use of seeder (wide level disc harrow with seeder) attached to the tractor. The seeding rate will be at 80 kg/ha. Prior to the seeding, seeds will be selected by a salt-solution with 1.13 specific gravity and then treated by a chemical (Benrate) to control diseases.

The seeds used in this programme will be prepared through seed multiplication programme to be conducted in the pilot farm which will be implemented rather soon nearby the Project area.

6.3.3 Water Control and Management

After the seeding, irrigation operation will be started and it will be continued until 10 or 15 days before harvesting. Regarding the irrigation operation, the following water control and management will be properly practiced with the growth of rice plants.

1) Sprouting stage

As stated in the sub-chapter 6.3.2, germination of seeds will be largely restricted under submerged conditions. Thus, at this growing stage, the irrigation water will be applied only for sustaining the soil moisture at the field capacity or little over in normal level. In the second cropping, stagnant rain-water on the soil surface at this stage should be drained out completely from the nursery field.

/1 : Labour requirement is only for initial stage of rice cultivation i.e. land preparation, seed preparation and transplanting or seeding.

2) Young seedling stage

In order to ensure the successful establishment of seedlings, it will be necessary to maintain the paddy field with either only the saturated moisture in the soil or inundation at levels very much less than normal, and this condition will be continued until the plant-age of 4 to 5 which is expressed by the leaf-number on the main stem. Even in this stage, if seedlings are completely submerged, they are seriously damaged. Therefore, excessive irrigation water and/or rain-water should be eliminated, as soon as possible, from the field.

3) Active tillering stage

At this stage, shallowly water-logged condition is required to effectively increase the number of tillers, and it also serves for controlling weeds. During the period from the stage of last emergence of bearing tillers to the stage of spikelet differentiation which roughly corresponds to 40 days to 27 days before heading, the water in the field, if possible, will be drained out completely. This practice is called as "Mid-season drying practice", and it is quite useful especially in ill-drained fields for controlling the non-bearing tillers and reductive soil conditions, and also for increasing the resistance in lodging of plants and the percentage of ripened grains.

4) Spikelet initiation stage to full ripening stage

After finishing "Mid-Season drying practice", the watering will start again and the field will consecutively be flooded until the full heading stage although, when necessary, water is also drained out for 2 or 3 days, at intervals of 10 days for encouraging the root activity. When rice plants attain to maturity and the 10th day before harvest, all the water will be drained out from the field for facilitating the operation of combine harvesters.

6.3.4 Fertilization

Proper application of fertilizers is essential for the realization of the agricultural potential in the objective area. The results of the detailed soil chemical analyses indicate that the nutrients necessary for proper rice production may not be always sufficiently contained in the soil. In such case, it is necessary to supplement some nitrogen and phosphorous and organic components.

Judging from the chemical properties of the soils, requirement of nitrogen and phosphate is estimated at about 70 kg/ha of N and 35 kg/ha of P_2O_5 for the first cropping

and 90 to 95 kg/ha of N and 45 kg/ha of P_2O_5 for the second cropping. These are respectively corresponding to about 150 kg/ha of urea and 75 kg/ha of triple-supper phosphate (T.S.P.) for the first cropping and 200 kg/ha of urea and 100 kg/ha of T.S.P. for the second cropping.

Out of the total dosage of fertilizers, about one third of urea and all the T.S.P. will be applied as the basic fertilizer. Application of these is done by the use of broadcaster and, thereafter, these are effectively mixed with soils by the practice of rotar-farrowing as described in the above.

In the first cropping, top-dressing of urea will be given initially with about 30 kg/ha just before the most active tillering stage (30 days after the seeding), and thereafter, the second with about 40 kg/ha just before the most active reduction division stage (20 days before heading, 70 days after the seeding) and the third with about 30 kg/ha at the full heading stage (90 days after the seeding).

Similarly, the second crop will grow under split-fertilization by urea, respectively, of 40 kg/ha just before the most active tillering stage, 60 kg/ha just before the reduction division stage and 40 kg/ha at the full heading stage.

The application of these urea top-dressings will be done by the use of power dusters with 40 m long pipe applicaters.

6.3.5 Plant Protection

According to the experience obtained in rice cultivation at Bukit Guram Pilot Farm, no remarkable damage is observed, at present. However, owing to the enlarged rice production programme and the continuous rice cultivation, insect, diseases and other pests will definitely develop and increase damages in the future. Therefore, the plant protection schedule must be provided in this rice production programme. For this purpose, about 30 kg/ha each of insecticides and fungicides are estimated in the respective crop season. However, as for the first fungicide application could be omitted for the first crop because it is grown during the dry season.

6.3.6 Weeding

Production decrease caused by weeds is the most serious obstruction in the rice cultivation in general. Particularly the rice production by direct sowing methods is liable to severe production decrease due to the extreme difficulty in mechanical weed control. In this production programme, therefore, chemical weed control will be introduced, taking into account the availability of labour force and the effective farm operation. The herbicides will be applied with about

30 kg/ha for about 30 days after the seeding. In the application of herbicides, chemical toxicity harmful to not only fishes and animals but also humanbeing need to be taken into serious consideration. Only the harmless varieties of chemicals such as MO, X-5-2, SWEP and SATURN will be selected and introduced. The herbicides will be applied by the power dusters, in the same manner as fertilizer top-dressing.

6.3.7 Harvesting

Harvesting of rice will be conducted by the rice combine harvesters with 4.0 - 4.5 m cutting width and half crawler type wheels. Prior to harvesting, the field should be drained completely.

The 1st crop will be harvested in August and September and the 2nd crop in March and April. The optimum time of harvesting in each crop will carefully be decided in order to avoid grain losses by lodging, shattering and spoil of the grains due to the clack (sun check), etc.

6.4 ANTICIPATED RICE YIELD

The target yield of paddy in the full development stage will be estimated at 4.2 tons/ha by the 1st cropping (off-season) and 3.8 tons/ha by the 2nd cropping (main-season) with the implementation of the project. The anticipated paddy production will increase year after year through improved field conditions and farming techniques. The following table shows the anticipated yields during the build up period.

Cropping	Year 1st	2nd	3rd	4th	5th
1st cropping (off-season)	2.6	3.0	3.4	3.8	4.2
2nd cropping (main-season)	2.4	2.8	3.2	3.5	3.8
Total(ton/ha)	5.0	5.8	6.6	7.3	8.0

In addition to the above, the rice bran would be produced as by-product and account for approximately 9% of paddy weight.

The 1st crop will grow in the off-season. The rice cultivation in this season has never been commonly conducted in Sabah mainly due to non-availability of irrigation water. According to the statistics, 3.72 tons/ha of off-season paddy was produced in 1980 (see Table V-52).

The 2nd crop will grow in the main season. It is a very mild climate for the critical growing stage of rice, i.e. reduction division, flowering and active ripening. Almost all rice cultivation in Sabah is, therefore, being concentrated in this season and yields of 2.77 tons/ha are harvested on an average.

According to an experimention at Tuaran, the drill seeding method has shown good yield (see Table V-46).

Besides, the projected paddy yield in Muda Schem in West Malaysia is as follows;

Year	Main Season	Off Season
1980	3.34 (ton/ha)	3.57 (ton/ha)
1990	4.02 (ton/ha)	4.35 (ton/ha)
2000	4.51 (ton/ha)	4.86 (ton/ha)

As information indicated in the above, it can be safely assumed that if more suitable varieties are selected and grow with proper irrigation with high technology of cultivation, the anticipated yield will successfully be obtained even in the initial stage of the development.

7. DEVELOPMENT OF PEAT SOIL AREA

In most countries including Malaysia, peat soils are considered as poor soils for agriculture. For example, about 20,000 ha are under pineapples in a vast area of land under peat in Peninsular Malaysia, the only crop recommended and successfully grown so far. About 80,000 ha are under a variety of crops like rubber, oil palm, coconut coffee and paddy. However, the yield of these crops are invariably poor in comparison with those grown on ordinary soils, because the peat soils are generally acidic and some very acidic so that only acid tolerant plants can be grown without adding of lime or ash.

7.1 SUITABLE CROPS

In fact, it was the generally accepted opinion up to 1965 that peat was not suitable for crops except for pineapples. In 1965 a peat research unit was set up in the Department of Agriculture in Federal Government and some of its works gave a better understanding of the peat and made it possible for growing many kinds of crops. According to the results, the peat soils are particularly suitable for root crops like tapioca and yams. Other suitable crops are maize, sorghum, kenaf, soyabean, groundnuts, mulberry, tomatoes, chilli, tobacco, lowland cabbage, fodder grasses, onions and many varieties of vegetables.

In the case of rice which is normally grown under flooded condition, the water logging of peat produces organic acids which are deterimental to the growth of paddy roots hence nutrient uptake is made poor and yield of grains affected.

7.2 CONSTRAINTS FOR DEVELOPMENT

7.2.1 Land Development

The removal of the timber and its root from the surface as well as that buried to depth of at least 30 cm is necessary in order to cultivate the peat. In some cases all the timber is removed to a spot, piled up, allowed to dry, and then burnt. This process in the peat area is both expensive and wasteful.

7.2.2 Cultivation

Mechanical cultivation of the peat area is difficult due to the presence of buried timber and the tendency of machinery to get bogged down especially when the ground is wet. Pedestrian tractors have been used to overcome the problem but they are slow and the cost of cultivation is high. Four wheel tractors with extended wheels have been used in the area, however, sticky soil does not allow easy operations.

It does appear that some particular make of tractors can with modification be adapted for use on peat. In any case, buried timber has to be removed and cultivation can be carried out only at certain times when the peat is fairly dry. However, normal cultivation in the peat area would be difficult due to rainfall, 194 mm per month in minimum, and difficulty of drainage.

7.2.3 Lack of Experiment

There are some suitable crops as above-mentioned in the peat soils. However, the soils would require delicate treatment for planting of crops, for example, adjustment of acidity (PH), application of fertilizers and minor elements (e.g., Zn, Mo, and Mn), due to the physical and chemical conditions of peat soils.

On the other hand, crop rotation in the cropping pattern of annual crops might be considered to avoid imbalance of soil nutrition and to cut down the fertilizer requirement.

However, at present experiments on the peat soil productivity in and around the project area have not yet been implemented. The experiments on the suitable crops for the peat soils should be conducted at the recommended experiment pilot farm in the project area, not only from agronomic but also marketability and other economic viewpoints.

8. AGRICULTURAL MECHANIZATION

8.1 SELECTION OF FARM MACHINERY

8.1.1 Soil and Farming Conditions

The soils in the project area are very deep with high-water holding capacities but low permeabilities. Under dry conditions, the soils are hard and deep cracks permit very rapid initial intake of water. When wet, however, the soils swell and seal the cracks, become very sticky and almost impermeable.

They can be effectively cultivated only when their moisture content is kept within a narrow range. Thus cultivation under irrigated condition requires special skills and careful water management.

Very fine clayey alluvial soil is another constraint on seed germination. The germination of seeds will be seriously restricted by clay coating under submerged conditions due to the soils having high swelling characteristics.

According to estimation, and through investigation of the results obtained in Bukit Garam Pilot Farm on the ground contact pressure of the soil in the project area, cone resistance values would be around 5 kg/cm^2 in depth of 30 cm of soil profile. These conditions indicate that even heavy machinery can be introduced into the proposed mechanization programme successfully. Under submerged conditions, however, the ground contact pressure decreases to less than 3 kg/cm^2. In this condition, trafficability and workability of the machinery decreases in efficiency and, sometimes, it will be difficult to use machinery at all.

Judging from the experiences in West Malaysia, where an alluvial soil group with same characteristics as in the project area is distributed, the submerged soils will be more than 5 kg/cm^2 after 7 or 10 days of draining-up of the paddy field.

The paddy cultivation practices such as puddling, levelling, planting, fertilizing, plant protection and weeding are usually performed in the muddy wet field. However, mechanical operation under said conditions in the project area will be handicapped by low efficiency and/or difficulty due to the soil charactaristics as mentioned before.

Thus, the proposed cultivation practices except for upkeeping of paddy plant will be performed under dry soil conditions. Land preparation and sowing will have to be done quite similarly to that for up-land crops. However, ploughing, harrowing, and levelling, sowing and water control will have to be carried out more carefully to ensure good germination and proper growth of paddy.

8.1.2 Selection of Farm Machinery

The selection of farm machinery was made in due consideration of the local climate and soil conditions in the project area, the proposed work and farming practices discussed earlier, and the prevailing farm mechanization experiences in Malaysia and other paddy producing countries in Asia also.

Tractors

Four-wheel tractors in 75HP class are selected as the master power in this programme. This type of tractors are popular in the State at present. This tendency is now becoming the world trend due to the requirement for more efficient higher horsepower machinery and labour saving devises. Furthermore, the land preparation in the dry paddy field will require operations similar to up-land cultivation using higher horsepower machinery.

In some areas where the soils could be very firmly consolidated and/or wet due to comparatively poor drainage, small crawler tractors (60HP Class) would be required to supplement wheel tractors.

Attachements

As for the elementary attachments to the tractors, the following type and size are selected.

For ploughing:	Disc plough having 26 x 5 discs will be used.
For harrowing:	Offset dise harrow which consists of two gangs. Front gang will be equipped with 9 to 12 number of notched type discs, while same numbers of plate type discs in rear gang. Each disc will be 22 to 24 inches in diameter and will have an individual scraper. Cutting width will be 8 - 10 feet. In addition to the above, rotarvator is proposed for final soil preparation. The rotary harrowing will be utilized for preparation of a good seed bed. For this purpose, a rotarvator having 2 meter working width is proposed.
For fertilizing:	Prior to rotary harrowing, application of urea and T.S.P. as the basic fertilizer is scheduled on the farm operation programme. For this practice, broadcasters having 400 liters tank capacity will be used.

Upon completion of all the above, arrangement for temporary field ridges and final levelling of seed bed will be carried out by attaching the followig equipment to the tractor.

For temporary ridge: one row ridger

For final levelling: grader with 3 meter width

As stated before, seeding under submerged condition is not a suitable practice for proper germination. Thus, it is recommended to sow the paddy seeds on dry field where soils have a moisture content with optimum satulation. In executing this practice, the following type of drill seeder will be applicable.

For sowing : Drill seeder with 12 to 15 feet in width, which have 24 to 30 number of discs and 20 to 24 seed boxes.

For transportation of farm inputs, farm products etc. trailers around 5 tons in capacity will be used. Dump-trucks will also be used as the main transportation means of farm inputs and farm products.

Combine Harvester

Because of relatively high shattering characteristics of paddy, the following type of combine harvester is selected.

Horsepower	: 100 HP
Cutting width	: 4 to 4.5m
Thresher	: tooth type
Capacity of tank	: 3,500 liters
Traffic	: Semi-crawler

To minimize labour, equipment and material requirements, transportation of paddy by bulk loading system would be applicable. This would also help making its delivery at rice will more convenient and efficient.

The harvesting will be carried out 10-15 days after drainage operation. The trafficability of the combine harvester will be satisfactory. In West Malaysia, where the soils have the similar characteristics as those in the project area, the submerged soils maintained more than 5 kg/cm^2 of cone resistance values even after 2 to 10 days from the completion of drainage operation.

Equipment for Other Works

As for supplementary application of fertilizers and chemicals for plant protection and weed control, aerial spraying by air-craft and/or traditional ground spraying is generally practiced in large scale farming.

Recently the aerial spraying by use of air-craft has been introduced in Sabah under the plant protection programme provided by the Paddy Board. The present spraying charges by aircraft are as follows:

Sowing	:	M$8/acre
Fertilizer application	:	M$10/acre
Chemical spraying	:	M$10/acre

Aerial spraying seems to be rather costly compared to the traditional method. The aerial spraying by aircraft will be unsuitable by the following reasons;

1) A suitable course for flying schedule will not be easily worked out in the project area due to the different growth stage of paddy.

2) Operation will be limited by wind velocity. Critical velocity is estimated at 3m/sec for spraying the powder, and 5m/sec for liquid type of chemicals.

Therefore, the proposed works would be best undertaken by the traditional ground spraying method. In this connection, power duster equipped with a long application pipe is selected to enable distribution of powder or granular type of fertilizers and agro-chemicals for a distance about 140 m from the farm road or field ditch.

Knapsack-type sprayer will be used for liquid spraying, but it will be only for an emergency measures and/or localized, on-the-spot countermeasures for insect or plant diseases.

8.2 REQUIRED NUMBER OF FARM MACHINERY

The number of required farm machinery was studied on the basis of the operation programme, workability specified for each machinery, and workable days.

8.2.1 Estimation of Workable Days and Working Hours

The workable days per year have been estimated, in consultation with the rainfall data for the last 10 years, on the assumption that 100% of days with precipitation 50 mm and over and 50% of days with 20 mm to 50 mm precipitation are unworkable, plus 5 days of Sundays and national holidays per month (see Table V-47). And the daily working hours have been assumed to be 12 hours under normal conditions, in two shifts of 6 hours each.

Thus monthly distribution of workable days and total workable hours per month are summarized as follows;

Workable Day and Working Hours

Month	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Workable days	22	19	24	23	24	22	23	23	23	23	22	23	271
Workable hours	264	228	288	276	288	264	276	276	276	276	264	276	3,252

(See Table V-47 in details)

8.2.2 Working Capacity and Working Efficiency of Machinery

Actual field working capacity and working efficiency of machinery for each operation of ploughing, harrowing and ridging are directly estimated on the basis of the results obtained in Asian countries. While, owing to limited informations on other machinery particulary for rice cultivation, the conditions are estimated through the references available in the case of rice cultivation in large scale farming in Japan. The efficiency and conditions of each machinery and equipment are shown in Table V-48.

8.2.3 Required Number of Tractors and Combine

In order to determine the most appropriate and economical number of tractor combines to be used, the following conditions were assumed.

Cropping Patterns

The 1st crop will be sown from 15th of April to the end of May and harvested from 15 of August to the end of September. The 2nd crop will be sown from 1st of October to 15th of November and harvested from 1st of May to 15th of April.

Working Conditions

The working hours per day are assumed at 14 hours, of which one hour for tea break and one hour for travelling from tractor pool to field are estimated as lost time. Thus, net field working hours are 12 hours per day with two shift.

The combine harvester will possiblly be operated for 6 hours per day even under high humidity conditions.

Taking into consideration the actual field capacity of the selected machinery and other factors as mentioned before, the required number of major farm machinery in one operation group is estimated in Table V-49 and Fig. V-19.

Accordingly, 400 ha will be covered by 2 combine harvesters and 6 tractors as an unit operation group. Thus, total area will be cultivated by 750 tractors and 250 combine harvesters including some stand-by machinery.

In this estimation, some 400 ha of irrigation block in average corresponding to 20 irrigation lots (each lot has 20 ha in acreage commanded by one on farm ditch) is tentatively defined as the unit acreage for machinery operation. Thus, as a whole, 110 units of operation group are organized in this project.

8.2.4 OPERATION AND MAINTENANCE

Fuel Consumption

The fuel consumption is estimated on the basis of the total operation hours allocated to each work item, unit fuel consumption and load factor defined in each machinery. Annual fuel consumption is about 56,000 liters as estimated in Table V-50.

Labour Requirement for Field Operation

The proposed machinery operation will minimize the labour requirement. In the operation for unit acreage of 400ha, some 10 operators and 10 assistant operators will be regularly required for the machinery operation with two shift. Besides, some 5 labourers will be required for the related works of the machinery operation. Thus, as a whole, 2,750 persons will be required for field works.

Workshop

The project has many kinds of farm machinery, vehicles, rice mills and other related equipment and tools. For efficient operations, and repair and maintenance of these mechanical facilities, the work-shop will be provided in the project area.

The project area will have 11 workshops in total: 10 branch workshops with light repair facilities and one central workshop with heavy repair facilities.

The workshops will be located in each tract nearby the rice mill and/or farm machinery centre.

9. RICE PROCESSING

Upon completion of the project, about 352,000 tons of paddy will be produced a year. It is essential for the project to be equipped with effective rice milling and storage facilities to maintain high quality and marketing under favourable conditions.

The rice mill proposed herein will be installed in 11 places in the project area in parallel with the stage-wise development programme. Each rice mill will have the same and/or similar processing capacity and processing system designed for the quantity to be produced, taking into account the operational conditions anticipated in the project, and maintaining the high quality of the rice.

9.1 PROCESSING SYSTEM

There are several different processing systems which are commonly used in modern rice mills. The proposed system which is believed to be the most adaptable to the project is as follows:

1) Receiving Section; to receive and to clean the paddy
2) Drying and Storage Section; to dry, to store and to control the grain moisture
3) Milling Section; to mill the paddy grain into quality white rice

9.2 CAPACITY OF THE PLANT

The estimate of the processing capacity of the plant proposed herein is based on the following assumptions.

9.2.1 Basic Design Conditions

Operation conditions

1) Cropping pattern: Double cropping per annum

2) Seasonal processing amount (by first crop):

   4,000 ha x 4.2 ton/ha ÷ 11 plant

   = 16,800 tons of unhusked paddy grain per plant in average

3) Working condition

Sections of the mill	Working daily (hour)	Operation days (day)
Receiving	12	35 x 2
Milling	24	270

Condition of grains to be processed

1) Moisture content of receiving paddy: 22-26% wet base

2) Apparent density of grains:

Unhusked grain: 0.52
Brown rice and white rice: 0.8

3) Variety of rice:

High yielding varieties produced in the project

4) Milling efficiency:

Husk : 23 %
Bran : 10%
Foreign matters: 2% or less
Recovery ratio : 68%

9.2.2 Capacity of the Plant

Based on the design conditions stated in the above and the delivery quantity from the field, the required capacity in each section of the proposed mill is estimated as follows;

Receiving and Cleaning Section

For estimation of the receiving capacity of the mill, the maximum yield of the 1st crop is assumed to be 4.2 tons/ha.

1) 44,000 ha x 4.2 ton/ha ÷ 11 unit plant = 16,800 ton plant
2) 16,800 ton ÷ 35 days ÷ 12 hr/day = 40 ton/hr per unit plant

Receiving quantity of paddy will be 40 ton/hr per unit plant as the capacity for constant operation. In due consideration of probable peak operation at the harvesting time, 60 ton/hr in receiving capacity is estimated in this processing programme.

Drying and Storage Section

In comparison with the receiving quantity, drying capacity and milling capacity are calculated as follows:

1) Total quantity of paddy to be received by unit plant during the harvesting time is 16,800 tons at its maximum.

2) About 60 ton/hr at peak season should be dried up between 14-15% of moisture content.

3) Total quantity which can be processed during the harvesting time of 35 days is 5,040 tons.

4) 16,800 tons - 5,040 tons = 11,760 tons
Say 12,000 tons

The required storage capacity is about 12,000 tons per season.

Milling Section

Assuming that 16,800 tons of paddy, the maximum quantity being expected from the 1st crop, needs to be processed during 135 net working days with 24 working hours per day by 3 shift operation, the milling capacity should be 125 tons/day or 5.2 tons/hour.

Two milling machines having 3 tons/hr capacity each are proposed for installation in two lines, for covering 6 tons per hour in the total milling capacity, with some allowances. This type of milling machine (3-ton type) is generally acceptable because of economical performance in its operation and the compactness of its size, requiring the least building space per unit capacity to accommodate it, in comparison with other types.

Some mechanical troubles on milling lines may be unavoidable, but such loss caused by possible troubles will be sufficiently compensated for by provision of ample capacity allowances with each processing section.

Power Supply Station

All of the machinery in the plant will be driven individually by electric motors. Electricity required to operate the machinery and lighting of the plant building and yard will be about 1,000 kW (440V/220V, 30/4W), and it will be supplied from the power generating station equipped with engine-driven generators. 4 units of 200 kVA generator with 300 HP diesel engine will be installed in each unit plant, including one stand-by unit.

Fuel Tank

The maximum daily fuel consumption of each power station is estimated at the amount of 5,760 litres in total (refer to 9.5.1).

As the interruptions of the mill operation are mostly due to fuel supply trouble, it is advisable to equip a storage tank with a stocking capacity of 80,000 litres or the equivalent of the requirement for 2 weeks' operation with some allowance, to ensure smooth operation of the mill.

For an easy and safe operation of the fuel storage, it is recommended to install 4 tanks, separately, each with 20,000 litres capacity, which is economical in size for both transportation and installation works.

9.3 MACHINERY AND EQUIPMENT

Machinery and equipment required for each rice mill plant are listed in the below:

1) Receiving and cleaning section (60 ton/hr)
   Grain Cleaner (20 ton/hr x 3), Dryer (20 ton/hr x 12)

2) Grain storage section (12,000 ton)
   Paddy storage bin (300 ton x 40)

3) Milling section (3 ton/hr x 2)

4) White rice storage (2,200 ton)

5) Power supply equipment (200 kVA x 4)
   Diesel-engine generator (300 HP/unit) x 4
   Fuel tank etc. (20,000 ton/tank x 4)

The plnat layout and flow diagram of rice processing and storage plant are shown Figs. V-20 and V-21.

9.4 OPERATION ORGANIZATION

To successfully operate and manage the proposed rice mill, the following section will be organized in each plant under the Department of Processing in the Project Organization (see Fig. V-22).

- Receiving and cleaning section
- Drying and storage section
- Milling section
- Repair and maintenance section

9.5 OPERATION AND MAINTENANCE

9.5.1 Fuel Consumption

As presented in the previous Chapter, all of the machinery will be driven by electric motors, and the electricity required will be generated in the power station individually installed nearby the unit mill plant. For the generator operation for one power station, an annual reuirement of the fuel is estimated on the basis of the following conditions;

- Fuel consumption of one unit generator	:	80 litre/hr
- No. of generator to be operate regularly	:	3
- Operation hour a day	:	24 hrs
- Operation duration a year	:	270 days
- Load factor for operation period	:	0.60

80 litre /hr x 3 (with dryers) x 24 hr/day x 70 days/year x 0.6 = 242,000 litre/year

80 litre /hr x 2 (without dryers) x 24 hr/day x 200 days/year x 0.6 = 461,000 litre/year

Thus, the annual fuel requirement for power generation per rice mill is about 703,000 liters.

9.5.2 Materials

The materials required for the mill operation are the sacks for packing the milled rice of 228,800 tons per annum. Sack 100 kg in capacity will be convenientg for the purpose of transportation and storing. To use these sacks, such consumables as sewing string are also indispensable. The number of sacks required is estimated to be about 2,288,000 a year.

10. PROJECT ORGANIZATION

In order to ascertain the responsibilities for the management of the project, it is proposed that an efficient autonomous organization with commercial base production activities is established for operation and maintenance of irrigation and drainage, paddy cultivation, rice processing, and the sale of agricultural products. The proposed organization is outlined in the organization chart in Fig. V-23 and summarized below.

The project would be administered by an autonomous Project Organization which will be supervised by the Project Coordinating Committee. The Organization will be responsible for the operation and maintenance of the project. The function of the Organization will be as follows;

1) Procurement of machinery and equipment required for the project

2) Operation and maintenance of the irrigation and drainage facilities, road networks etc.

3) Operation and maintenance of farm machinery and equipment

4) Operation of farming practices including input supply

5) Operation and maintenance of the rice mills and related facilities

6) Operation and maintenance of the workshops and related facilities

7) Procurement of the farm inputs, and other production materials

8) Storage and marketing of the products

9) Accounting and administrative affairs

10) Experiment and training on farm production at experiment pilot farm.

For executing the project, the Organization under the management of the Project Manager will consist of seven departments, and an attatched experiment pilot farm, namely Department of Planning, Department of Personnel and General Affairs, Department of Finance and Accounting, Department of Marketing, Department of Engineering, Department of Agricultural Production, and Experiment Pilot Farm. Total required manpower would be 4,007 persons as described hereinafter.

For the efficient management of the project, paddy area of 44,000 ha will be divided into 3 blocks. Each block will be divided into tracts; and the total number will be 11 tracts with an average area of 4,000 ha. A Tract Manager (agriculturist) will be assigned for the management of each scheme. Each tract is subdivided into several field operation units of 400 ha each. A Field Operation Master (Head of the farm machinery operator) is assigned for each field operation unit. He manages all the production process from land preparation through harvesting in the field operation unit.

10.1 DEPARTMENT OF PLANNING

Department of Planning of the Organization will be responsible for the following functions:

1) Formulation of overall yearly plan for the whole project

2) Formulation of overall budget plan for the whole project

3) Studies for finding out the best way of controlling the production cost

4) Evaluation and follow-up of the project

5) Economic and social studies about the effect of the project

Staff required for this department would be as follows;

Profession	Required Number
Director	1
Agro-economist	3
Statistician	1
Management Assistant	4
Clerk	6
Total	15

10.2 DEPARTMENT OF ENGINEERING

Department will be divided into three sections, namely Construction, O & M, and Mechanical Engineering.

Function

1) O & M Section
   - O & M of irrigation and drainage system
   - Control of irrigation water supply
   - Maintenace work on buildings

2) Mechanical Engineering Section
   - Operation of workshops
   - Repair and maintenance of farm machinery, processing facilities, and pumping stations
   - Repair and maintenance of on farm facilities, office buildings and others

Staff requirement

Profession	Required Number O & M Sec.	Mech. Eng. Sec.	Total
Director	-	-	1
Section Chief	1	1	2
Irrigation Eng.	46	-	46
Civil Eng.	5	-	5
Surveyor	5	-	5
Carpenter	5	-	5
Gate Keeper & Pump Operator	200	-	200
Mechanic	-	40	40
Electricial	-	12	12
Regular Employee for Repair/ Drivers etc.	-	60	60
Total	262	113	376

10.3 DEPARTMENT OF AGRICULTURAL PRODUCTION

Department will carry out all farming operations from land preparation to harvesting by machinery, plant protection, fertilizer application and seed multiplication. The Department will also cooperate with pilot farm for research and experiment works for crops and the training of farming staffs at the experiment pilot farm which will be established near the project area. Staffs required at the full development stage are as follows:

Profession	Required Number
Director	1
Clerk	11
Agriculturist	25
Farm Mechanization Eng.	25
Farm Machinery Operator	2,200
Farm Labour	550
Total	2,812

10.4 DEPARTMENT OF PROCESSING

The department will handle the operation and management of rice mills and the storage of paddy and rice. Staffs required for this Department at the full development stage are summarized as follows;

Profession	Required Number
Director	1
Asst. Director	1
Plant Manager	11
Foreman	11
Operator/Asst. Ope.	121
Labour	407
Total	552

10.5 DEPARTMENT OF FINANCE AND ACCOUNTING

Department will be divided into two sections, Finance and Accounting. The Finance section will be responsible for financing and repayment of the loan. Accounting section will be in charge of all the monetary affairs associated with the project operation and maintenance works of the whole project. the staffs required for this department will be as follows;

Profession	Finance Sec.	Acconting Sec.	Total
Director	-	-	1
Section Chief	1	1	2
Accountant	4	22	26
Clerk	10	26	36
Total	15	49	65

10.6 DEPARTMENT OF COMMERCIAL AFFAIRS

Department will be divided into two sections, the Logistic and Marketing. The Logistic section will be responsible for the procurement of all inputs including farm machinery, storage and supply of farm inputs, purchasing of spare parts, etc. The Marketing section will be engaged in the marketing activities including selling of products. The following workers will be equired for each section:

Profession	Logistic Sec.	Marketing Sec.	Total
Director	-	-	1
Sectin Chief	1	1	2
Office Staff	3	15	18
Accountant	5	5	10
Clerk	20	20	40
Total	29	41	71

10.7 DEPARTMENT OF PERSONNEL AND GENERAL AFFAIRS

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

Profession	Required Number
Director	1
Office Staff	20
Clerk	40
Total	61

10.8 ATTACHED EXPERIMENT PILOT FARM

The Experiment Pilot Farm will undertake the experiment and training on rice and upland crop cultivation, facility operations and machinery operations. Staffs required for the Experiment Pilot Farm are as follows;

Profession	Requirement Number
Director	1
Irrigation Engineer	3
Farm Machinery Expert	3
Rice Mill Expert	2
Rice Farming Expert	4
Agronomist (Upland crops)	2
Assistant Staffl	14
Clerk	5
Farm Labour	20
Total	54

Some experts, such as irrigation engineer, farm machinery expert, rice mill expert, rice farming expert and agronomist for upland crops will have to be recruited from abroad owing to sever shortage in experienced personnel in the State.

11. RICE PRODUCTION

11.1 INTRODUCTION

Rice is the staple food of approximately half of the world's population. In many developing countries, rice is the "preferred" grain and in Asia it is the main source of calories for 2 billion peaple. Rice may be regarded as one of the most important foodstuff in the world. Despite this dominance, world's annual production of rice is roughly 250 million tons i.e., only about 55% of annual wheat production.

World's demand and supply of rice are both projected to increase by 2.6% per annum between 1974/76 and 1990 (Table V-51), and the world's per capita consumption of rice is projected to increase from 55kg to 60kg between 1975 and 1990 /1.

11.2 PRESENT PADDY PRODUCTION IN SABAH

It is estimated that there are some 78,198 acres (31,280 ha) of land under wet paddy, of which about 50% are irrigated, and a further 30,000 acres (12,000 ha) under hill paddy in Sabah at present. The annual production of rice in the State has been 65,786 tons, whilst the annual import run at 68,266 tons in 1980, thus making Sabah only about 50% self-sufficient in this all-important commodity (see Tables V-52 and V-53).

The population of Sabah is 1,098,000 in 1980 and showing an annual increase of 3.2%. If the present trend continues, it would reach the two millionth mark by around the year 2000. The present consumption of rice, which does not take into account the amount of rice converted into rice wine (tapai), shows that 120 tons of rice is required for every 1,000 persons. If this trend continues it would require 240,000 tons of rice in the year 2000.

In this connection, the sectoral policy of the Fourth Malaysia Plan in Sabah is emphasized the special attention towards increasing production of food crops and other grains in an effort to attain self-sufficiency and price stabilization.

Present plans for development of rice production are involved, 1) introduction of new techniques including new varieties to increase the average yield, 2) opening up of additional new paddy field, and 3) introduction of double-cropping with irrigation.

/1: Price Prospects for Major Primary Commodities, IBRD, Jan., 1980.

Present plans for development of rice production are involved 1) introduction of new techniques including new varieties to increase the average yield, 2) opening up of additional new paddy field, and 3) introduction of double-cropping with irrigation.

11.3 POSSIBLE AREAS FOR PADDY DEVELOPMENT

A provisional soil map has already been published in which the main soil types have been broadly deliniated. The topography of much of the agriculturally potential areas has also been surveyed, although not yet to the extent or in detail necessary for detaileld planning. After discussion with Government officers concerned, the following areas generally made up of flat land have been indicated as potential paddy areas:

1) Klias Plain, 2) Bandan Plain, 3) Lower Labuk,
4) Segama Vallay, 5) Tabin-Lumerau Plain,
6) Semporna Peninsula, and 7) Kinabatangan Valley

However, except some part of Terusan Sapi in the Lower Labuk, almost all areas have some constraines for paddy field development, for example, inconvenient source of water, water-retaining of soils, aliniation for other purposes, serious flood problems, scattering of small parcels of area, etc.

In view of the natural factors and hazards outlined above in respect of the first six areas, only the Kinabatangan area remains for further consideration. Although this valley also suffers from a flood problem, it offers a vast potential of land suited for wet paddy development. It has been estimated that approximately 163,000 acres (65,000 ha) of alluvial soil area occurs in the area, the bulk of which along a continuous stretch on both banks of the Kinabatangan river. Allowing for some reduction in this area for proposed dam reservoirs and other unidentified pockets of unsuitable topography and soils, it is estimated that not less than 137,500 acres (55,000 ha) out of which area of 110,000 acres (44,000 ha) of land in the lower basin of the proposed dam can be developed for large scale paddy farming.

11.4 FARMING FORM

Assuming that 11,000 acres (44,000 ha) could ultimately be developed for cultivating of paddy, the total number of farming families involved would be over 22,000 if the area is to be developed by small-holders on the basis of 5 acres to a family. Allowing 5 persons per family, the number of persons who could be settled on this paddy scheme would be over 110,000. When considered together with the attendant non-farming families required to provide services to the settlers, the movement of the total population involved would be a huge undertaking which might take many years to achieve.

One of the major handicaps likely to be felt in the development of the Kinabatangan plains is the lack of labour force. The population of the whole valley is estimated 25,000 people at present. Most of the men are engaged in the timber industry, in logging camps, etc. and agricultural pursuits are carried out almost entirely by the women. There is yet no wet paddy planting experience in the area, except at Bukit Garam Pilot Farm, as only hill paddy has been planted so far.

For successful paddy cultivation by individual farmers who, in general, will not have had any previous experiences, a considerable extension work, especially in farm mechanization and rice mill operation, would be required to be carried on with in a long term with serious efforts.

It may, therefore, be desirable to consider commercial paddy-planting in large scale, farming utilizing machinery and a minimum of man-power (refer to Table V-54). Thus, training facilities for autonomous commercial base organigation employees and the workers in the experimental pilot farm would have to be established very early in the development programme.

11.5 PRICE PROSPECT OF RICE

According to the development plan of the project, the Sabah will attain self-sufficiency of rice in 1990/91. Afterwards, domestic production will exceed domestic demand of rice and the surplus including the rice produced by the project would be exported abroad. International market price of rice, therefore, be applied for the price of rice produced by the project.

Forecasted prices of rice in 1980 constant dollars and in current dollars in the international market projected by the International Bank for Reconstruction and Development (IBRD) are given in Table V-55 and V-56 together with actual data in the past. Price of rice goes up gradually until it becomes almost constant in 1990 at the price of US$575 per ton in 1980 constant dollars.

In the short range of the foreseable future, as IBRD forecasts, demand and supply of rice will be in balance at 2.6%. In the long range, however, demand seems to be stronger than supply. World population has been increasing rapidly and the growth rate is likely to remain high in the future. As shown in Table V-57, annual growth rate of the world population will double after 35 years. The corresponding figure for developing countries where more than half of rice was consumed and more than three fourths of internationally traded rice was imported in 1977, is 2.60%. The total population of these countries will double after about 26 years. On the other hand, agricultural production including rice production is expected to expand at a slower rate than population growth.

It is expectable, therefore, that in the long run demand for rice will remain continuously bigger than its supply. Under the circumstances, the rice price would be kept at high level in the long run.

The economic mill gate price of rice which will be produced by the project is estimated on the basis of the international market prices for 1990 at 1980 constant dollars as projected by the IBRD, taking associated costs such as transportation cost from the project area to Sandakan into consideration. The details are given in Table V-58.

11.6 PRICE OF FARM INPUTS FOR RICE PRODUCTION

According to the IBRD price forecast published in June 1981/1, economic and financial prices of fertilizers will steadily go up from 1980 till 1990 as shown in Tables V-55 and V-56. Economic and financial prices of fertilizers for the Project are estimated based on the said forecast. Economic and financial prices of agro-chemicals for the project are estimated on the assumption that they will follow a similar price trend as fertilizers. The economic and financial farm gate prices of the farm inputs are given in Table V-59.

/1: "Mid-year updating Commodity Price Forecast", IBRD, June 1981

12. COST ESTIMATE

The necessary information for estimation of agricultural development has been collected from various sources, i.e. Department of Agriculture, DID, Paddy Board and Quantity Section of Public Works, and was thoroughly examined and discussed by the Survey Mission in coolaboration with the counterpart staff. The project cost has been estimated based on current prices in 1981. The conversion rate from Malaysian currency to foreign currency is M$2.3 = US$1.

The difference between the fund requirement and economic price amounts derives principally from the variance in market and economic prices of diesel oil, which are estimated at M$0.50 and M$0.70 respectively.

The total required costs for agricultural development are indicated in Tables V-60 and V-61 for the fund requirement and economic price, respectively. The said tables also include amounts required for resettlement and land acquisition relevant thereto.

Adopting the internationally accepted procedures with similar projects, the engineering fee has been set at 10% of direct cost. Of this amount, 80% is to be rendered in foreign currency and 20% in local currency. Physical contingency has been determined at 10% of direct cost.

12.1 CONSTRUCTION SCHEDULE

As for the construction schedule for developing the net agricultural land of 44,000ha, a rapid development schedule was adopted from the economic viewpoint and the paddy could be planted as early as technically possible following protection from flood damage through dam construction.

During the dam construction period, paddy cultivation in the off-season will be possible because the habitual flood will occur during main season only.

Therefore, single cropping in the off-season will continue until 12th year of construction, and after completion of the dam, double cropping will be implemented as projected.

Accordingly, an entire construction period for agricultural development will require at least for 8 years. The construction schedule covering all the stages is shown in Fig. V-24.

The net development area will be divided into 7 portions namely land development group for stepwise development. Each portion will be developed within three years including jungle clearing, land levelling, construction of irrigation and drainage facilities and farm road network, constructon of pumping stations and office buildings etc. in the given order.

12.2 LAND DEVELOPMENT COST

As is indicated in Table V-62, the total cost for land development was estimated at US$231.5 million. It includes the cost for principal construction work, i.e. jungle clearing and levelling, construction of irrigation and drainage facilities and farm road network, etc., as well as a 10% provision for temporary/preparatory works.

12.3 CONSTRUCTION COST OF PROCESSING, STORAGE AND OFFICE FACILITIES AND WORKSHOPS

Cost required for construction of a pilot farm, processing facilities, storage, office facilities and workshops are estimated to total M$202 million. The breakdown of the costs is given in Table V-63 and Table V-64.

12.4 INITIAL FARM INVESTMENT

The initial farm investment comprises the procurement cost of farm machinery required for the initial operation of the project.

The initial farm investment amounts to M$128 million. The breakdown of the procurement cost of farm machinery and equipment is given in Table V-65.

12.5 REPLACEMENT OF THE INVESTMENT FACILITIES

Economic life of each type of facilities included in the initial investment is assumed as follows:

1)	Buildings	50 years
2)	Rice Mill Plant	10 years
3)	Equipment of Workshops	10 years
4)	Equipment of Pilot Farm	10 years
5)	Farm Machinery	7 years

12.6 ANNUAL DISBURSEMENT SCHEDULE

The total project cost for agricultural development is summarized in Table V-60. The total cost ammounts to US$279.6 million in foreign currency component and US$180.4 million in local current component.

The annual disbursment schedule of agricultural development cost is given in Table V-66.

12.7 ECONOMIC PRODUCTION COST

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

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

2) O&M cost of rice mills,
3) O&M cost of irrigation & drainage facilities, and
4) Administration cost.

The said cost at the full operation stage is estimated at M$125 million which consists of M$42 million in the foreign currency component and M$83 million in the local currency component. The details of the production cost are shown in Table V-67.

12.8 NET VALUE WITH THE PROJECT

At the full operation stage, 239,360 tons of milled rice and 31,680 tons of rice bran will be produced by the project.

On the basis of the unit prices of rice and rice bran, M$1,242/ton and M$417/ton respectively, the gross production value is estimated at M$310 million (refer to Table V-68). The net production value of the project is estimated to be M$180 million by deducting the production cost of M$125 million (M$2,854/ha) and damages cost of M$8 million due to the flooding over a 20-year return period from the gross production value (refer to Table V-69).

13. NATURAL ENVIRONMENT IMPACTS

Implementation of this project may bring about some impacts to the natural environment in the Kinabatangan River Basin, as mentioned below:

1) Micro-climate

The micro-climate conditions of the area such as the rate of evapotranspiration and radiation heat may widely change due to land use conversion : jungle with a canopy of 20-30 m is to newly form paddy field.

2) Soil Erosion

Cover vegitation will be removed so as to create a cultivable land, which may cause more serious soil erosion than that before the project.

3) Water Pollusion

Chemical fertilizers, insecticides, pesticides, herdicides, etc. are used extensively for cultivation of paddy rice. These agricultural chemicals become a source of water pollution, so that the fishing industry and sanitary of people along the river course may be deteriorated.

A long-term study will be required, because of many unknown factors now, to clarify these impacts in quantitative terms. These impacts to the project area should be carefully studied in the next study stage.