

WOSSAC: 42584

GOVERNMENT OF MALAYSIA
GOVERNMENT OF THE NETHERLANDS

REGIONAL ECONOMIC DEVELOPMENT PLAN
FOR THE STATE OF TRENGGANU

VOLUME 2

- ANNEX I - GEOLOGY AND GEOMORPHOLOGY
ANNEX II - CLIMATE AND HYDROLOGY
ANNEX III - LAND AND SOILS
ANNEX IV - CROP AND LIVESTOCK PRODUCTION

December 1968



International Land Development
Consultants - ILACO N.V.
Arnhem

Netherlands Engineering
Consultants - NEDECO
The Hague

Dutch Technical Aid Mission

GOVERNMENT OF MALAYSIA

Government of the Netherlands

REGIONAL ECONOMIC DEVELOPMENT PLAN
FOR THE STATE OF TRENGGANU

VOLUME II

- ANNEX I - GEOLOGY AND GEOMORPHOLOGY
- ANNEX II - CLIMATE AND HYDROLOGY
- ANNEX III - LAND AND SOILS
- ANNEX IV - CROP AND LIVESTOCK PRODUCTION

December 1968

Code 4103

International Land Development
Consultants - ILACO N.V.
Arnhem

Netherlands Engineering
Consultants - NEDECO
The Hague

Dutch Technical Aid Mission

ANNEX I

GEOLOGY AND GEOMORPHOLOGY

CONTENTS

	<u>Page</u>
1 THE GEOGRAPHIC SETTING	1
2 SHORT OUTLINE OF THE GEOLOGY	2
2.1 General	2
2.2 The Geology of the State of Trengganu	2
2.2.1 The Old Sedimentary Rocks	2
2.2.2 The Igneous Rocks	3
2.2.3 Younger Sediments	3
3 THE MAJOR GEOMORPHOLOGICAL UNITS	
3.1 The Complex of Alternating High-lying Beach Ridges and Lower-lying Shallow Troughs	4
3.2 Tidal Flats	5
3.3 The Coastal Plain	5
3.4 The Uplands	6
3.5 The Steepland	7
LIST OF REFERENCES	8

ANNEX I

GEOLOGY AND GEOMORPHOLOGY

1 THE GEOGRAPHIC SETTING

The State of Trengganu, which is situated in the eastern part of the Malay Peninsula, extends approximately between latitude 4°N and latitude 6°N and from longitude 102°30'E to longitude 103°30'E.

More or less elliptical in shape the State covers a total area of approximately 5,020 square miles or 3.2 million acres.

At the western (landward) side Trengganu is separated from the adjacent States of Kelantan and Pahang by a boundary which follows the watershed. The eastern side of the country faces the South China Sea over its entire length of 140 miles.

Except the limited occurrence of mud flats and mangrove swamps in the tidal reaches of river-mouths the coastal landscape is dominated by long sandy beaches with a few rocky spurs of the Trengganu Uplands.

The main rivers are the Sg. Besut, the Sg. Trengganu, the Sg. Chukai and the Sg. Kemaman. These rivers show signs of variable maturity such as meanders, ox-bows and levees. All of them debouch direct into the South China Sea. Because of their smaller discharges the lower courses of a number of minor streams run in a northward direction, parallel with the coast, generally following the troughs between the beach ridges.

The interior of the State consists of hilly uplands and mountainous steepland.

A number of islands are located in front of the coast.

The population is concentrated in the coastal area which comprises approximately 10 per cent of the total area.

The plain of Kuala Trengganu ranks among the earliest settled areas of Malaya, but the barrier of the Main Range and the Trengganu steepland caused the State as such to be strongly isolated from the rest of Malaya.

Administratively the State is divided into 6 districts viz. from North to South, Besut, Kuala Trengganu, Ulu Trengganu, Marang, Dungun and Kemaman. Each district is sub-divided into mukims, which in turn comprise a number of kampongs.

2 SHORT OUTLINE OF THE GEOLOGY

2.1 General

The structural framework of Malaya got its shape during the Jurassic and/or Cretaceous (1,2,3). As a result of orogenic forces associated with the emplacement of granites the Malayan land mass emerged from the sea. The granites intruded into and cropped up from the original Palaeozoic and Mesozoic cover of sedimentary rocks that once formed the floor of the sea.

The granites form the principal mountain ranges of the country. They caused the intense folding of the older sedimentary rocks which now occur along the flanks of these ranges and in the intervening, lower-lying areas (4). The boundary between Kelantan and Trengganu (4) e.g. is formed by such a range.

Volcanic activity has occurred throughout Malaya but it concentrated in the East Coast States. The outcrops are not very extensive, except for a well-marked Eocene (2) basalt lava flow near Kuantan in Pahang (4).

Sediments which have accumulated since the emplacement of the granite are mainly of Holocene and Pleistocene ages, and, to a very small extent, of Tertiary age.

2.2 The Geology of the State of Trengganu

The geological strata of Trengganu may be divided into three main groups :

- the old sedimentary rocks
- the igneous rocks
- the young sediments.

2.2.1 The Old Sedimentary Rocks

These rocks may be of the argillaceous, arenaceous or rudaceous types (5).

The argillaceous rocks mainly consist of shales but silt and mudstones are also found. They represent the oldest (Low Carboniferous) formation.

The arenaceous rocks have attained great development in Trengganu. Thermally metamorphosed they chiefly appear as quartzites, but hornfels or slate may be found locally. When non-metamorphosed they include sandstones, grits, greywackes, conglomerates, etc. Especially the latter three are well-exposed in the valley of the Sg. Setiu. Interbedded with the arenaceous rocks are lenses and bands of shale and quartz.

The rudaceous rocks comprise both conglomerates and pebble beds. In parts of North Trengganu they have achieved great thickness and linear extent as between Kuala Besut and Kuala Merang. On the eastern side of the Besut valley they are strongly folded.

2.2.2 The Igneous Rocks

These rocks are either of volcanic or of plutonic origin, the latter having the greatest extent.

The plutonic rocks consist of granites and associated rocks, found as a series of more or less parallel ranges, running approximately North-South.

The common types of rocks are grey porphyritic granite, granodiorite, quartz diorite and diorite. Minor intrusions of mainly quartz porphyry occur in the granites (2). Syenite occurs on the Perhentian Islands.

The granites are considered to be either Jurassic or late Cretaceous.

Igneous rocks of volcanic origin are almost entirely rhyolite, dacite, andesite and quartz-andesite.

Hardly folded remnants of an extensive basalt lava flow of lower Tertiary age are extensively found in the Kuantan Area in Pahang and, to a minor extent, in the South of Trengganu.

Small dolerite dykes associated with the basalt cut the granite at various places (2).

The volcanic rocks are hard, dark-coloured and finely crystalline. They contain a high proportion of minerals rich in iron (4).

2.2.3 Younger Sediments

Sediments which have accumulated since the emplacement of the granite are of Pleistocene and Holocene ages. They are found either as marine, fluvial or swamp deposits.

3 THE MAJOR GEOMORPHOLOGICAL UNITS

Within the State of Trengganu 5 broad physiographic units have been distinguished, viz.:

- the complex of beach ridges and elongated shallow troughs
- the tidal flats
- the coastal plain
- the undulating rolling and hilly uplands
- the steepland.

3.1 The Complex of Alternating High-lying Beach Ridges and Lower-lying Shallow Troughs

The beach ridges form a series of distinct, parallel sandy ridges, generally occurring close together and separated by elongated depressions which function as drainage channels.

The height of the ridges is between 10 and 15 feet near the sea (young beach ridges) and increases landward (inland beach ridges). Heights of approximately 30 feet occasionally occur, e.g. south of Chukai.

Observations along the East Coast have shown that beach ridges build themselves up to a maximum height of 10 to 15 feet above sea level when situated adjacent to the coast.

Greater heights then point to their originating when the sea level was higher. The maximum height of the inland beach ridges being 35 feet, it may be concluded that there has been a relative fall of the sea level of 20 feet or less. This relative fall should be ascribed to a Holocene eustatic withdrawal of the sea (2, 6, 7, 8, 9).

The beach ridge deposits are marine and do not contain clay, and, in many cases, neither silt.

The material forming the ridges mainly originates from capes where the interior hills abut on the coast and fresh rock is exposed to marine abrasion. Current and beach-drifting may transport the abrasion products over considerable distances.

The beach ridges start as spits, bars and tombolas on the leeward side of exposed headlands. The bars extend under the influence of waves and currents and link up a number of cores, islands, capes and even small rock stacks and submerged cliffs. Tidal flats may act as a basis on which the bars accumulate. Consequently, tidal flats deposits (clay, sandy clay) underlie the beach ridges at many places.

Recently emerged bars and spits are separated from the mainland by a creek or narrow lagoon. The growing spit pushes the mouth of the creek further along the beach and in order to remain open to the sea the creek erodes the beach near its mouth. Ultimately the creek is silted to form a muddy trough which separates one sand ridge from another.

3.2 Tidal Flats

In the proximity of river outlets large quantities of fluvial sediments are discharged. Being deprived of its coarser constituents the sedimentation load mainly consists of silt and clay. As the sea is shallow near these outlets and the supply of sediment is large, tidal flats are readily formed there. The tidal flats generally bear a mangrove vegetation though nipah may occur.

3.3 The Coastal Plain

The development of the Coastal Plain (Plate I-1/II-1 is greatly influenced by the geological events that took place in Malaya in the past.

During the Pleistocene, the sea level in Malaya is known to have fluctuated between - 400 and + 230 feet (2). As the repeated regressions of the sea caused accelerated erosion and scouring away of earlier high-level deposits (fluvial and marine), their presence in the present landscape is rather restricted.

After the last post-glacial rise in sea level, the sea washed against the core of igneous and sedimentary rocks which formed the Malaya Peninsula. The existing rivers and bays were fully submerged (6). A number of offshore islands were formed and the principal river mouths became broad estuaries penetrating far inland (2). It seems likely that the formation of the present inland beach ridges started when the sea-level was still some 20 feet higher than at present. The ridges obstructed the estuaries and bays completely, often by connecting islands with the mainland, thus producing the first 'blocked' areas. Emergence of these areas followed because of rapid filling with alluvial sediment. Geological features of the tectonically stable coast around the Pacific and the Indian Ocean tend to confirm that a fall of the sea level occurred in the late Holocene (10).

The observations made on the East coast of Malaysia by Nossin (2, 6, 7, 8, 9) also point to a recent eustatic fall of 20 feet or slightly less.

Simultaneously with the withdrawal of sea, lower-lying beach ridges were formed and more areas were cut off until the present configuration came into existence (6).

Most of the discharge of the uplands and the steep land was effected by rivers which were debouching in the 'blocked' areas. The large rivers were able to maintain their outlets direct through the developing spits and beach ridges. Some of the minor rivers, however, have not been able to do so; they disappeared into the 'blocked' areas.

The formation of the beach ridge barrier has not only strongly prevented the ingress of sea water into the 'blocked' areas

but also impeded the seaward flow of sediment-loaden river-water, which resulted in the gradual aggradation of the entrapped areas. During the process of filling, the principal rivers extended their courses over the newly formed flats. Thus, levees were formed on either side of the river courses with lower-lying basins extending behind them.

Many of the basins thus formed have a strongly impeded external drainage bordered as they are by beach ridges on their seaward side and by levees and upland hills on their landward side. As they are prone to regular inundation and, moreover, consist of impervious clay, nearly all the water is retained which causes hydromorphic characteristics (swamps) to develop.

Since the rivers shifted their courses frequently, a large part of the former estuarine of bay areas consist of relatively higher-lying, non-swampy grounds. These are either levees or the highest parts of basins.

All fluviatile deposits have a high silt content.

Within the riverine parts of the Coastal Plain several terrace levels are distinguished, which may well correspond with stationary stages in the regression of the sea. Coastal terraces were found on several islands further offshore (6).

3.4 The Uplands

Between the steepland and the coastal plain (Plate I-1/II-1) an area of undulating, rolling and hilly land is found, consisting of the weathering products of igneous rocks.

A conspicuous feature of the uplands is the dissection of the terrain, especially in areas which are underlain by sedimentary rocks.

Governed, of course, by the process of weathering, the type of parent rock subjected to this process and the degree of erosion which greatly depends on the slope of the regolith are also factors which influence the formation of the relief. Although, in general, the hill and mountain slopes are and were clad with dense tropical rain forest the colluvial removal of the upper part (the soil part) of the regolith has not been prevented. The present landscape points to a long period of erosion. Regional differences are mainly attributable to the variations in rock type.

Associated with the dissected erosion surface are the valley tracts : the middle part of stream courses with moderate slope-gradients and fairly wide valleys. In approaching the coastal plain these valley tracts gradually widen and change into rivulets and rivers which are often flanked by terraces.

Where granite rock underlies the landscape, the latter is characterized by a number of pronounced hills with rounded tops. The drainage pattern as formed by the valley tracts is radial in shape.

Where Argillaceous and Arenaceous rocks form the substratum of the regolith, the dissection of the terrain is more intricate as compared to that of areas underlain by granite. The pattern of the drainage system is dendritic instead of radial and the number of valley tracts is far greater, which causes the landscape to obtain a more broken appearance. The more rugged appearance of the sedimentary areas is also due to the fact that their initial relief was more pronounced because they were folded and subjected to erosion for a longer period.

In comparison with the sedimentary rocks both granite and basalt (the latter occurring in the South of Trengganu) are geologically younger. Especially the basalt has had a very subdued relief right from the beginning. Although the landscape of the basalt area is not as rugged as that of the sedimentary areas it is strongly dissected by narrow, well-defined valleys. Its drainage pattern is also dendritic.

The individual hills of the Uplands seldom rise to more than 250 feet above the coastal plain. The configuration of the terrain points to the occurrence of a strongly dissected erosion surface. The slopes of the hills generally vary from 5° to 20° .

3.5 The Steepland

The mountains of the steepland are characterized by their long slopes generally exceeding 25° and their comparatively great heights.

The hills of the uplands seldom rise to more than 250 feet, whereas the mountains of the steepland may rise to 5000 feet.

The transition from the undulating, rolling or hilly uplands to the predominantly steep and very steep mountainous country of the steepland is very obvious and rather abrupt. This indicates that the so-called steepland boundary coincides with the edge of an old erosion surface.

The rock formation of the individual mountain ranges determines their shape. Granite mountains often have a more or less pyramidal form; their spurs branch off radially from a rather pointed top. The shape of mountains which consist of sedimentary rock is mostly elongated with their spurs branching off laterally from a ridgy summit.

LIST OF REFERENCES

- (1) Fitch, F.H. (1952)
- The geology and mineral resources of the neighbourhood of Kuantan, Pahang. Geological Survey (Malaya) Memoir No 6.
- (2) Nossin, J.J. (1964)
- Geomorphology of the surroundings of Kuantan (Eastern Malaya). *Geologie en Mijnbouw*, Vol. 43, no. 5, p. 157-182.
- (3) Mac-Donald, S.
(not yet published)
- The geology and mineral resources of North Kelantan and North Trengganu. Dept. of Geol. Survey, Ministry of Land and Mines.
- (4) Panton, W.P. (1961)
- Topography, geology and soils. Malayan Forest Records no 23, Part II - environmental factors and tree properties, p. 2/1-2/21.
- (5) Leamy, M.L. and
Panton, W.P. (1966)
- Soil Survey Manual for Malayan Conditions. Ministry of Agriculture and Co-operatives. Div. of Agr. Bull. no 119
- (6) Nossin, J.J. (1961)
- Relief and coastal development in North-Eastern Johore (Malaya). *Journ. of Trop. Geography*, Vol. 15, p. 27-38.
- (7) (1962)
- Coastal sedimentation in North-Eastern Johore. *Zeitschrift für Geomorphologie, Neue Folge*, Band 6, p. 296-317.
- (8) Nossin, J.J. (1964)
- Beach ridges on the East coast of Malaya. *Journ. of Trop. Geography*, Vol. 18, p. 111-117.
- (9) (1965)
- The geomorphic history of the Northern Pahang Delta. *Journ. of Trop. Geography*, Vol. 20, p. 54-64.

(10)

(1965)

- Analysis of younger beach ridge deposits in Eastern Malaya. Zeitschrift für Geomorphologie, Neue Folge, Heft 2, Band 9, p. 186-208.

ANNEX II

CLIMATE AND HYDROLOGY

CONTENTS

	<u>Page</u>
1 CLIMATE	1
1.1 General	1
1.2 Rainfall	1
1.3 Other Climatological Factors	3
1.3.1 Temperature and Relative Humidity	3
1.3.2 Wind Speed	3
1.3.3 Sunshine	8
1.3.4 Evaporation	9
2 HYDROLOGY	9
2.1 Introduction	9
2.2 Floods and Flood Control	11
2.2.1 Floods	11
2.2.2 Flood Control	12
2.2.2.1 Sg. Besut	13
2.2.2.2 Sg. Trengganu	13
2.2.3 Recommended Action	15
3 HYDRO-METEOROLOGICAL NETWORK	15
LIST OF REFERENCES	17
FIGURE 1 - Rainfall-Duration-Frequency Curves	
Jerteh and Pasir Akar	4
Ayer Puteh	5
Sungei Tong	6
Pulau Musang	7

ANNEX II

CLIMATE AND HYDROLOGY

1 CLIMATE

1.1 General

The major characteristics of the climate are a high annual rainfall total, a high relative humidity of the air and an equable temperature throughout the year.

Of importance is the prevalence of a north-east and a south-west monsoon separated by intermonsoonal periods. The onset of the north-east monsoon is usually at the middle of November; the period lasts until the beginning of March. During May the south-west monsoon becomes well-established. The transition period to the north-east monsoon falls mainly in October.

The monsoonal seasons are clearly reflected in the annual rainfall pattern, in the wind velocity values, in the duration of bright sunshine and also in the magnitude of the evaporation.

Although a substantial number of rain gauges has been installed within the State, reliable data over long periods are lacking. As compared to the coastal area fewer rainfall stations are located in inland areas; in the stepland area proper they are almost absent. Climatological records other than rainfall are only available for Kuala Trengganu and Kota Bharu (Kelantan).

The location of the meteorological stations, the data of which have been used for a more detailed study of the climate, is shown on Plate I-1/II-1. The stations concerned are: Kota Bharu, Jerteh, Pasir Akar, Sg. Tong, Pulau Musang, Kuala Brang, Kuala Trengganu, Jerangau, Bukit Besi and Ayer Puteh.

1.2 Rainfall

The annual rainfall total normally attains a value of about 120 inches, at least in the coastal area; heavier precipitation is experienced in foot-hill areas (160 inches).

The variation in values for a specific month over a number of years is large. Table 1-1 on the next page gives an indication of the distribution and variation of the monthly rainfall for Kuala Trengganu and Kuala Brang.

Table 1-1 - Rainfall (1) at Kuala Trengganu and Kuala Brang (in inches) *low many years?*

Month	Average		Maximum		Minimum		Number of rain-days *
	Kuala Trengganu	Kuala Brang	Kuala Trengganu	Kuala Brang	Kuala Trengganu	Kuala Brang	
January	10.3	18.5	55.7	56.4	1.7	0.9	19
February	5.6	10.5	25.2	29.4	0.6	1.6	12
March	6.8	6.8	21.4	25.5	0.4	0.4	13
April	5.8	5.6	24.3	20.0	0.7	1.0	11
May	5.2	8.5	9.2	15.3	2.9	2.6	12
June	4.7	7.8	9.7	15.7	0.5	1.7	11
July	4.7	8.0	11.1	12.8	1.5	1.3	12
August	6.2	10.0	12.9	20.9	3.0	3.3	12
September	7.1	13.6	12.0	26.5	3.4	7.2	17
October	12.8	14.7	32.2	29.8	7.5	4.8	20
November	24.5	21.7	43.0	40.0	6.6	9.9	21
December	23.3	28.8	57.6	49.9	2.2	7.0	23
Year	121.3	152.6	184.0	201.7	81.9	98.7	184

* For Kuala Trengganu only.

To characterize the rainfall in more detail 'rainfall-frequency-duration' curves have been prepared. This has been done for:

- the stations Jerteh and Pasir Akar; owing to paucity of records of the individual stations, the data of the two stations have been combined by means of the 'station-year-method' (2)
- Pulau Musang
- the stations Sg. Tong, Jerangau and Bukit Besi; in this case, too, the relevant data have been combined (2)
- Ayer Puteh.

To prepare the curves daily readings have been mechanically processed, whereby overlapping periods have been taken into account. In assessing the rainfall expectations for the wet periods, daily readings covering the period September-March have been used. To obtain an insight into both frequency and duration of dry periods the daily data for the period January-August have been analyzed. The results are given in Figure 1 (in 4 sheets) next to this page.

A comparison of the relevant curves reveals that during the north-east monsoon the rainfall tends to be lowest at the station of Ayer Puteh. Ranking next to this station is the Besut Area (Pasir Akar, Jerteh). Highest rainfall during the north-east monsoon is to be expected at the station of Pulau Musang. As compared to the inland stations of Sg. Tong, Jerangau and Bukit Besi the differences in precipitation quantities are small.

During the south-west monsoon (dry period) the situation reverses. A slightly higher rainfall is to be expected at the last-mentioned stations than at Pulau Musang.

1.3 Other Climatological Factors

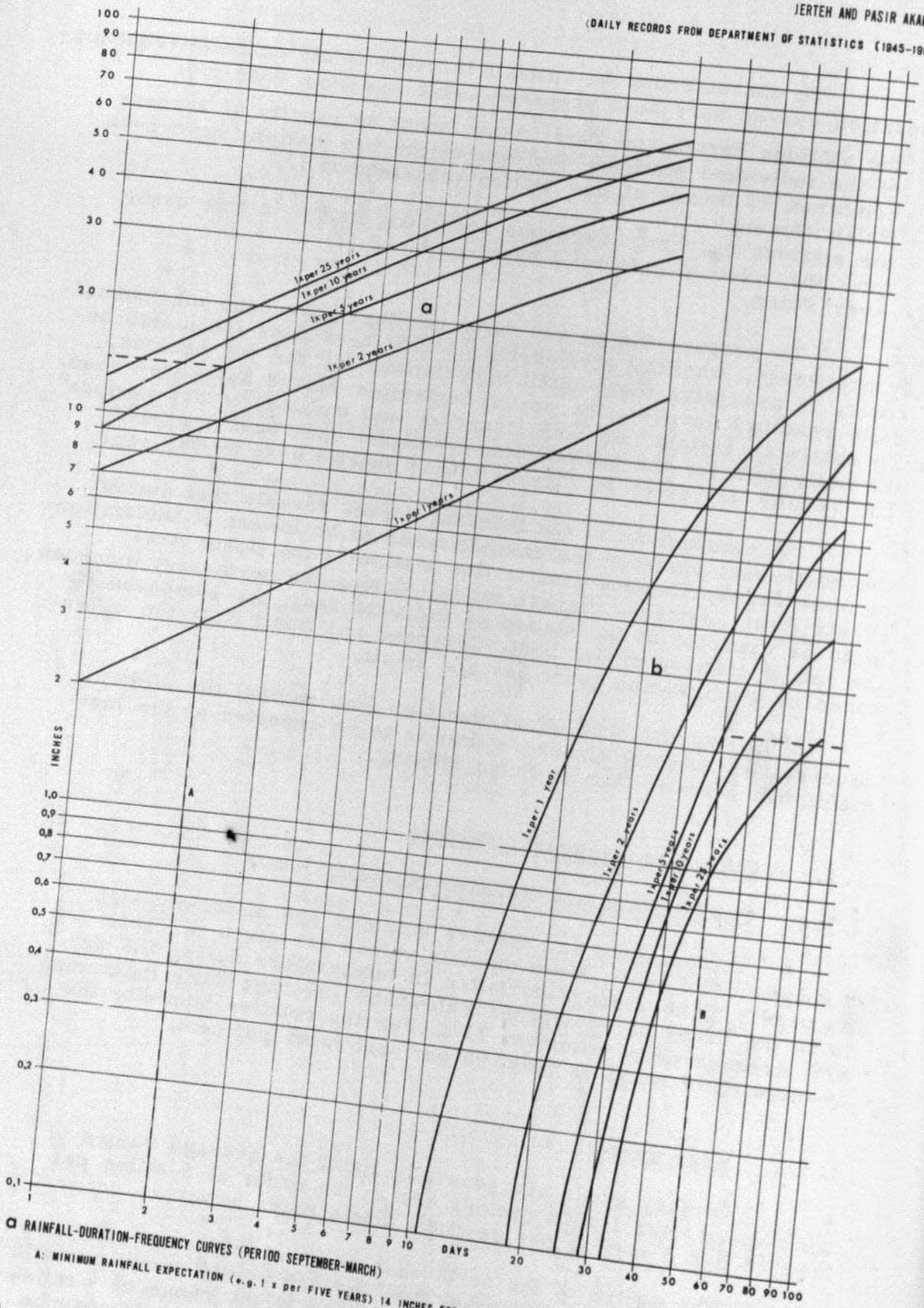
1.3.1 Temperature and Relative Humidity

Temperature and relative humidity are uniformly high throughout the year. Mean monthly values are given in Table 1-2 on page 8. The average variation in temperature during the day is in the order of 14 degrees Fahrenheit (average daily maximum 87°; average daily minimum 73°). For the relative humidity the average daily range is from 98 per cent to 65 per cent.

1.3.2 Wind Speed

Surface winds are generally light; the average values of wind speed over longer periods are in the order of 5 miles per hour (2.0-2.5 metres per second). Gusts may, however, occur.

The period of the north-east monsoon forms an exception and especially during December and January strong winds prevail. The average wind velocity values are then in the range of 9 miles per hour (4 metres per second) but at times wind speeds may be much higher.

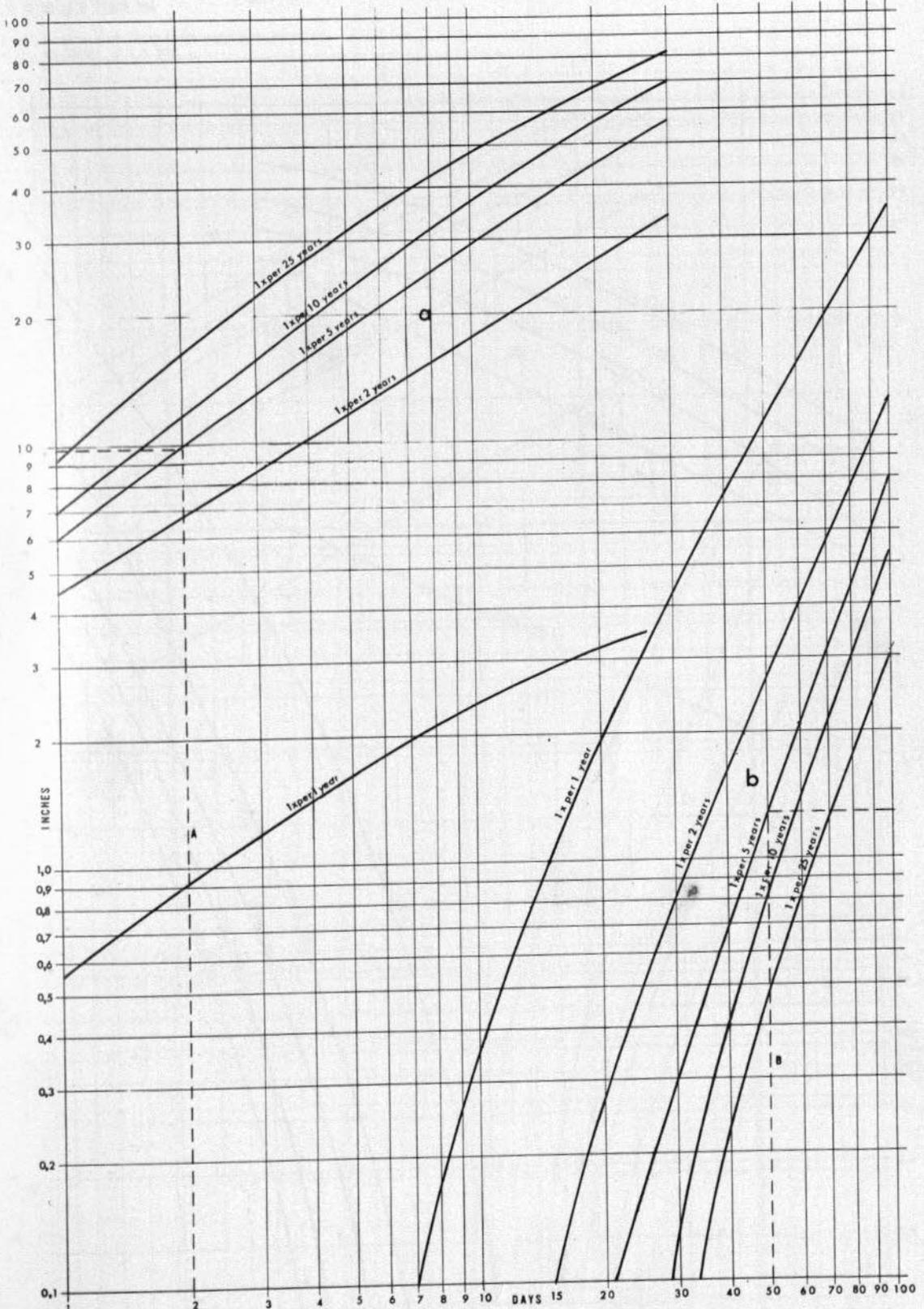


a RAINFALL-DURATION-FREQUENCY CURVES (PERIOD SEPTEMBER-MARCH)
 A: MINIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 14 INCHES FOR A 2-DAYS PERIOD

b RAINFALL-DURATION-FREQUENCY CURVES (PERIOD JANUARY-AUGUST)
 B: MAXIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 2.2 INCHES FOR A 50-DAYS PERIOD

FIG 1
(SHEET 1)

(DAILY RECORDS FROM DEPARTMENT OF STATISTICS 1957-1966)



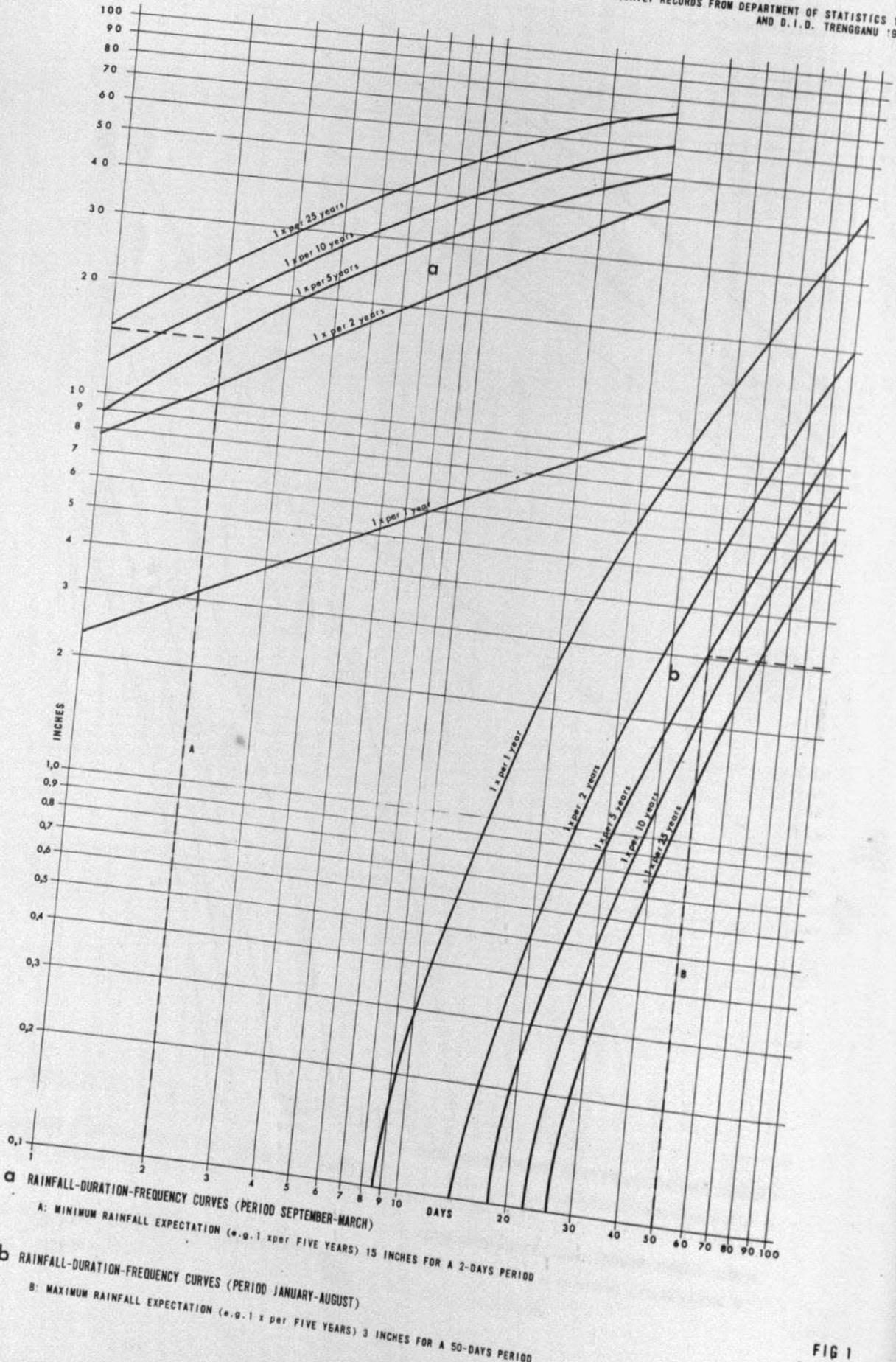
RAINFALL-DURATION-FREQUENCY CURVES (PERIOD SEPTEMBER-MARCH)

A: MINIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 9.6 INCHES FOR A 2-DAYS PERIOD

RAINFALL-DURATION-FREQUENCY CURVES (PERIOD JANUARY-AUGUST)

B: MAXIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 2.5 INCHES FOR A 50-DAYS PERIOD

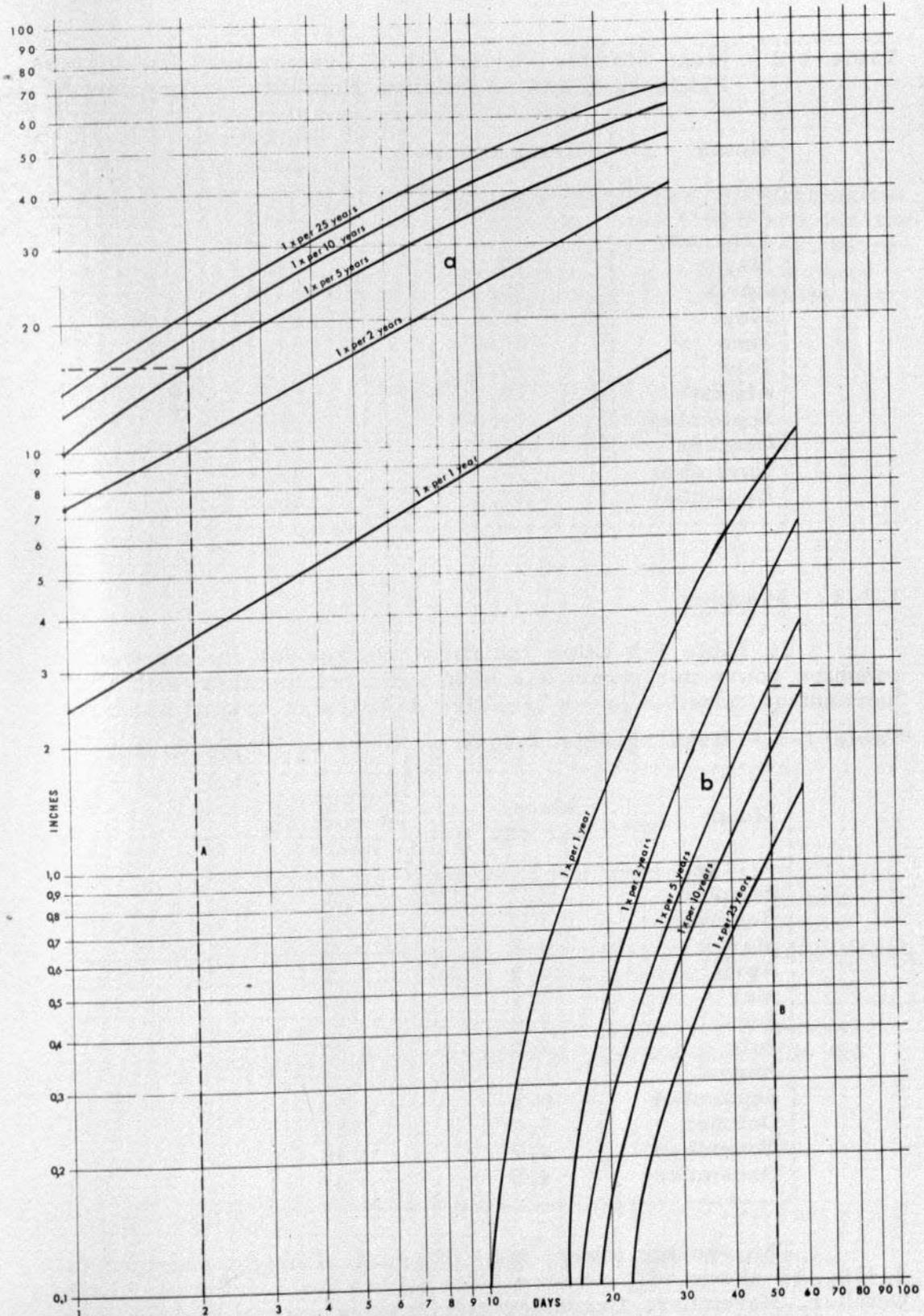
FIG 1
(SHEET 4)



a RAINFALL-DURATION-FREQUENCY CURVES (PERIOD SEPTEMBER-MARCH)
A: MINIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 15 INCHES FOR A 2-DAYS PERIOD

b RAINFALL-DURATION-FREQUENCY CURVES (PERIOD JANUARY-AUGUST)
B: MAXIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 3 INCHES FOR A 50-DAYS PERIOD

FIG 1
(SHEET 3)



a RAINFALL-DURATION-FREQUENCY CURVES (PERIOD SEPTEMBER-MARCH)

A: MINIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 15.5 INCHES FOR A 2-DAYS PERIOD

b RAINFALL-DURATION-FREQUENCY CURVES (PERIOD JANUARY-AUGUST)

B: MAXIMUM RAINFALL EXPECTATION (e.g. 1 x per FIVE YEARS) 2.8 INCHES FOR A 50-DAYS PERIOD

Table 1-2 - Mean Monthly Values (1) of Temperature (in degrees Fahrenheit) and of Relative Humidity (in per cent)

Month	Temperature	Relative humidity
January	77.4	84.8
February	77.9	84.7
March	79.3	84.5
April	80.4	84.5
May	80.6	84.7
June	80.0	84.7
July	79.5	85.2
August	79.2	85.2
September	79.0	85.6
October	78.5	87.4
November	77.7	88.9
December	77.3	86.9

1.3.3 Sunshine

In Table 1-3 below the daily average for the number of sunshine hours per month has been indicated together with the 'percentage possible hours (relative duration of bright sunshine)'.

Table 1-3 - Mean Monthly Values of Hours of Bright Sunshine (1)

Month	Hours per day	Percentage of possible hours
January	5.7	49
February	7.7	65
March	8.5	72
April	8.5	70
May	7.4	61
June	7.0	57
July	7.0	57
August	6.7	55
September	6.5	54
October	5.9	50
November	4.7	40
December	4.8	41

The average annual total of hours of bright sunshine is 2,460. As shown in the above table the values for the months of October, November, December and January are on the low side, in particular those for November and December. Notwithstanding the favourable annual total, the lack of sunshine during the north-east monsoon period will influence the oil palm yields.

The number of sunshine hours in any particular month may largely fluctuate.

1.3.4 Evaporation

Evaporation values have been computed from meteorological data such as temperature, relative humidity, wind speed and duration of bright sunshine by means of the energy balance method (meteorological data taken from Malayan Meteorological Service: Summary of Observations Kuala Trengganu and Kota Bahru). The results are given in Table 1-4 below.

Table 1-4 - Mean Monthly Values of Potential Evaporation

Month	Inches per month	Millimetres per day
January	5.3	4.4
February	5.7	5.2
March	6.6	5.4
April	6.7	5.6
May	6.2	5.1
June	5.8	5.0
July	6.0	4.9
August	5.8	4.9
September	6.0	4.9
October	5.4	4.4
November	4.6	3.9
December	4.5	3.7

The values mentioned represent the evaporation of a hypothetical completely saturated surface with the aero-dynamic and thermal properties of a short-cut grass cover with a reflection coefficient (albedo) of 25 per cent (3). The above defined evaporation is usually called the potential evaporation (symbol E_0).

Comparison of the above table with Table 1-1 indicates that the values for the potential evaporation exceed those for the months of April, May, June and July.

2 HYDROLOGY

2.1 Introduction

Apart from a number of small watersheds Trengganu has four large catchment areas, (Plate I-1/II-1), viz. Sg. Besut (335 sq. miles), Sg. Trengganu (1,770 sq. miles), Sg. Dungun (640 sq. miles) and Sg. Kemaman (810 sq. miles).

Over 75 per cent of the catchments are jungle-covered steepland; the remaining part is alluvial plain. The rivers meander strongly.

During the wet season large quantities of sediment are being carried downwards. In the northern part of the State, the river plain of the Sg. Trengganu included, the river sediment is comparatively coarse-grained and sand banks are found all along the river courses. In the southern part the sedimentation load consists of fine-grained material and sand banks do not occur at all or only locally (Sg. Dungun, Sg. Paka, Sg. Chukai, Sg. Kemaman).

During periods of floods sand is brought down and deposited in the sea just beyond the river mouths.

An appreciable number of hydrological gauging stations (49 river stick gauges, 5 water level recorders and 5 cableways) have been installed in the State. As with the rainfall stations, there is a lack of reliable data over longer periods. Moreover, there are unfortunately, no stage-discharge curves available in a number of cases.

For the larger rivers some characteristic discharge data are summarized in Table 2-1 below.

Table 2-1 - River Discharge Data (in cfs)

Rivers	Data on discharges	Maximum discharge	Average monthly minimum discharge (dry season)	Average minimum discharge 10-day period (dry season)
Sg. Besut (1)		50,000	310	250
Sg. Trengganu (2)		220,000	1,890	1,860
Sg. Dungun (3)		?	650	510
Sg. Kemaman (4)		?	800	680

- (1) Gauging stations Jerteh and Kg. Rantau Panjang (see Plates I-1/II-1); period of recording 1959, 1960, 1961, 1963, 1964, 1965.
- (2) Gauging stations Kuala Brang and Kg. Tanggol (see Plates I-1/II-1); period of recording 1948-1967 (the minimum flow data in the above table only relate to the period 1959-1965, excluding 1962).
- (3) Gauging station Kg. Jerangau (see Plates I-1/II-1); period of recording 1965, 1966, 1967 (limited number of records).
- (4) Gauging station Kuala Taylor (see Plate I-1/II-1); period of recording 1966 only.

For the Sg. Dungun and the Sg. Kemaman the data should be considered as highly approximative.

2.2 Floods and Flood Control

2.2.1 Floods

During the north-east monsoon, especially in the months of November, December and January, continuous heavy rain results in high discharges and often in flash floods.

In most rivers the discharges increase rapidly and the water levels reach bankful stage within 24 to 48 hours. Frequently, the rivers overtop their banks and local flooding occurs in the alluvial plains, threatening kampongs and padi fields. Very often these local floods are only of one or two days' duration, but sometimes the inundation lasts for seven days or more.

In particular the valleys of the Sg. Besut, Sg. Setiu, Sg. Nerus and Sg. Trengganu are affected. There is no simple explanation for this fact. One of the reasons might be that the catchment areas of the northern rivers include a larger proportion of steep-land than the rivers in the southern part of the State.

The worst flood on record occurred in December 1926, when the water level in the Sg. Trengganu reached an elevation of 60.5 feet above mean sea level (MSL) at Kuala Brang. The second flood in severity was the one of 1966/67 with a water level elevation of 53.2 feet above MSL at Kuala Brang.

The last-mentioned flood was caused by heavy rainfall in the periods 24th-30th December 1966 and 4th-11th January 1967. Rainfall totals were in the order of 40 and 70 inches for the Sg. Trengganu and Sg. Besut plains respectively. The flood of 1965 was also very severe, but of shorter duration than the 1966/67 flood.

Insufficient data are available to determine a relation between the inundation period and the losses incurred through the inundations. For the 1965 flood the total damage has been estimated at M\$ 4,500,000; for the 1966/67 flood a preliminary estimate of the damage is in the order of M\$ 15,000,000.

Based on data from stick gauge readings at Kuala Brang (DID gauging station, period of recording 1955-1966) the return period of peak water level elevations in the Sg. Trengganu has been determined by means of plotting these data on log-probability paper. By this procedure the return period works out at about 20 years. For this return period the above amount of M\$ 15,000,000 corresponds to an annual cost of M\$ 750,000. Based on this figure and on an interest rate of 6 per cent, the investment for a flood control project is expected not to exceed M\$ 12,500,000.

The above figure is only a very rough approximation, because no allowances have been made for losses of human lives, for work or rescue organizations, maintenance of the flood control works, etc. Moreover, it has to be taken into consideration that the value of the losses, expressed in M\$, will increase in the course of time as the development of the area proceeds.

2.2.2 Flood Control

It is stressed that insufficient data are available to give a detailed indication of possible flood control projects. Nevertheless, it might be useful to consider a number of steps that might be taken in this respect. A distinction is to be made between short-term measures such as the installation of a flood warning system and long-term measures for which large investment is required besides the collecting of additional hydrological data.

At present, a warning system is in operation for the Sg. Besut, the Sg. Setiu, the Sg. Trengganu and the Sg. Nerus. The system comprises the transmission by telephone of water level elevations from gauging stations located along upstream river stretches. The warning point for the Sg. Trengganu is Kuala Brang. However, since the flood peak in this river shifts from Kuala Brang to Kuala Trengganu within 12 hours, the time is very short to take the necessary measures to restrict damages and losses, or to render assistance to the population in the areas threatened by inundation. Moreover, the flooding at Kuala Trengganu usually starts at night as high tide during the months of November, December and January always occurs during the dark hours. The darkness hampers the taking of emergency measures.

There is a shortage of wireless transmitters. Pasir Akar, which fills the key position in the warning system of the Besut Valley, does not have a transmitter. Once the telephone connections are out of order, the whole warning system of the Besut Valley is rendered useless.

The DID Research Station has suggested that the following equipment (for locations see Plates I-1/II-1) should be installed:

- a telemetering water level recorder at the confluence of the Sg. Kerbat and the Sg. Trengganu near Kg. Pasir Berching
- three telemetering rainfall recorders at G. Lawit (4982 feet + MSL), G. Ganau (4518 feet + MSL) and Bt. Jetah (2235 feet + MSL)
- a relay station at G. Chirgoi (2804 feet + MSL) which will transmit all the data to Kuala Trengganu for interpretation and prediction
- several wireless transmitter sets; in any case one transmitter is required at Pasir Akar.

The investment costs of the above measures, including the installation of the equipment will be about M\$ 150,000. The annual maintenance and operation costs will amount to M\$ 15,000.

The long-term measures aim at the prevention of inundations, especially those caused by the Sg. Besut and Sg. Trengganu.

2.2.2.1 Sg. Besut

From the point of view of flood control the Sg. Besut may be divided into two parts, i.e. the parts upstream and downstream Jerteh.

The cross-section upstream Jerteh is more or less regular, but locally the banks are low. Below Jerteh the banks are generally very low; even at low discharges the river is nearly bankful.

Protection against floods can be achieved by the layout of dikes on the low stretches along the river upstream Jerteh, and dikes along both sides of the river downstream Jerteh. The top level of the dikes will have to be determined after careful study of the economic aspects in relation to the return period and damage.

2.2.2.2 Sg. Trengganu

It is quite likely that the capacity of the Sg. Trengganu is sufficiently high to evacuate up to some 30,000 cfs without causing inundations, some extremely low stretches in the embankments, e.g. near Kuala Telemong excepted.

With discharges below 30,000 cfs inundations may be easily prevented by closing off the low stretches in the embankments. With higher discharges the river overtops its embankment over nearly its whole length and to prevent inundations major works must be carried out, such as:

- the construction of dikes on either side of the entire river and/or of a spillway with a short-cut to the sea
- the construction of a flood retention reservoir.

The construction of dikes on either side of the river

There are two possibilities of realising the alignment of the dikes: either adjacent to the river or at some distance from the river. The choice cannot be made, until additional data have been collected and comparative cost estimates have been prepared.

The construction of a spillway

Possible locations for a spillway are Kg. Kubang Teras (East bank) or Kg. Getang Ulu (East bank). The Sg. Ibai which possibly has been a branch of the Sg. Trengganu in the past, should form part of the short-cut.

The construction of a flood retention reservoir

The opinion has been expressed that a hydro-electric power dam, which can be also used for flood control and water supply might be the solution. The Central Electricity Board has already made some investigations to find a possible site and carried out a feasibility study of such a dam (4). The possible site is at about 10 miles upstream Kuala Brang.

With regard to generating hydro-electric power it should be noted that the power demand in the State of Trengganu does not justify the construction of a power dam either at present or in the near future. According to information from the National Electricity Board a power dam in the Sg. Trengganu will not be justified before approximately 1990 and at that time only if the power demand on the West Coast of West-Malaysia exceeds the supply in that area.

One of the additional benefits of flood control by the construction of a retention reservoir might be the prevention of salt intrusion in the Sg. Trengganu.

At present this intrusion really poses a problem for the supply of drinking water since it affects the quality of the river-water at the intake at Pulau Musang. As the demand for drinking water will equal the capacity of the existing purification plant within a few years and the present site does not allow any extension, the PWD has planned a new intake and plant near Kg. Tapu. The latter is situated 16 miles upstream the river mouth and it is not expected that the saline wedge in the Sg. Trengganu will ever protrude so far.

The demands the river water has to meet for irrigation purposes are less stringent as those for drinking water. Only once during 6 years of observation* the daily 12-hour flow for the Pulau Musang Pumping Scheme (off-season padi irrigation) attained an average salt content exceeding 400 parts per million (ppm). A salt content of over 3,000 ppm occurs twice a month on an average during the off-season period and then only for a few hours.

This holds true in particular for the months of June and July during 'dry' years. Only when water with a high salt content is continuously diverted to the padi fields over a long period of time, a decrease in the padi yields may be expected.

Taking the foregoing aspects into consideration it may be concluded that construction of a dam with reservoir in the near future could only serve the purpose of flood control. The necessary investment will then by far exceed the amount needed for implementation of a project under which dikes at either side of the river and/or a spillway with a short-cut to the sea will be constructed exclusively serving the latter purpose.

* Data collected by the Public Works Department.

2.2.3 Recommended Action

The selection of an adequate solution to the flood control problem is complicated and time-consuming. Some alternatives have been mentioned which might be used as guidelines for further investigations. Much work will be required before definite conclusions can be brought forward. It is therefore recommended to start as soon as possible with the collecting of data, such as:

- longitudinal profiles and cross-sections of the Sg. Trengganu, Sg. Nerus, Sg. Setiu and Sg. Besut.
- peak water discharges and the frequency of occurrence of such discharges of the above rivers.

3 HYDRO-METEOROLOGICAL NETWORK

The development of agricultural projects as foreseen in the future combined with the necessity of studying flood control measures, will require an improvement of the present hydro-meteorological network as well as its adaption to the future situation.

As far as flood control is concerned in sub-section 2.2.2 measures have been suggested that should be taken for the implementation of a flood warning system as proposed by the DID.

The installation of automatic rainfall and streamflow recorders on an integrated basis for both the Sg. Trengganu and the Sg. Besut is of primary importance since for these two rivers the study of flood control measures is the most urgent.

Also for the other rivers the installation of the recorders mentioned is strongly recommended since hydro-meteorological data are lacking completely.

The implementation of future irrigation projects to realize the growing of padi during the off-season will depend on the timely collecting of these data.

With regard to the collecting of purely meteorological data the following should be noted:

- For the implementation and management of the agricultural development projects (oil palm, padi) it is necessary to have a number of rainfall recording stations. The network of these stations will have to be adapted to the future land use pattern.
- To realize adequate management of the agricultural projects, it will also be necessary to obtain information about other climatological factors such as temperature, relative humidity, wind speed, sunshine. For the collecting of these data the number of stations should be restricted as much as possible. In determining their location the future land use should be taken into account.

As a guide for the installation of a hydro-meteorological network, publication no. 168 of the World Meteorological Organization, Geneva, Switzerland is recommended (Guide to hydro-meteorological practices).

Norms for the density of networks can be found in the above-mentioned guide. On the basis of these norms the number of rainfall stations to be installed in the steepland of Trengganu should be about 10.

The stage discharge curve of the most suitable gauging stations on the main rivers and also those on the smaller ones of importance for possible development projects should be rated by current meter measurements for both low and high discharges.

The stage discharge curve obtained in this manner should be checked regularly.

Sometimes it might be necessary to make an estimate of the runoff from a small catchment. A method has been developed for Malaysia (5) by which the runoff is estimated from rainfall data in comparison with known similar catchments.

Up to now no standard catchment has been selected on the East Coast of West-Malaysia. As the number of records particularly regarding the discharges of rivers in minor catchments is small it will be very useful to have a standard catchment in the State.

LIST OF REFERENCES

- (1) Malayan Meteorological Service - Summary of Observations (20 years)
- (2) Hofstad, K. C. - Reliability of station-year-rainfall frequency determinations.
Trans. A.S.C.E., Vol. 107, 1942
- (3) Penman, H. L. - Natural evaporation from open water, bare soil and grass.
Proc. Roy. Soc. London (A) 193, 120-145
- (4) Central Electricity Board - Preliminary investigation of potential hydro-electric schemes in Trengganu and South-eastern Kelantan, 1961
- (5) Charlton, F. G. - Standard Catchments in the Estimation of Flood Flows.
The Journal of Tropical Geography

ANNEX III

LAND AND SOILS

CONTENTS

	<u>Page</u>
1 INTRODUCTION	1
1.1 Purpose of the Survey	1
1.2 The Working Method	2
2 WEATHERING OF THE MAJOR ROCK TYPES CONSTITUTING THE OLD LAND OF TRENGGANU	4
2.1 General	4
2.2 The Weathering of Granite and Allied Plutonic Rocks	4
2.3 The Weathering of Basalt and Allied Volcanic Rocks	5
2.4 The Weathering of Quartzite (Metamorphic Rock)	5
2.5 The Weathering of Sandstone and Conglomerate (Sedimentary Rock)	5
2.6 The Weathering of Shale (Sedimentary Rock)	6
3 SOIL CLASSIFICATION AND SOIL MAPPING UNITS	6
3.1 General	6
3.2 Units of Soil Classification and Soil Mapping	6
4 DESCRIPTION OF THE SOILS	8
4.1 Sedentary Soils	8
4.2 Fluvio-Alluvial Soils	8
4.2.1 River Alluvium	8
4.2.2 Soils of the Valley Bottom Association (VBA)	13
4.2.3 Soils of the Gully and Ravine Bottoms - Local Alluvium and Colluvium (LAA)	13
4.3 Peat Soils (Pet/s and Pet/de)	16
4.3.1 General Characteristics	16
4.3.2 Acidification of the Mineral Substratum of Peat Swamps	18
4.4 Marine Soils	21
4.4.1 Soils of the Beach Ridges (RDU ₁ and RDU ₂)	21
4.4.2 Soils of the Beach Ridge Troughs (RSL)	21
4.4.3 Soils of the Tidal Flats (KNJ)	24
4.5 Soil Moisture Retention	24
5 ACREAGE DISTRIBUTION OF THE SOIL MAPPING UNITS	26
6 CLASSIFICATION OF THE LANDS ON THEIR SUITABILITY FOR AGRICULTURE	26
6.1 General	26
6.2 Suitability of the Lands for the Cultivation of Crops under Present Conditions	28

	<u>Page</u>
6.2.1 General	28
6.2.2 Evaluation of the Land on its Suitability for the Cultivation of Tree Crops, including Fruit Trees, Oil Palm, Rubber, Cocoa, Coco-nut, and Cashew	29
6.2.3 Evaluation of the Land on its Suitability for the Cultivation of Annual Crops, Pineapple and Vegetables	29
6.2.4 Evaluation of the Land on its Suitability for the Growing of Sawah Padi	32
6.2.5 Summarized Land Suitability Classification; Acreage Distribution of the Classification Items	34
6.3 Suitability of the Lands for the Cultivation of Crops under Technically Improved Conditions	34
6.3.1 General	34
6.3.2 Possible Improvement of Unsuitable Soils for the Cultivation of Tree Crops	34
6.3.3 Possible Improvement of Unsuitable Soils for the Cultivation of Annual Crops, Pineapple and Vegetables	36
6.3.4 Possible Improvement of Unsuitable Soils for the Cultivation of Sawah Padi	45
List of References	46

LIST OF TABLES

Table 4-1 - Sedentary Soils; Major Soil Mapping Units and their Morphometric Characteristics	9
Table 4-2 - Sedentary Soils; Average Physico-Chemical Characteristics	10
Table 4-3 - 'Key Values' for the Evaluation of Soil Chemical Fertility	11
Table 4-4 - Fluvio-alluvial Soils; Physico-Chemical Characteristics	14
Table 4-5 - Fluvio-alluvial Soils; Major Soil Units and their Morphometric Characteristics	15
Table 4-6 - Water Content of Peat Soils	17
Table 4-7 - Peat Soils; Analytical Data of Soil Layers at Various Depths in Peat Swamps	19
Table 4-8 - Data relating to the Potential Acidity of the Mineral Substratum of Peat Swamps	20
Table 4-9 - Average Analytical Data of Marine Soils	23
Table 4-10 - Soil Moisture Percentages at various Soil Moisture Tensions	25

	<u>Page</u>
Table 5-1 - Acreage Distribution of the Soil Mapping Units	27
Table 6-1 - Classification of Soil Units in Terms of their Suitability for the Growing of Tree Crops	30
Table 6-2 - Classification of Soil Units in Terms of their Suitability for the Growing of Annual Crops, Pineapple and Vegetables	31
Table 6-3 - Classification of Soil Units in Terms of their Suitability for the Growing of Sawah Padi	33
Table 6-4 - Summarized Soil Suitability Classification and Acreage Distribution of the Classification Units	35

LIST OF FIGURES

Figure 1 - Analysis of Young and Inland Beach-Ridge Sands after J. J. Nossin	22
Figure 2 - Cross Sections of Peat Swamps	38-44

1 INTRODUCTION

1.1 Purpose of the Survey

Two types of survey were carried out, viz. a reconnaissance survey of the soils of the State and some detailed reconnaissance surveys of parts thereof.

The objectives of the reconnaissance survey were:

- mapping of the various soil units found in the State
- determination of the main physico-chemical characteristics of these soil units
- classification of the land in terms of the suitability of the relevant soil units for agriculture.

The results of this survey served as an indispensable element for the Regional Development Plan to facilitate the ultimate decision whether, and if so, in which parts of Trengganu agricultural development should be given priority.

Soil survey activities in Malaysia have reached a high level. Various parts of the State have been mapped on a detailed reconnaissance scale, whilst a schematic reconnaissance map (scale 1 : 500,000) of the entire State has been completed and issued.

The reconnaissance survey carried out by the DTAM is meant to supplement the knowledge on soils in Trengganu to such a degree that the location and extent of soil units suitable for various forms of agriculture might be indicated more precisely (see Plate III-1).

Apart from the overall survey two detailed reconnaissance surveys were carried out to provide fundamental data to assess the feasibility of the SEDC oil palm project at Sungei Tong and of the extension (Stage II) and intensification of the Besut Irrigation Project (Stage I).

A third detailed reconnaissance survey was carried out in the Trengganu alluvial plain to supply information on any problems which may be encountered in the preparation and construction of a Lower Trengganu Irrigation Scheme.

1.2 The Working Method

The field work has been facilitated and strongly accelerated by the extensive use of aerial photographs and geological maps. But for these helpful items the aim of the survey could not have been achieved within the limited period of time available.

The greater part of the terrain is too inaccessible to allow extensive field investigations. Thus the preparation of the basic reconnaissance map depended greatly on aerial photo interpretation.

Information was collected as much as possible from road cuttings, valley exposures and quarries which could be easily reached by motor transport. If this was not feasible trace lines (rentis²) were cut. In this way a maximum amount of data could be obtained in the shortest period of time.

At those spots where the soil profile could not be readily examined use was made of handborings generally reaching to a depth of 4 feet. Where deemed necessary the borings were extended to a maximum depth of 12 feet, as e.g. in the peat swamps. In a pre-field work analysis of the aerial photographs (scale 1 : 25,000) it was determined where field data were preferably to be collected.

The systematic stereoscopic analysis of aerial photographs and a subsequent geo-morphic classification resulted in the delineation of units differing in topography, hydrology and vegetation. The major units are:

- the complex of alternating beach ridges and troughs
- the tidal flats
- the coastal and inland swamps
- the fluvial plain with its river terraces
- the valley tracks
- the uplands
- the steepland

Under the prevailing hot and humid climate, rock-weathering is very intense and often reaches great depths. Consequently, the parent material of a soil is commonly very different in nature from the original parent rock. However, variations in broad rock types are still noticeable in weathered, unconsolidated parent materials and even, to a lesser degree, in the soils derived from them. Thus, the broad-scale soil pattern as occurring in the uplands and the steepland (Old Land) is, to a very great extent, dictated by the nature of the parent material (1). Hence, the delineation of the pattern of the geological substratum which underlies the soils of the Old Land, provided a useful starting point for soil mapping there.

Differences in landform features as observed on the aerial photographs permitted the delineation of areas underlain by either granite rock or sedimentary rock, both in uplands and steepland.

The relevant features are most distinct in the steepland and boundaries could be determined more easily there than in the uplands. In the steepland, however, the boundary determination is

of less importance since this land is not suited to agricultural development due to its excessive steepness.

The available geological maps (scale 1 inch to 1 mile) show the regional distribution of the two broad groups of rock mentioned and could be used to check and improve boundaries. The aerial photo analysis hardly allowed a further differentiation between the argillaceous and arenaceous components of the sedimentary rocks on the one hand and between granite and allied rocks on the other.

The vegetation cover is very uniform and therefore does not illustrate any differences either in soil or in geological formations. The types of landform within the granite and sedimentary areas also do not differ conspicuously. The fact that the sedimentary rocks have been intensely folded certainly accounts for the lack of features permitting the delineation of boundaries in this main unit. The vertical diversity of the initially horizontally extending sedimentary rocks has been upset and exposed at the surface. As a result of this, great variations in kinds of rocks may occur over very short distances.

Locally, however, boundaries between areas underlain by argillaceous and arenaceous rocks could be traced owing to differing hill shapes.

Here again, the geological maps have been of great help in delineating the variety of the geological substratum.

The configuration of mountainous and hilly areas and the gradient of the prevailing slopes are features which can be noted stereoscopically on aerial photographs. The stereoscopic examination as such does not offer the possibility to derive absolute values for the angles of slope from the photographs but variations in steepness are readily perceived. In correlating field observations on gradient with the steepness of the terrain as pictured on the photographs, a key was found to differentiate between areas of varying slope class. It will be clear that the interpretation of steepness was only possible by assuming that the correlations found are generally applicable throughout Trengganu. Slope classes of areas thus delineated were compared with those for the same areas derived from the available contour maps (scale 1 inch to 1 mile). This comparison revealed that the actual steepness and ruggedness of the terrain is more pronounced than the contour maps suggest. The contours shown on the topographical maps are the result of stereo-plotting the aerial photographs. Especially the Old Land is covered by tropical forest with non-uniform tree heights. The tree height is generally lowest on the top of hills and mountains whilst it increases down the slopes and in ravines. Thus the actual topography is masked by the dense canopy. The latter has been scanned by the stereo-plotter.

When aerial photo-interpretation is used in soil mapping one must be able to attach definite soil characteristics to the delineated units of differing physiography. It stands to reason that a possible correlation can be only established with the aid of field observations.

The field observations made in areas of non-sedentary soils did not give rise to any problems in this respect.

In the areas of sedentary soils, however, underlain as they are by various types of igneous and sedimentary rock, the correlations were less clear-cut. In these regions the relation between the physiography as pictured on the photographs and the characteristics of the soil as found in the field was examined and, wherever possible, established in representative areas already mapped on a detailed reconnaissance scale by Panton (2). The aerial photo-interpretation of the areas underlain by sedimentary and igneous rocks was supported by evidence from numerous field checks carried out outside the key areas, and by the geological maps.

The principle which underlies the applied photo-interpretation is that the soil-physiography relationships as found in and outside key (sample) areas are thought to hold true for the entire area under consideration (method of generalization).

2 WEATHERING OF THE MAJOR ROCK TYPES CONSTITUTING THE OLD LAND OF TRENGGANU

2.1 General

'Old Land' constitutes that part of the State of Trengganu that is not covered by fluvial or marine deposits but that consists of soils formed on igneous and sedimentary rocks.

The rate and character of weathering are influenced by such factors as rock composition, climate and topography.

The soluble products of weathering are carried away by groundwater, streams and rivers whereas the insoluble, residual substances are left behind as the 'mantle rock' or regolith.

The regolith consists of two distinct parts, viz. a fully weathered upper part, i.e. the soil and a less completely weathered lower part, the parent material of the soil. The parent material still shows its association with the underlying parent rock. The character of both the parent material and the soil depends in all cases greatly on the amount and size of resistant minerals present in the rock, of which quartz is the most significant (1, 7).

2.2 The Weathering of Granite and Allied Plutonic Rocks

The transition from the fully weathered part (= soil) of the regolith into the solid rock is very gradual.

This transitional zone (= soil parent material) consists of 'rotten' (3) granite and is several tens of feet thick.

On the hill tops the regolith is approximately 10 feet deep. Downward along the slopes its thickness increases.

Upon weathering the stable components of the granite rock as quartz, muscovite and zircon disintegrate into grains, flakes and grits. The residue of the chemically unstable feldspars consists of newly formed clay. Biotite, as a result of its iron content,

contributes to the colouring of the regolith. Apatite is entirely removed.

As the silica content of granitic rocks varies, the texture of both parent material and soil will reflect these variations. The soils derived from granodiorites and quartz diorites (granitic rocks of progressively lower free silica content) are redder hued and contain more clay than those derived from granite.

2.3 The Weathering of Basalt and Allied Volcanic Rocks

The regolith of basalt consists of homogeneous, brown clay and generally reaches great depths.

The clayey texture may be directly linked to the presence of a majority of chemically unstable minerals in the basalt rock (plagioclase, augite, olivine and sometimes nepheline).

The deep reddish-brown colour of the soils developed on basalt is caused by the presence in the rock of minerals rich in iron which weather down to iron oxides. Titaniferous magnetite and ilmenite withstand weathering.

The regolith of andesite is also very deep and homogeneous. The andesite rocks contain plagioclase, biotite, amphibole and pyroxence.

2.4 The Weathering of Quartzite (Metamorphic Rock)

Quartzite results from the thermal metamorphism of sandstone. It consists of quartz grains cemented together by siliceous material. Upon weathering it produces a sandy regolith. The Malayan quartzites are generally not formed from pure sandstone, the latter being admixed with varying amounts of clay. Upon weathering these quartzites produce a loamy or clayey regolith.

2.5 The Weathering of Sandstone and Conglomerate (Sedimentary Rock)

Sandstone is a rock composed of consolidated sand which chiefly consists of quartz grains. Ferruginous, argillaceous or siliceous material may be the cementing agencies.

The weathering of sandstone does not give rise to pronounced chemical changes. Generally the constituent grains fall apart and rapid desintegration ensues.

Conglomerate consists of consolidated gravel or cobbles of any kind of rock. Usually quartz and quartzite are the major constituents. Depending on the presence of clay-producing rock fragments the regolith may be either sandy or loamy.

2.6 The Weathering of Shale (Sedimentary Rock)

Shales are soft, finely grained rocks which are mainly composed of clay and silt that have assumed a thinly stratified or fissile structure.

The mineral composition of shales varies greatly. In various parts of Trengganu they either contain appreciable quantities of sand or are very rich in carbon.

The regolith of the normal shale is clayey. Its lower part (soil parent material) still shows the characteristic stratification. Depending on the pureness of the shale its regolith may be clayey or loamy.

3 SOIL CLASSIFICATION AND SOIL MAPPING UNITS

3.1 General

Presuming that the soils resulting from the weathering of various types of rock have been subjected to the same influences of climate and vegetation, the intricate soil pattern as found in the Old Land of Trengganu is predominantly to be related to the variations in parent material. Differences in topography and consequently in hydrological conditions, however, are responsible for the development of different types of soil on identical parent material.

The fluviatile and marine sediments, which constitute the relatively low-lying Coastal Plain, represent the transported and sedimented soil material of the Old Land. In the Coastal Plain the differences in soil pattern relate primarily to the deposition system of the meandering and frequently shifting streams that carried the sediments in suspension, to the wave-generated currents of the sea and to the eustatic fall of the sea level in the late Holocene.

Apart from a possible sequence of differently textured soil layers the deposits of recent age do not show signs of profile development in the sense that eluviation and illuviation have taken place to result in the development of master horizons. Generally, a gleyed layer is, however, present.

Sub-recent deposits show a varying degree of soil profile development. The inland beach ridges for instance are distinctly podzolized whilst many of the sub-recent river terrace soils show soft plinthite.

3.2 Units of Soil Classification and Soil Mapping

The predominant soil mapping unit of the reconnaissance soil map, scale 1 : 250,000 (Plate III-1), is the soil association, a compound mapping unit consisting of a group of soil series.

The soil series as such embraces all types of soil with horizons similar in differentiating characteristics and arrangement in the profile (except for the texture of the surface soil) and developed from a particular type of parent material (4).

The question as to what constitutes the similarity in the profile characteristics of alluvial soils which do not have sequences of genetically related horizons is not easy to answer. For this reason no attempts have been made to distinguish between morphologically differing soil units in the alluvial land. Nevertheless, a sub-division of the alluvial land has been made in terms of differing physiography (Low Water Plain; High Water Plain; terraces). The same applies to a number of landscape types which are easily delineated on the aerial photographs, e.g. inland and coastal swamps, ravines and gullies, piedmonts and steep land. Commonly these types of landscape are very inaccessible which renders a morphological classification without detailed terrestrial survey very difficult.

Since the variations in soil slope are wide enough to have an impact on both land use and management, the soil associations and series relating to the Old Land (sedentary soils) have been sub-divided into slope phases. This sub-division was necessarily a broad one, the variations in slopes being indefinite. Terrains with angles of slope varying between 2° and 12° have been designated with the symbol c; where the soil slope varies between 12° and 20° the symbol d has been used.

Since the results of the soil survey were primarily to serve the planning of future land development programmes, the method of investigation centred on aspects of a practical rather than on those of a purely soil-scientific nature.

Thus the delineation of individual soil series as mapping units has been only practised in cases where field observations readily confirmed the hypothesis that the soils of a distinct physiographic unit as seen on the aerial photographs belong to one series (troughs in beach ridges, tidal flats, soils formed on basalt).

Where a differentiation on series level could not be achieved - as in the majority of the cases - the mapping units are soil associations.

In comparison with the existing schematic reconnaissance soil map, scale 1 : 500,000 (2), Plate III-1, shows a somewhat more refined differentiation in soil associations and physiographic mapping units. The formerly distinguished Kuala Brang-Marang-Apek association has been split up into a Munchong-Apek and a Kuala Brang-Marang association, whilst the riverine alluvium has been subdivided into various terraces of differing elevation. In the peat swamps a subdivision has been made between areas where the depth to the mineral sub-soil is less than 2 feet and where it is more. It was also found that a part of the riverine alluvium (terraces) was formerly considered to belong to the Kuala Brang-Marang-Apek association. The qualities of the various soil associations, series and physiographic units are dealt with in Section 4.

4 DESCRIPTION OF THE SOILS

4.1 Sedentary Soils

Soils derived 'in situ' from parent material that has been formed from and still overlies its parent rock are defined as sedentary.

The sedentary soils are found in the hilly and mountainous areas of Trengganu, in the so-called 'Old Land'.

Following the soil classification system of the Division of Agriculture as outlined in Bulletin no 119 (1) the commonly occurring sedentary soils in Trengganu are morphometrically summarized in Table 4-1 on the next page. Physio-chemical characteristics of the relevant soil series are given in Table 4-2 on page 10.

The latter information is self-explanatory when interpreted according to the 'key values' given in Table 4-3 on page 11.

4.2 Fluvio-Alluvial Soils

4.2.1 River Alluvium

These soils are formed from fluviially transported and subsequently sedimented material originating from the sedentary soils of the Old Land.

According to the principles that underlie sedimentation in riverine areas the following physiographic units have been distinguished:

- river levees, the relatively high-lying and narrow strips of land found at either side of the river
- river basin slopes, the extensive, lower-lying, slightly sloping plains behind the levees
- basin depressions, the lowest-lying, more or less central parts of the river basins

The soils of the river levees generally have a sandy or a loamy texture. Sometimes, however, they are clayey. Those of the basin slopes are clayey whilst the basin depression soils consist of heavy clay.

As a result of the recent eustatic fall of the sea level in the Late Holocene, sub-recent and recent terraces have been formed. This terrace formation means that the river incised its bed rather deeply in its own sediments, removed them laterally as a consequence of its meandering and built up a new sequence of levees and basins at a lower level. Depending on what has been left behind as a remnant of the former river plain, a terrace may chiefly consist either of soils of a light texture (former levee) or of soils of a clayey texture (basins).

Table 4-1 - Sedimentary Soils: Major Soil Mapping Units and their Morphometric Characteristics

Type of rock	Major soil series	Main soil profile features	Remarks	Soil mapping unit
granite	Rengam (RGM)	A well structured, brownish-yellow (10 YR 6/8), porous, coarse sandy clay to clay loam soil of good internal and external drainability. The surface consists of 4"-8" of dark brown (10 YR 4/3) sandy clay loam of fine crumbly texture. The subsoil becomes redder with depth, is friable when moist and has a fine-subangular blocky structure. Below a depth of 4 feet there is a gradual change to a reddish brown (2.5 YR 6/8) whilst the texture becomes coarser. The parent rock is generally found below a depth of 10 feet.	The soils display little variation. The soil texture may vary from sandy loam to fine sandy clay loam. Hardened plinthite may occur at a depth of approx. 3 feet in soils on flat hill tops or at the foot of slopes edging swamps	Jerangau-Rengam Association (symbol JRA-RGM)
	Rengam red variant	As above but with a red to yellowish-red (2.5 YR 5/8-5 YR 4/6) colour within 2 1/2 ft	None	
	Tampin (TPN)	A pale coloured, coarse-textured soil derived from highly siliceous granite. The thin surface soil is greyish-brown (10 YR 5/2) to light-grey (10 YR 7/2), loose sandy loam of a fine-crumbly structure. The subsoil consists of structureless, massive, friable sandy loam to clay loam of good internal drainability, pale yellow (2.5 YR 8/4) in colour. The gravel and clay content and the compactness of the soil increase with depth. Below 3 feet depth there is hardly any root development.	Hardened plinthite may occur at depths of approx. 3 feet in soils on gently sloping hill tops or at the foot of slopes edging swamps	
	Jerangau (JRA)	The surface soil consists of 4"-8" dark brown (10 YR 4/3), friable, fine-crumbly sandy clay loam. The subsoil changes from a yellowish-brown (10 YR 5/4-5/6) fine sandy clay loam of a fine-crumbly structure to a strong brown (7.5 YR 5/6-5/8), firm sandy clay loam of fine-subangular blocky structure. The soil has a good internal and external drainability, is deep and shows good root development to a depth of at least 5 feet.	A very uniform soil with very little profile differentiation.	Kuantan Series (symbol KUN)
	Kampong Kolam (KKM)	A deep friable, yellowish-red (5 YR 4/8-5/8) to reddish-brown (5 YR 4/3-5/4) clay to clay loam soil of medium to fine-crumbly structure. The surface soil may be 10" thick and has a fine-crumbly structure. The soil is porous, well tillable and has a good internal and external drainability.	A very uniform soil. A continuous band of hardened plinthite may be occasionally found.	
	Kuantan (KUN)	A deep, extremely uniform dark yellowish-brown (10 YR 4/4) to reddish-brown (5 YR 4/4) clay of medium-subangular blocky structure. Structural elements break easily into fine crumbs. High clay percentages. Good internal and external drainability.	This series is of very limited occurrence.	Segamat-Katong Association (symbol SGT-KTG)
	Segamat (SGT)	A deep, very uniform, predominantly red (2.5 YR 4/6; 5 YR 4/8-5/8) clay of fine to medium subangular blocky structure.	This series is of very limited occurrence.	
	Katong (KTG)	A moderately deep, brown (10 YR 5/6-7.5 YR 5/6) silty clay or clay of medium to fine subangular blocky structure. Few pores. Medium internal drainability.	This series is of very limited occurrence. Small pebbles of quartz andesite below depths of 30"	
shale, inter-mixed with quartzite bands	Munchong (MUN)	A deep, strong brown (7.5 YR 5/6) to reddish-yellow (7.5 YR 6/8), firm silty clay loam of medium-subangular blocky structure. The surface soil may be 4" thick, is dark yellowish-brown and consists of fine-crumbly silt loam.	The soil textural classes comprise fine sandy clay loam, clay loam and silty clay. Hardened plinthite sometimes occurs below 3 feet.	Munchong-Apek Association (symbol MUN-APK)
arenaceous	Apek (APK)	The subsoil consists of rather compact, light grey (10 YR 7/1-5/1) fine sandy clay loam to (silty) clay, structureless and massive. Soil depth generally 3 feet. Occasional reddish-yellow mottling in the lower part of the profile. The thin surface soil is a very weakly crumbled, grey (10 YR 5/1) fine sandy loam or silt loam. Root development practically restricted to the surface soil.	None	
	Kuala Brang (KLG)	Moderately deep, yellowish-brown (10 YR 5/8) to brownish-yellow (10 YR 6/6), friable fine sandy loam, loam or fine sandy clay loam of a medium-subangular blocky structure. The clay content generally increases with depth. At a depth of 3 feet loose, decayed shale or remnants of quartz vein occur.	Soil depth greatly depending on soil slope. Colour and texture very uniform over large areas.	Kuala Brang-Marang Association in dependence of the major component series occurring locally, (symbol KLG-MRG or MRG-KLG)
arenaceous	Marang (MRG)	Moderately deep, light yellowish-brown to pale yellow (2.5 YR 6/4-7/4) loamy sand, sandy loam, sandy clay loam to sandy clay of medium-subangular blocky structure. The surface soil is generally 2"-4" thick and consists of dark greyish-brown (10 YR 4/2) loamy sand or sandy loam. Depth of the profiles generally 3 feet. Rooting generally restricted to the upper 2 feet of the profile.	None	

Table 4-2 - Sedentary Soils: Average Physico-Chemical Characteristics

Depth	0" - 12"						12" - 24"						24" - 48"					
	JRA	RGM	KUN	MUN	APK	KLG	MARG	JRA	RGM	KUN	MUN	APK	KLG	MARG	JRA	RGM	KLG	MARG
Soil series	SC/SCL	SC	C	CL	CL	CL	SCL	SC	SIL/SL	C	CL/SCL	CL	CL/SC	SCL	SC	SC	SC/CL	SCL
texture	58	55	9	51	34	52	57	56	55	9	54	34	49	56	46	45	47	58
% silt	6	5	10	20	27	17	17	5	22	10	12	29	13	16	4	4	15	12
% clay	36	40	81	29	39	31	26	39	23	81	34	37	38	28	50	51	38	30
H ₂ O	4.7	4.5	4.2	4.7	4.5	4.3	4.3	4.7	4.3	4.2	4.9	4.5	4.3	4.1	4.7	4.5	4.4	3.9
pH	4.1	-	4.2	3.8	3.8	3.7	3.7	4.2	-	4.2	3.9	3.6	3.9	3.6	4.2	-	3.8	3.8
% Nitrogen (N)	0.05	0.06	0.07	0.08	0.06	0.08	0.09	0.04	0.02	0.07	0.04	0.03	0.03	0.06	0.03	0.03	0.03	0.05
% Carbon (C)	0.58	1.31	0.67	0.98	0.92	0.91	1.05	0.35	0.30	0.67	0.69	0.74	0.34	0.41	0.29	0.45	0.25	0.21
C : N	12	22	10	12	15	11	11	9	15	10	17	25	11	7	10	15	8	4
P ₂ O ₅ available (p.p.m.)	180	40	323	174	89	164	116	154	26	323	190	93	115	106	139	23	117	66
total	312	-	1344	588	165	244	186	284	-	1344	385	241	341	188	313	-	424	155
K ₂ O available (p.p.m.)	28	43	33	48	29	51	39	21	20	33	24	24	32	41	21	10	21	42
total	482	-	385	2986	1444	2528	1300	530	-	385	4141	1541	1902	1605	530	-	1926	1669
cation-exchange capacity (m.e./100 g)	7.6	-	10.6	7.1	7.8	10.1	9.2	6.2	-	10.6	9.8	7.3	8.0	7.1	6.6	6.3	7.2	6.6
Ca	0.2	-	0.1	0.2	0.1	0.3	0.2	0.1	-	0.1	traces	0.1	0.1	0.2	traces	-	0.1	0.2
Mg	0.2	-	0.1	0.3	0.3	0.7	0.7	0.2	-	0.1	0.2	0.3	0.4	0.8	0.2	-	0.6	1.0
K	0.1	-	0.1	0.1	0.1	0.1	0.1	traces	-	0.1	0.1	0.1	0.1	0.1	traces	-	0.1	0.1
Na	0.1	-	0.1	0.1	0.1	0.1	0.1	0.1	-	0.1	0.1	0.1	0.1	0.1	0.1	-	0.1	0.1
total	0.6	-	0.4	0.7	0.6	1.2	1.1	0.4	-	0.4	0.4	0.6	0.7	1.2	0.3	-	0.9	1.4
% base saturation	8	-	4	10	8	12	12	6	-	4	4	8	9	17	5	-	12	21

Table 4-3 - 'Key Values' for the Evaluation of Soil Chemical Fertility

Nutrients	Quantities in	Very low	Low	Moderately low	Medium high	High	Very high
carbon	%	< 0.50	0.50-1.00	1.00-1.50	1.50-2.50	2.50-4.00	> 4.00
nitrogen	%	< 0.05	0.05-0.10	0.10-0.15	0.15-0.25	0.25-0.40	> 0.40
P ₂ O ₅	readily available	< 10	10-20	20-50	50-100	100-200	> 200
	totally available	< 100	100-150	150-200		200-400	> 400
K ₂ O	readily available	< 100	100-150		150-200	200-400	> 400
	totally available	< 100	100-200	200-500		500-1000	> 1000
exch. cations	Ca					15	
	Mg					5	
	K					0.2-0.3	
	Na					traces	

The soils of the recent and sub-recent terraces are still too young to show clear signs of eluviation and illuviation. What they often do show is a sequence of layers that differ in texture and in characteristics governed and induced by the prevailing hydrological conditions (gleying, soft plinthite).

Soil profile development took place with the soils of the Older Alluvium. This Older Alluvium occurs as a terrace above an elevation of 230 feet and is of Early Pleistocene times. In Trengganu it has been found at various locations, e.g. near Chukai and near Kg. Gemuroh (on the main road Kuala Trengganu-Kg. Buloh; topo sheet 38 Malaya, 1 : 63,360). This Older Alluvium is not of widespread occurrence and the patches encountered are of too small an extent to be represented on the 1 : 250,000 soil map.

A sequence of five river plain levels has been distinguished:

- The Low Water Plain (LWP). This is the relatively lowest-lying and most recent riverine area. At various places along the main rivers in Trengganu this plain is of a very limited extent and as it were still in formation. Around the mouths of the Sg. Chukai and the Sg. Kemaman, however, it covers large areas. Further inland the Low Water Plain is only flooded by river water during the rainy season when high water levels prevail. When, however, the plain borders the lower reach of a river the flood-tide of the sea causes a diurnal inundation. The soils of the Low Water Plain are fine-textured and very poorly to imperfectly drained. Consequently, the zone of permanent reduction (grey coloured) is found at shallow depths. Apart from their surface layers the sediments are immature (half ripened to unripened). With the exception of the Kranji series which includes the soils formed under mangrove, it did not prove possible to delineate areas of differing soil conditions within the Low Water Plain. Soils deposited in a brackish environment are likely to occur. Although of somewhat higher elevation than the Low Water Plain, the same as discussed above applies to the High Water Plain (see below).
- The High Water Plain (HWP). This is the major alluvial plain found with a restricted number of rivers in the central and southern parts of Trengganu. These plains penetrate far into the interior, e.g. the plains of the Sg. Kemaman, the Sg. Bungkus, the Sg. Ibok and the Sg. Dungun. Various rivers traverse a High Water Plain in their lower reaches e.g. the Sg. Kerteh, the Sg. Paka, the Sg. Marang, the Sg. Dungun and the Sg. Besut. Being prone to regular inundation the High Water Plain is swampy and peaty at various places.
- The First Terrace (T_1). As to the First Terrace, its lower-lying clayey basin soils (T_1B) are still prone to flooding during the rainy season whilst its sandy to loamy levee soils (T_1L) remain virtually dry. The basins are well-suited to the growing of tree crops. In the basins the level of the groundwater is found at shallow depths whilst it

generally occurs below a depth of 3 feet in the levees. This terrace is found along the Sg. Kerteh, the Sg. Paka, the Sg. Alu, near the mouth of the Sg. Trengganu, along the Sg. Dungun, the Sg. Loh, the Sg. Jengai and the Sg. Besut.

- The Second and Third Terraces (T_2 and T_3)

The Second Terrace extends along the upper reaches of the Sg. Kemaman, the Sg. Trengganu, the Sg. Brang, the Sg. Bintang, the Sg. Nerus and its confluents, and the Sg. Besut.

At places it consists of sandy or loamy levee soils and distinctly lower-lying clayey basins; elsewhere the pattern of an original river plain is no longer visible and has been lost since the entire area shows a hilly configuration as a result of erosion. This applies especially to the Third Terrace which is virtually found in the same areas as mentioned above. However, it is of a far smaller extent and often more fragmented. A relatively extensive area is found along the Sg. Trengganu, in the neighbourhood of the Sg. Telemong.

The fluvio-alluvial soils have been classified in terms of physiography and are morphometrically summarized in Table 4-4 on the next page. Physico-chemical information on the units distinguished is given in Table 2-3 of the Detailed Project Evaluation of the Besut Irrigation Scheme.

This information is self-explanatory when interpreted according to the 'key values' of Table 4-3 (page 11) in this report.

4.2.2 Soils of the Valley Bottom Association (VBA)

The relatively small plains found at either side of the minor confluents of the main rivers are considered as valley bottoms. They form the transition between the more strongly sloping gully and ravine bottoms on the one hand and the slightly sloping T_2 and T_3 terraces on the other. They act as the natural collector drains of the mountainous land, a great number of ravines and gullies joining them laterally.

The valley bottoms have to cope with considerable quantities of runoff water during the wet season and may be periodically ponded. Where runoff water for some reason or another is obstructed in its course, permanent waterlogging and the subsequent formation of peat may result.

The soils of the valley bottoms do not virtually differ from those of the T_2 and T_3 terraces adjoining them (see Tables 4-4 (page 14) and 4-5 (page 15)).

4.2.3 Soils of the Gully and Ravine Bottoms - Local Alluvium and Colluvium (LAA)

Alluvial and colluvial deposits originating from sedentary soils on adjacent sloping land are found in the relatively narrow gully and ravine bottoms.

The texture of these deposits is closely related to the nature of the surrounding sedentary soils. As these ravines and

Table 4-5 - Fluvio-alluvial Soils
Major Soil Units and their Morphometric Characteristics

Formation	Parent material	Soil series	Principal soil profile features	Soil mapping unit
low water plain	alluvial deposits	not identified	poorly drained, regularly flooded, lowest-lying riverine deposits of varying texture, often sandy	soils of the low water plain (symbol LWP)
high water plain	originating from	identified	regularly flooded, generally clayey soils which may be locally peat-covered or swampy	soils of the high water plain (symbol HWP)
first terrace	sedentary soils		pattern of well-drained sandy or loamy levee soils and imperfectly drained clayey basin soils	soils of the first terrace (symbol T ₁)
second and third terrace			well-drained, friable sandy loam or sandy clay loam soils	soils of the second and third terrace (symbol T ₂ , T ₃)
valley bottoms			as above but sometimes covered with peat	valley bottom association (symbol VBA)
gully and ravine bottoms	alluvial and colluvial deposits originating from sedentary soils on adjacent sloping land	not identified	the texture of the alluvial deposits is related to that of the surrounding sedentary soils; the colluvial deposits are often sandy; the soils are poorly or imperfectly drained and often peat-covered	local alluvium and colluvium (symbol LAA)

gullies serve as natural drainage ways for the mountainous area they are prone to periodical inundation. Moreover, the groundwater table is invariably found at shallow depths. Locally, permanent waterlogging occurs with the consequent development of swamps with peat soils.

For practical purposes no distinction has been made between soils of colluvial and those of alluvial origin, both types being united in the Local Alluvium Association. They do, however, differ. The colluvial deposits are as a result of soil creep and local wash of a more coarse sandy texture than the adjacent alluvial material. The colluvial soils generally occur in the narrow ravines and gullies. In the wider ones they are mostly found as a small band which separates the sedentary soils from the alluvial ones.

4.3 Peat Soils (Pet/s and Pet/de)

4.3.1 General Characteristics

In the coastal region a considerable part of the basin depressions of both the Low Water Plain and the High Water Plain are covered with peat as a result of hydromorphic conditions prevailing there. Most of the peat has developed under forest and is consequently termed woody or forest peat. At the edges of the peat swamps the depth of the peat cover to the mineral substratum is generally shallow (less than 2 feet) but it increases with the distance from the edge.

Apart from the large coastal accumulations which often cover thousands of acres, relatively small patches of peat are found in inland areas which either form part of higher-lying terraces (T₁, T₂, T₃) or are valleys without an outlet enclosed by mountains or hills. The peat soils as such are organic and may either entirely or partly consist of decomposed organic matter or of a mixture of mineral soil with organic material. They are oligotrophic in nature since they are low in mineral matter content and are acid in reaction. Their loss on ignition exceeds 65 per cent.

Organic soils having a loss on ignition between 35 and 65 per cent are referred to as muck soils. They occur around the edges of the peat swamps where they form a transition between the peat and the surrounding mineral soils. The muck soils are generally formed as a result of partial oxidation of surface peat. The oxidation causes a relative increase in the mineral content of the surface layer whilst admixture with the underlying layers takes place. When the loss on ignition varies between 20 and 35 per cent the relevant soil is referred to as organic clay.

Under natural conditions the peat swamps remain waterlogged up to the surface.

On drying the peat shrinks considerably. The water content exceeds the weight of the solid components (organic matter, sand, silt and clay) by 3 to 9 times. When completely dehydrated the peat cannot be wetted again or only with great difficulty (complete or partial irreversibility of drying and shrinking). If partly dried the shrinkage is rather well recovered after re-moistening (see Table 4-6 on the next page).

Table 4-6 - Water Content of Peat Soils

No of sample *	Percentage of peat and water by volume		Percentage recovery of shrinkage by volume	Percentage of water by weight (1)		Percentage of peat by weight (2)	Ratio (1) : (2)	Specific gravity of solid material
	under natural conditions	after partial de-moistening after re-moistening		water	solid material **			
C85-97-PA	100	67	11	69	31	2.2	0.8	
C85-97-PB	100	73	14	90	10	9.0	0.5	
C85-97-PC	100	76	11	81	19	4.3	0.5	
C85-97-PD	100	74	8	87	13	6.7	0.4	
C60-177-PE	100	74	7	87	13	6.7	0.7	
C87-97-PF	100	83	11	84	16	5.3	0.2	
C57-157-PG	100	74	4	75	25	3.0	0.4	
C85-97-PH	100	78	14	76	24	3.0	0.7	
C85-208-PI	100	83	2	77	23	3.0	0.6	

* the first part of the sample number refers to the aerial photograph run, the second to the photograph number and the third to the boring number

** solid material = organic matter + mineral soil

Closely related to both the depth of the peat and its physical properties is the question whether and, if so, how the peat areas are to be developed for agriculture. This problem - which is also linked to the possible acidification of the mineral substratum of the peat - will be dealt with in Sub-section 4.3.2.

The physico-chemical characteristics of peaty organic clay and muck layers are given in Table 4-7 on the next page.

4.3.2 Acidification of the Mineral Substratum of Peat Swamps

It is well known that unripened marine muds may be prone to strong acidification on oxidation if they contain great quantities of sulphides or elemental sulphur and are virtually free from lime.

These sulphides are changed into sulphuric acid. The oxidation is greatly influenced by the bacteria *Theobacillus thio-oxydans* which thrive in an organic environment.

Since the substratum of the coastal peat swamps is most likely of fluvio-marine origin, a number of samples of this substratum have been investigated in order to obtain information on the degree of soil acidity to be expected after possible drainage and aeration.

An indirect method to determine the sulphide content of the soils is a quantitative analysis on sulphates. In reducing the total quantity of sulphates by the quantity easily soluble in water (originating from e.g. gypsum which may be present in the non-oxidized soil), the amount of sulphates present as the result of oxidation of sulphides (pyrite) becomes known. The higher the latter amount the greater the potential acidity of the soil if it does not contain free carbonates.

All soils investigated appeared to be free from carbonates. Part of the exchangeable and soluble calcium ions may react with the sulphuric acid formed. For this reason the total quantities of calcium present and those easily soluble have been determined. The difference between the two (total calcium minus soluble calcium) represents the amount that will possibly compound with a part of the acid formed. The results of the analyses are given in Table 4-8 on page 20.

Comparing the figures of the column 'excess SO_4 ' and those of the column 'pH - H_2O after oxidation' as given in the table, a correlation appears to exist between the order of magnitude of the quantities of sulphate obtained after strong oxidation and the level of the pH finally reached.

Generally speaking, strong acidification (pH values of less than 3.5) is bound to take place when the amounts of 'excess SO_4 ' surpass 100 milli-equivalents per 100 gr of non-oxidized soil.

Soils that are deposited in a marine environment and upon drainage and aeration show signs of strong acidification (mottlings and streaks of basic ferric sulphate; low pH) are referred to as acid sulphate soils or 'cat-clays'.

It stands to reason that the pH values of acid sulphate soils are variable and depend on such factors as the sulphide content of the soil, the original sulphate content of both the soil and the soil solution, the lime content of the soil, the degree of leaching of the

Table 4-7 - Peat Soils: Analytical Data of Soil Layers at Various Depths in Peat Swamps

Depth	0" - 10"			10" - 40"			40" and deeper			
	peaty	organic	muck to peat	peaty	peaty	peaty	peaty	peaty	muck	organic
Nature of the soil										
texture of soil mass after removal of organic matter	SCL	C	-	SiL	SCL	C	SiCL	SiC	C	C
% sand	56	8	-	34	67	17	20	7	12	12
% silt	14	22	-	36	8	23	33	34	22	22
% clay	30	65	-	30	25	60	47	59	66	66
pH	5.1	4.3	3.8	4.6	4.7	4.2	4.4	4.0	3.4	3.4
	KCl	4.0	3.6	-	3.9	3.5	-	-	3.0	3.0
% nitrogen (N)	0.12	0.52	0.80	0.07	0.04	0.10	0.07	0.76	0.20	0.20
organic matter	2.12	9.08	26.31	2.30	1.82	3.80	4.36	16.76	8.48	8.48
% loss on ignition	4.7	20.7	61.8	5.0	4.0	11.5	10.9	41.9	21.2	21.2
ratio C/N	18	17	33	33	45	38	62	22	42	42
P ₂ O ₅ (p.p.m.)	181	263	364	-	117	159	-	-	335	335
total	384	706	1080	-	255	310	-	-	465	465
K ₂ O (p.p.m.)	49	75	168	-	25	34	-	-	41	41
total	578	3700	1155	-	530	1976	-	-	3346	3346
C.E.C.	6.1	27.0	41.7	8.7	4.1	22.2	12.8	49.1	21.6	21.6
Ca	0.6	1.0	2.6	0.8	0.3	0.5	0.5	0.9	0.7	0.7
Mg	0.4	1.3	3.3	traces	0.5	0.9	0.9	0.8	0.4	0.4
K	0.1	0.3	0.5	0.1	0.1	0.2	0.1	0.1	0.2	0.2
Na	0.2	0.2	0.4	traces	0.1	0.2	traces	traces	0.1	0.1
total	1.3	2.8	6.8	0.9	1.0	1.8	1.5	1.8	1.4	1.4
% base saturation	21	10	16	10	-	-	-	-	-	-
electrical conductivity (EC) of sat. extract (mmhos/cm)	-	-	-	-	0.9	1.4	0.4	1.1	6.2	6.2

Table 4-8 - Data relating to the Potential Acidity of the Mineral Substratum of Peat Swamps

No of sample	Depth	meq. per 100 gr. of soil										pH - H ₂ O before oxidation	pH - H ₂ O after oxidation
		total SO ₄	Ca	water soluble SO ₄	Ca	total SO ₄ minus water soluble SO ₄	total Ca minus water soluble Ca	excess SO ₄					
C 34- 21-11	152" - 192"	198.2	2.8	10.3	2.7	187.9	0.1	187.8	3.6	2.9			
C 34- 42- 5	8" - 40"	1.9	0.4	traces	0.1	1.9	0.3	1.6	4.4	4.2			
C 28-181- 5	24" - 40"	7.5	1.3	0.8	0.2	6.7	1.1	5.6	3.5	3.5			
	40" - 88"	174.6	3.8	18.6	1.2	156.0	2.6	153.4	3.3	2.3			
C 28-181-12	24" - 48"	36.0	3.0	traces	traces	36.0	3.0	33.0	4.6	4.5			
C 60-177-11	124" - 164"	17.2	1.4	0.3	0.2	16.9	1.2	15.7	4.8	4.4			
C 60-183-13	8" - 48"	5.6	1.3	traces	traces	5.6	1.3	4.3	4.9	4.7			
C 60-183-15	exceeding 60"	192.1	7.0	2.2	1.7	189.9	5.3	184.6	4.2	3.4			
C 73- 79-11	12" - 52"	233.2	0.3	6.3	traces	226.9	0.3	226.6	3.4	3.2			
	52" - 80"	291.8	3.1	6.0	0.1	285.8	3.0	282.8	3.3	2.9			
C 85-216- 9	32" - 48"	9.4	1.2	traces	0.1	9.4	1.1	8.3	4.5	4.1			
	48" - 68"	222.1	1.0	1.7	0.1	220.4	0.9	119.5	3.9	3.4			
C 85-218- 9	0" - 48"	13.0	2.7	traces	traces	13.0	2.7	10.3	4.8	4.4			
	48" - 68"	1.7	0.9	traces	0.1	1.7	0.8	0.9	4.3	3.9			
C 85-218-12	110" - 152"	1.9	2.1	traces	0.1	1.9	2.0	mil	4.4	4.2			

acid formed and the cation status of the exchange complex.

From the results obtained it appears that the unripened mineral sub-soil of shallow peat swamps becomes less acid after oxidation than that of deep ones. It is quite possible that this soil - generally found at the edges of the swamps - consists of fluvial sediments which overlie a marine substratum.

4.4 Marine Soils

The marine soils comprise the soils of the beach ridges, of the elongated shallow troughs between them and of the tidal flats.

4.4.1 Soils of the Beach Ridges (RDU₁ and RDU₂)

The soils of the ridges consist essentially of sand. The grain size distribution of beach ridge sands is given in Figure 1 on the next page. The older and therefore higher-lying ridges are podzolized. The lower-lying ridges that fringe the sea are non-podzolized.

The depth over which podzolization took place may vary considerably. Thus, the bleached, light grey, eluvial A₂ horizon may extend from the surface to a minimum depth of 8 inches or to a maximum depth of 5 feet. Generally, this horizon is overlain by a very dark brown organic surface layer, the thickness of which may vary from 8-16 inches.

The very dark brown or very dark grey humus-iron, illuvial (B₂) horizon extends below the bleached horizon over a depth of 6-16 inches when found in the upper part of the profile and of 20-30 inches when found below a depth of 2 feet. Generally, the illuvial horizon is not cemented, though it may be somewhat hardened locally (e.g. near Kampong Tabuan, topo sheet 38).

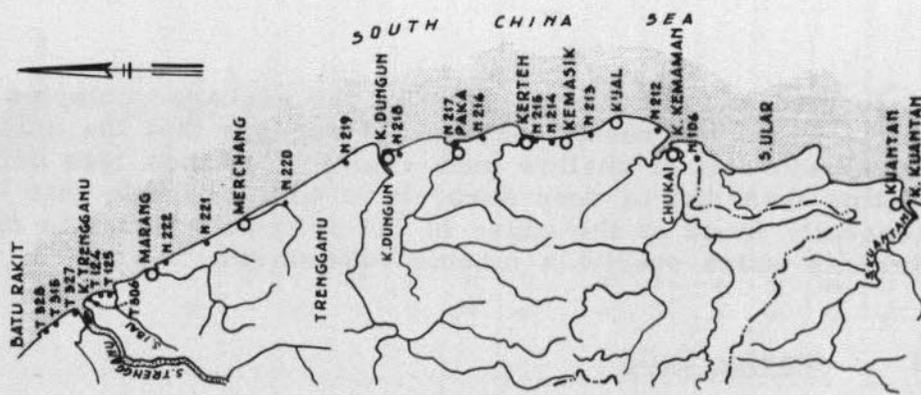
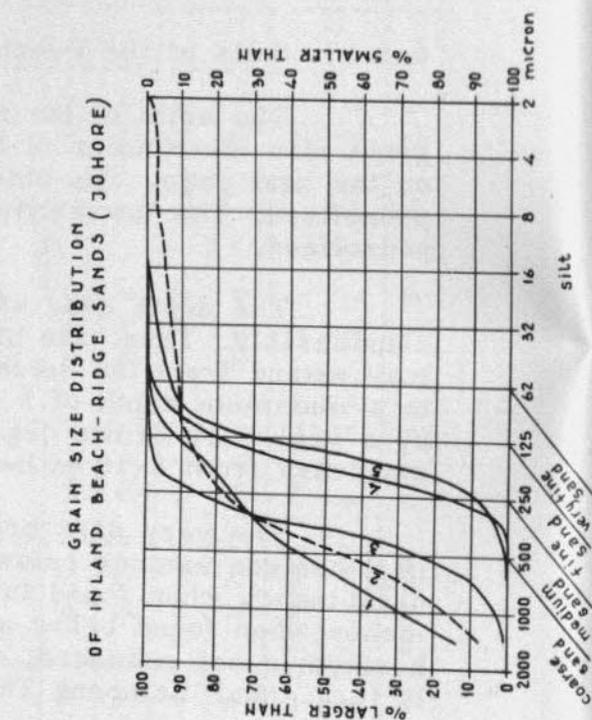
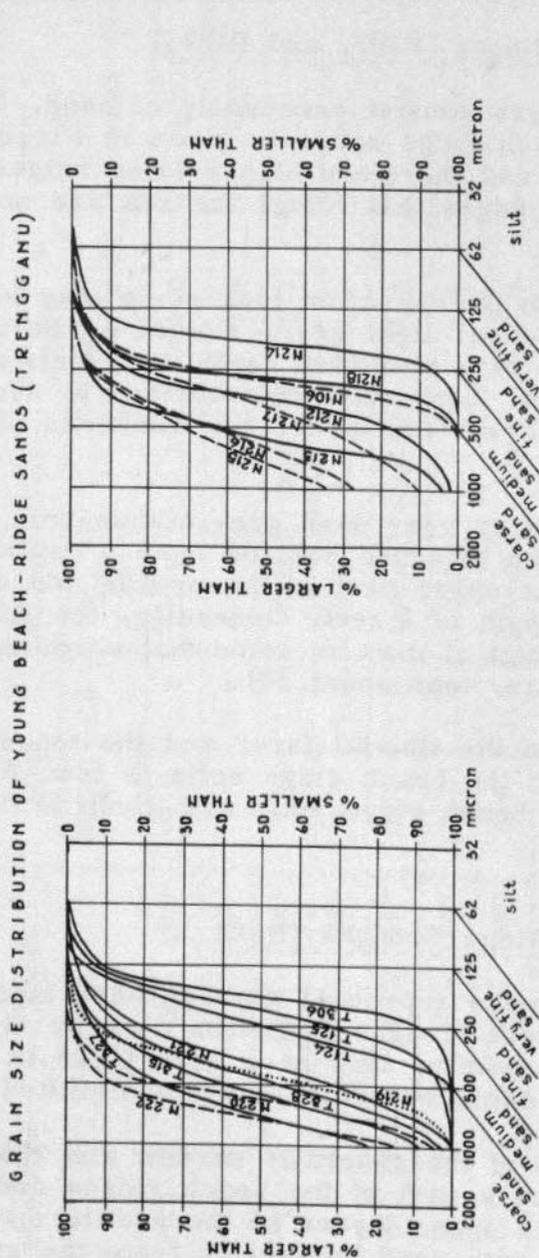
With the exception of the illuvial layer and the top soil, the organic matter content of the beach ridge soils is low. Average analytical data of podzolized beach ridge soils are given in Table 4-9 on page 23.

4.4.2 Soils of the Beach Ridge Troughs (RSL)

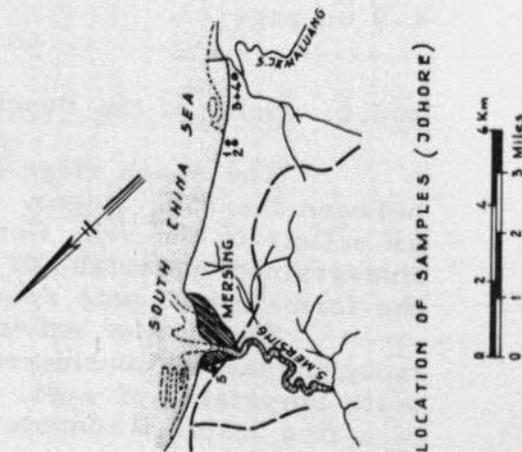
The beach ridge troughs represent the aggraded lagoons between the sand ridges. These troughs are often used by rivers as outlets to the sea. Consequently, they have been filled in with fine-grained material and became waterlogged which resulted in the formation of peat swamps.

The deeper sub-soil of the generally narrow and shallow troughs may be considered as a part of the beach ridges and consists unvariably of sand. The upper layers of the profile may be of a fine texture; admixture with sand brought in from the sur-

LAND AND SOILS
ANALYSIS OF YOUNG AND INLAND BEACH-RIDGE SANDS
AFTER J. J. NOSSIN



LOCATION OF SAMPLES (TRENGGANU)



LOCATION OF SAMPLES (JOHORE)

Table 4-9 - Average Analytical Data of Marine Soils

physiographic unit		beach ridges (RDU 1 and 2)						beach ridge troughs (RSL)		tidal flats (KNJ)				
profile development		podzolized				non-podzolized			variable		unripened			
horizon		A ₀	A ₁	B ₂	B ₃	1	2	3	1	2	1	2	3	
depth		0"-10"	10"-30"	30"-50"	50"-68"	0"-14"	14"-36"	36"-60"	0"-12"	12"-24"	0"-12"	12"-28"	28"-72"	
text ure	class													
	% sand	93	91	85	87	73	46	50	70	60	28	26	19	
	% silt	2	2	4	4	10	15	17	12	16	30	29	30	
	% clay	5	7	11	9	17	39	33	18	24	42	45	51	
	H ₂ O	4.4	5.0	4.9	4.6	5.1	3.8	3.6	4.4	4.6	3.3	3.1	3.4	
	KCl	3.9	3.8	4.3	4.4	4.1	3.3	3.4	3.7	3.8	3.2	2.9	3.1	
% Nitrogen (N)		0.04	0.02	0.03	0.02	0.05	0.03	0.02	0.05	0.03	0.17	0.15	0.14	
% Carbon (C)		0.67	0.19	0.73	0.55	0.86	0.75	0.45	1.39	0.53	4.58	4.42	4.19	
C : N		17	9	24	27	17	25	22	28	18	27	29	30	
P ₂ O ₅ (p.p.m.)	readily available	111	133	322	101	134	62	71	121	117	386	372	342	
	total	244	206	610	183	282	240	183	183	183	598	546	502	
K ₂ O (p.p.m.)	readily available	22	18	31	54	26	47	60	28	33	57	54	71	
	total	462	106	353	385	385	1733	1733	1252	1637	3179	3243	2986	
ex- change- able cations (m.e./ 100 g)	CEC	5.0	2.9	10.4	11.4	7.1	5.1	-	7.6	5.6	19.9	18.0	18.1	
	Ca	0.4	0.1	0.1	0.1	0.5	0.4	-	0.2	0.1	3.3	3.6	3.0	
	Mg	0.5	0.1	0.3	0.8	0.4	1.1	-	0.3	0.4	4.2	4.0	4.7	
	K	0.1	trace	0.1	0.1	0.1	0.1	-	0.1	0.1	0.3	0.1	0.1	
	Na	0.1	0.1	0.1	0.1	0.1	0.1	-	0.1	0.2	2.1	1.5	1.9	
	total	1.1	0.3	0.6	1.1	1.1	1.7	-	0.7	0.8	9.9	9.2	9.7	
% base saturation		22	10	6	10	16	33		9	14	50	51	53	
satur- ation ratio of ex- tract (m.e./l)	electrical conductivity	EC _e (mmhos/cm)	-	0.05	1.2	1.0	-	-	-	0.2	0.2	14.0	14.0	15.0
	com- posi- tion	Ca	-	0.2	0.9	0.7	-	-	-	0.4	0.2	19.2	16.2	16.6
		Mg	-	0.4	6.6	5.8	-	-	-	1.0	0.5	21.8	16.6	22.9
		K	-	0.1	1.3	1.2	-	-	-	0.1	0.1	2.3	0.6	1.3
		Na	-	0.2	1.3	1.1	-	-	-	0.8	1.0	110.0	112.5	99.1
		Cl	-	nil	trace	8.3	-	-	-	nil	nil	129.5	126.3	91.4
		SO ₄	-	nil	nil	trace	-	-	-	nil	nil	136.5	153.8	193.0
		CO ₃	-	nil	nil	nil	-	-	-	nil	nil	nil	nil	nil
		HCO ₃	-	nil	nil	nil	-	-	-	nil	nil	nil	nil	nil
		NO ₃	-	nil	trace	trace	-	-	-	nil	nil	nil	nil	nil

rounding beach ridges often occurs. Since hydromorphic conditions prevail in these troughs their top soil is very often peaty or mucky. Analytical data of trough soils are given in Table 4-9 on page 23.

4.4.3 Soils of the Tidal Flats (KNJ)

The tidal flats extend along the mouths of the main rivers in Trengganu. They generally support a mangrove vegetation.

Consisting of clay loam or silty clay the tidal flat deposits are marked by their high and rather constant silt content (27-33 per cent).

The organic matter content of these deposits is very high. Decayed mangrove roots are the main source of this organic matter. The flats are waterlogged at high tide. All soil layers are strongly saline. Average analytical data of tidal flat soils are given in Table 4-9 on page 23.

4.5 Soil Moisture Retention

Plants can grow in soils over a range of moisture contents referred to as the 'available range of moisture'. The quantity that is retained by the soil at a soil moisture tension of 0.1 atmosphere satisfactorily approximates the upper boundary of this range (field capacity, $pF = 2.0$).

The lower limit is formed by that quantity of moisture that is retained at a soil moisture tension of 15 atmospheres (wilting point, $pF = 4.2$).

The quantity of moisture retained by various soils at the same moisture tension differs and depends on soil texture, on soil structure and on the variations in pore-size distribution.

The quantity of 'available moisture' is defined as the difference between the soil moisture contents at field capacity ($pF = 2.0$) and at wilting point ($pF = 4.2$).

Both soil moisture percentages (by volume) at various moisture tensions and the quantities of 'available moisture' are shown for soil samples of the major soil mapping units in Table 4-10 on the next page.

From the figures mentioned in the table it appears that the percentages of 'available moisture' are low (1-8 per cent) in the case of beach ridge soils, the more sandy type of levee soil, some of the basin soils, especially in the Besut area, and the soils of the Marang series.

All other soils either retain moderately low to medium high (9-14 per cent) or high (15-40 per cent) quantities of 'available moisture'.

Table 4-10 - Soil Moisture Percentages at various Soil Moisture Tensions

Geo-morphological unit	Soil mapping unit	Profile no	Depth	Soil textural class	Available moisture percentage	Percentage of soil moisture retained at moisture tensions of:			
						0.1 atm. pF 2.0	0.5 atm. pF 2.7	2.6 atm. pF 3.4	15.2 atm. pF 4.2
first river terrace	levee (T ₁ L)	C 73- 9-A	14"	26	16	31	26	25	15
		C 73- 9-B	16"	18	9	24	20	19	15
		ditto	32"	22	8	21	17	20	13
		C 67-12-C	16"	29	24	37	33	24	13
		C 67-12-D	16"	35	19	36	33	30	17
		ditto	32"	42	15	35	33	32	20
		C 67-12-E	14"	43	16	42	39	38	26
		C 67-12-F	16"	46	15	36	33	32	21
		ditto	32"	49	13	39	38	35	26
	C 73- 9-N	14"	34	16	27	23	20	11	
	C 69-72-J	14"	-	8	32	29	27	24	
	basin (T ₁ B)	C 73- 9-G	16"	39	7	39	28	-	23
		C 73- 9-H	16"	67	12	48	47	46	36
		C 73- 9-I	16"	62	10	44	43	-	34
ditto		34"	36	9	41	36	-	32	
C 69-72-L		14"	45	15	42	39	39	27	
C 69-99-V		12"	58	15	45	43	-	30	
		24"	47	18	42	39	-	24	
second river terrace	levee (T ₂ L)	C 85- 91-P	14"	41	22	36	32	29	14
			28"	58	16	31	27	24	15
		C 85-207-Q	12"	22	9	23	22	18	14
			24"	26	9	23	22	19	13
		C 85-207-S	12"	16	8	11	8	5	3
		ditto	24"	12	21	28	23	12	7
	C 69- 94-T	12"	43	15	34	31	30	19	
	ditto	24"	39	12	35	32	29	17	
	basin (T ₂ B)	C 69-94-V	12"	54	18	45	44	41	27
		ditto	24"	49	25	46	42	41	22
beach ridge barrier	ridge	C 73-9-K	16"	31	4	15	13	12	11
		ditto	32"	15	6	12	8	6	6
peat swamps	shallow peat (PET/s)	C 85-207-R	12"	22	13	31	29	28	18
mountainous land on igneous rock (granite)	Jerangau series	C 54-113-Y	18"	42	14	34	32	25	20
		C 46-157-ZZZ	12"	36	11	29	26	23	18
		ditto	24"	48	13	33	29	28	20
mountainous land on sedimentary rock	Marang series	C 54-113-X	12"	26	14	23	18	12	9
		ditto	24"	34	9	32	30	27	23
	Kuala Brang series	C 39- 93-Z	14"	40	15	34	31	29	19
ditto	28"	49	13	37	36	35	24		

5 ACREAGE DISTRIBUTION OF THE SOIL MAPPING UNITS

In Table 5-1 on the next page the distribution of the acreages covered by the various types of soil within the districts and within the State are shown.

It appears that about half of the State territory is occupied by steep land. The remaining portion is made up of about 16 per cent sedentary soils with slopes of less than 20 degrees, of approximately 9.5 per cent local alluvium and colluvium soils (found as gully and ravine bottoms), of about 12 per cent fluvio-alluvial land (river plains, terraces), of about 4.5 per cent of marine soils (beach ridges, tidal flats) and of 4.5 per cent of peat swamps.

6 CLASSIFICATION OF THE LANDS ON THEIR SUITABILITY FOR AGRICULTURE

6.1 General

In determining the suitability of the lands for agriculture the aspects which are inherent to crop production as such and those which influence its economic output have to be determined.

The factors which determine the economic output of crop production are dealt with in the Annex on Crop and Livestock Production.

Those inherent to crop production as such are:

- the suitability of the soil in the context of its physico-chemical characteristics
- the suitability of the site in the context of climatic, topographic and hydrological characteristics

It will be clear that the suitability of the site may be influenced or even determined by certain characteristics of the soil. A low soil permeability e.g. may result in permanent waterlogging of the site under natural conditions. It also stands to reason that the evaluation of both soil and site is closely linked to the envisaged type of crop production. The ecological demands of e.g. oil palm are quite different from those of padi. Consequently, the soils and sites have to meet varying requirements.

The soil suitability classification in Malaya as outlined in Bulletin no 119 of the Division of Agriculture (1) is based on soil (and site) features which limit the suitability of the land.

Based on data obtained from the schematic reconnaissance survey of Malaya this classification system is necessarily broad in approach and aims primarily at the assessment of suitabilities for the main cash crops of the country, i.e. rubber and oil palm.

With the planning of the agricultural development schemes for the State of Trengganu more crops, however, are taken into consideration. Though basically the same as the system mentioned in Bulletin no 119 (5 suitability classes, comprising soils with no limitations up to and including soils with at least one very serious limitation to agriculture), the evaluation of the soil units has been

Table 5-1 - Acreage Distribution of the Soil Mapping Units

Reference number on soil map J. 250,000	Soil mapping unit			Districts						State	
	Name	Angle of slope	Symbol	Besut	Kuala Trengganu	Ulu Trengganu	Marang	Dungun	Kemaman	Total	Percentage of total acreage
1	Jerangau-Rengam Association	< 12°	JRA-RGM c	15,376	25,892	40,672	4,960	17,806	20,138	124,844	3.9
2	Kuantan Series	< 12°	KUN c	-	-	-	-	-	5,059	5,059	0.2
3	Kuantan Series	12°-20°	KUN d	-	-	-	-	-	1,109	1,109	0.1
4	Munchong-Apek Association	< 12°	MUN-APK c	13,789	3,075	7,490	-	11,240	2,331	37,925	1.2
5	Segamat-Katong Association	< 12°	SGT-KTG c	-	-	397	-	-	-	397	0.01
6	Jerangau-Rengam Association	12°-20°	JRA-RGM d	9,622	12,004	31,545	-	20,782	36,109	110,062	3.5
7	Segamat-Katong Association	12°-20°	SGT-RGM d	-	-	3,869	-	-	-	3,869	0.1
8	Kuala Brang-Marang Association	< 12°	KLG-MRG c	2,034	7,440	2,281	198	8,872	24,403	45,228	1.4
9	Munchong-Apek Association	12°-20°	MUN-APK d	12,698	4,960	31,645	-	20,288	6,994	76,585	2.4
10	Kuala Brang-Marang Association	12°-20°	KLG-MRG d	2,579	6,300	12,249	695	12,549	31,000	65,372	2.1
11	Local Alluvium and Colluvium		LAA	26,587	21,924	58,578	13,591	89,627	87,296	297,603	9.4
12	Soils of the First Terrace (undifferentiated)		T1	6,498	99	2,728	1,339	38,390	6,547	55,601	1.8
13	Soils of the First Terrace (levee soils)		T1 1	15,277	1,340	645	-	-	-	17,262	0.6
14	Soils of the First Terrace (basin soils)		T1 b	22,520	10,516	198	1,290	-	-	34,524	1.1
15	Soils of the Second and Third Terraces (undifferentiated)		T2, T3	22,717	19,096	42,011	-	2,381	5,208	91,413	2.9
16	Soils of the Second Terrace (levee soils)		T2 1	-	17,261	2,083	-	-	-	19,344	0.6
17	Soils of the Second Terrace (basin soils)		T2 b	-	21,031	4,414	-	-	-	25,445	0.8
18	Valley Bottom Association		VBA	1,489	6,448	5,308	198	2,480	3,174	19,097	0.6
19	Soils of the high water plain		HWP	13,690	3,912	8,433	10,218	19,344	42,061	97,658	3.1
20	Soils of the low water plain		LWP	2,877	1,538	546	4,663	1,389	8,333	19,346	0.6
21	Soils of the beach ridges (Rudua Series)		RDV 1	44,045	16,220	-	11,557	8,630	10,267	90,719	2.9
22	Soils of the truncated beach ridges		RDV 2	19,394	6,051	-	1,389	893	1,190	28,917	0.9
23	Soils of the beach ridge troughs (Rusila Series)		RSL	1,786	2,431	-	3,670	2,877	2,083	12,847	0.4
24	Soils of the tidal flats (Kranji Series)		KNJ	1,998	347	-	496	694	3,571	7,106	0.2
25	Soils of the peat swamps (shallow phase)		PET/s	546	2,728	-	10,863	6,398	2,530	23,065	0.7
26	Soils of the peat swamps (deep phase)		PET/de	24,750	27,234	198	20,287	29,611	22,469	124,549	3.9
27	Marang-Kuala Brang Association	< 12°	MRG-KLG c	2,629	794	595	15,079	2,034	893	22,024	0.7
28	Marang-Kuala Brang Association	12°-20°	MRG-KLG d	446	447	99	8,630	2,778	50	12,450	0.4
29	Steepland	> 20°	STP	207,626	89,776	686,018	27,479	360,691	287,234	1,658,824	52.4
Disturbed land, towns, villages				500	1,389	-	-	1,686	694	4,269	0.1
Rivers				2,232	2,480	1,091	694	3,968	5,803	16,268	0.5
T o t a l				475,887	318,586	951,376	137,296	665,458	617,123	3,165,726	100
District-wise percentage distribution				15.0	10.1	30.4	4.2	21.0	19.3	100	

somewhat more attuned to a wider range of crops, whilst also the number and kind of limitations that influence the suitability of the land may somewhat deviate from those recognized in the 'Soil Suitability Classification in Malaya' (1).

The location and extent of areas which are considered suitable for the growing of a great variety of crops (tree crops, padi, etc.) are indicated on Plate III-1.

Within the scope of this study a distinction has been made between the following types of agriculture:

- the cultivation of tree crops, including fruit trees, oil palm, rubber, cocoa, coconut and cashew
- the cultivation of annual crops and pineapple
- the cultivation of wet padi (irrigated and rainfed sawah padi)

Both the suitability of the soil and the site may be evaluated in terms of the prevailing conditions or in terms of ameliorated conditions.

In the assessment of the future suitability of soil and site the results of reclamation techniques have to be taken into account to a larger extent than in the evaluation under the present conditions.

The cost involved in improvement of soils and sites for crop production as such is, of course, but one of the many factors which influence its economic feasibility.

6.2 Suitability of the Lands for the Cultivation of Crops under Present Conditions

6.2.1 General

In determining the suitability of the lands for the cultivation of crops the following characteristics have been evaluated in terms of the degree to which they meet the ecological requirements of these crops:

- | | | |
|---|---|---|
| - soil morphometric characteristics | } | factors determining the suitability of the soil as such |
| - soil physico-chemical characteristics | | |
| - soil permeability | | |
| - soil depth | | |
| - internal drainage and drainability | | |
| - moisture retention | | |
| - soil slope | } | factors determining the suitability of the site |
| - liability to flooding | | |
| - external drainage and drainability | | |
| - shape and extent of the soil unit | | |

The distributive pattern of the soil units is to determine which regions with promising soils should be given attention in the planning of agricultural development schemes.

6.2.2 Evaluation of the Land on its Suitability for the Cultivation of Tree Crops, including Fruit Trees, Oil Palm, Rubber, Cocoa, Coco-nut, and Cashew

A paramount criterion in evaluating land on its suitability for the cultivation of tree crops is that it should be constituted of nearly level to hilly terrain with, preferably, homogenous soils. These soils should be rather deep, well-aerated and medium to moderately fine-textured. Limitations that restrict or impede the production of tree crops are:

- excessive steepness of the terrain (angle of slope more than 20 degrees)
- the presence of thick, hardened plinthite or rock at a depth of less than 2 feet in the soil profile
- a poor external and internal drainage as manifested by permanent or very frequent waterlogging or high groundwater tables
- regular flooding
- a very fine or coarse texture of the soil
- a low moisture-retaining capacity of the soil
- a strong dissection of the terrain
- the presence of water-saturated peat above the mineral subsoil
- a strong acidity of the soil
- a high potential acidity of the soil
- soil salinity and alkalinity
- a low nutrient level of the soil

A classification of the soil units in terms of their suitability for the growing of tree crops has been made by comparing the kind of limitations applicable to the different soil units and the degree to which these limitations manifest themselves with the ecological demands of such crops (see Table 6-1, page 30).

6.2.3 Evaluation of the Land on its Suitability for the Cultivation of Annual Crops, Pineapple and Vegetables

The presence of nearly level to level terrain with rather deep, well-aerated, moderately coarse to moderately fine-textured preferably homogenous soils is also here the criterion in evaluating the land on its suitability for the cultivation of annual crops, pineapple and vegetables.

The limitations which restrict or impede the production of these crops are identical to those mentioned in Sub-section 6.2.2; the excessive steepness of the terrain, however, has to be extended to an angle of slope of more than 3 degrees.

The classification of the soil units in terms of their suitability for the growing of annual crops, pineapples and vegetables is shown in Table 6-2 on page 31.

Table 6-1 - Classification of Soil Units in Terms of their Suitability for the Growing of Tree Crops

Suitability of the soil units for the growing of tree crops	Soil units *	Type of tree crop
highly suitable	JRA-RGM c; KUN c SGT-KTG c; T ₂ + T ₃ ; T ₂ L; T ₁ L	oil palm fruit trees cocoa coco-nut
	JRA-RGM c; KUN c; KUN d; SGT-KTG c; MUN-APK c; VBA; T ₂ + T ₃ ; T ₂ L; T ₁ L	rubber
highly suitable to suitable	KUN d; MUN-APK c; VBA	oil palm, fruit trees, cocoa, coco-nut
	JRA-RGM d; SGT-KTG d; KLG-MRG c; MUN-APK d	rubber
locally suitable	LAA; T ₁	oil palm, fruit trees, rubber, cocoa, coco-nut
suitable to marginally suitable	JRA-RGM d; SGT-KTG d; KLG-MRG c	oil palm, fruit trees, cocoa, coco-nut
marginally suitable	MUN-APK d	oil palm, fruit trees, cocoa, coco-nut
	KLG-MRG d	rubber
unsuitable	RDU ₁	cashew and coco-nut
	MRG-KLG c; MRG-KLG d; STP; PET/s; PET/de; RDU ₂ ; KNJ; RSL; T ₂ B; T ₁ B; HWP; LWP	all tree crops mentioned

c = angle of slope less than 12°

d = angle of slope 12° - 20°

* see Table 4-1

Table 6-2 - Classification of Soil Units in Terms of their Suitability for the Growing of Annual Crops, Pineapple and Vegetables

Suitability of the soil units for annual crops, pineapple & vegetables	Soil units	Type of annual crop
highly suitable	VBA T ₂ + T ₃ T ₂ L T ₁ L	root crops, pulses grain crops* pineapple, vegetables
locally suitable	T ₁	root crops, pulses, grain crops*, pine- apple, vegetables
suitable to marginally suitable	T ₁ B T ₂ B	pulses, grain crops* pineapple, vegetables
marginally suitable	HWP	pulses, grain crops* pineapple, vegetables
unsuitable	JRA-RGM c+d KUN c+d SGT-KTG c+d MUN-APK c+d KLG-MRG c+d MRG-KLG c+d STP; RDU ₁ ; RDU ₂ ; RSL; PET/s; PET/de; LAA; KNS; LWP	root crops, pulses, grain crops, pine- apple and vegetables

c = angle of slope less than 12°

d = angle of slope 12° - 20°

* chiefly maize and dry-land padi

6.2.4 Evaluation of the Land on its Suitability for the Growing of Sawah Padi

For the cultivation of sawah padi under the present or slightly improved conditions the land has to meet different requirements.

A very important criterion that determines the possibility of padi growing is the availability of water. The water should be present in such quantities that the growth of padi is neither made impossible nor inhibited.

During periods of river floods - coinciding with the main season - the Low Water Plain and certain parts of the High Water Plain are inundated in such a way that the cultivation of padi is impossible, as the seedlings would be entirely submerged.

Successful padi-growing in sawahs is only possible when the land is less deeply submerged than the stalk-length of the seedlings permits and transplanting starts before the heavy rains of the main season set in.

The use of tall padi varieties which can stand higher inundations at the time of maximum flooding offers the possibility of cultivating somewhat lower-lying terrain. These varieties, however, give lower yields.

At any rate, the suitability of the terrain is greatly determined by the maximum submergence and therefore by its elevation and by the possibility of good external drainage. This means that only the basin slopes may be used for padi-growing during the main season since on the one hand an adequate water supply and on the other sufficient runoff towards the low-lying depressions and 'alors' are guaranteed here.

As to the possibility to cultivate sawah padi rather soon after the floods, i.e. in the beginning of February, various parts of the High Water Plain are adequately drained externally to permit the transplanting of padi. The rainfall is, however, low after the recession of the flood water. Moreover, the quantity of 'available moisture' (see Sub-section 4.5) in the soils is rather low and cannot make up for the deficiency in rain on the long run. The cultivation of sawah padi in the off-season is, therefore, restricted to the lowest-lying parts of the basins where the inundation water has sufficiently receded to allow padi-growing but the land has not yet emerged.

The classification of the soil units in terms of their suitability for the cultivation of sawah padi is shown in Table 6-3 on the next page.

Table 6-3 - Classification of Soil Units in Terms of their Suitability for the Growing of Sawah Padi

Suitability of the soil units for sawah padi	Soil units	Type of crop
highly suitable	T ₁ B T ₂ B	sawah padi
locally highly suitable	T ₁	
locally suitable	LAA	
highly suitable to marginally suitable (depending on the rate of submergence)	HWP	
marginally suitable	RSL PET/s	
unsuitable	JRA-RGM c+d KUN c+d SGT-KTG c+d MUN-APK c+d KLG-MRG c+d MRG-KLG c+d STP PET/de VBA; T ₂ + T ₃ ; T ₂ L; T ₁ L; RDU ₁₊₂ ; KNJ; LWP	

c = angle of slope less than 12°

d = angle of slope 12° - 20°

6.2.5 Summarized Land Suitability Classification; Acreage Distribution of the Classification Items

In order to provide a practical guide for the future agricultural use of the lands of the State the results of the land suitability classification are summarized in Table 6-4 on the next page.

6.3 Suitability of the Lands for the Cultivation of Crops under Technically Improved Conditions

6.3.1 General

In determining the suitability of the land for agriculture under technically improved conditions the aspects of soil and site improvement have to be taken into account in the criteria.

The costs involved in improvement, of course, have a great impact on the decision whether and, if so, to which areas of unsuitable land reclamation techniques should be applied.

Within the scope of the study of the land capability it did not prove possible to arrive at reliable estimates of the actual costs involved in various reclamation measures considered necessary for an improvement of soil and site. Therefore only the aspects of reclamation and their expensive nature, when necessary, have been mentioned.

Soil and site improvement include such items as tillage, fertilizing, lowering of the groundwater table by artificial or improved natural drainage, desalinization and de-acidification, clearing, levelling, terracing, flood protection, improvement of surface drainage and construction of irrigation systems.

6.3.2 Possible Improvement of Unsuitable Soils for the Cultivation of Tree Crops

A considerable part of the soil units which are considered unsuitable for the growing of tree crops will remain so because of the nature of their limitations.

The unit MRG-KLG e.g. might be given high fertilizer applications to improve the nutrient level of its soil, but the shallowness and the coarse texture of the profile are qualities which cannot be changed. The same applies to the greater part of the steep-land.

Where deep profiles occur, the steep-land needs terracing to become suitable for the cultivation of tree crops. Apart from the extra costs involved in the preparation of the terraces, the costs for road building will increase tremendously whenever this steep-land would be made suitable. It is therefore very unlikely that tree crop production will be ever profitable here.

Other units, such as the basin soils of the terraces, the soils of the High Water Plain and the Low Water Plain and the mineral soils of the peat swamps are too fine-textured for tree crop production and neither proper drainage nor flood protection or any other reclamation measures can change this.

Table 6-4 - Summarized Soil Suitability Classification and Acreage Distribution of the Classification Units

Units of the suitability classification	Soil mapping units	Districts					Total	In per- centages of total acre- age	
		Besut	Kuala Trengganu	Ulu Trengganu	Marang	Dungun			Kemaman
(1) Soils highly suitable to suitable for the growing of a great variety of tree crops	JRA-RGMc; KUN c+d; MUN-APK c; SGT-KTG c	29,165	28,967	48,559	4,960	29,046	28,718	169,415	5.4
(2) Soils suitable to marginally suitable for the growing of a great variety of tree crops; highly suitable to suitable for the growing of rubber	JRA-RGM d; KLG-MRG c	11,656	19,444	37,659	198	29,654	60,512	159,159	5.0
(3) Soils marginally suitable for the growing of a great variety of tree crops; suitable for the growing of rubber	MUN-APK d	12,698	4,960	31,645	-	20,288	6,994	76,585	2.4
(4) Soils marginally suitable for the growing of rubber	KLG-MRG d	2,579	6,300	12,249	695	12,549	31,000	65,372	2.0
(5) Soils locally suitable for the growing of a great variety of tree crops and locally suitable for the growing of sawah padi	LAA, T 1	33,085	22,023	61,306	14,930	128,017	93,843	353,204	11.1
(6) Soils highly suitable for the growing of a great variety of tree crops and annual crops	T ₂ + T ₃ ; T ₂ L; T ₁ L; VBA	41,665	49,998	58,330	198	4,911	8,878	163,980	5.1
(7) Soils marginally suitable for the growing of cashew and coconut	RDUI	44,045	16,220	-	11,557	8,630	10,267	90,719	2.8
(8) Soils highly suitable for the growing of sawah padi; suitable to marginally suitable for the growing of annual crops	T ₂ P; T ₁ B	22,520	31,547	4,612	1,290	-	-	59,969	1.8
(9) Soils marginally suitable for the growing of sawah padi	HWP; RSL; PEI/s*	16,022	9,071	8,433	24,751	28,619	46,674	133,570	4.2
(10) Unsuitable for agricultural development	STP; MRG-KLG c+d; PET de; RDV2; KNJ; LWP; D1L; rivers, disturbed land	262,452	130,056	688,547	78,717	403,744	330,237	1,893,753	59.8
Total		475,887	318,586	951,376	137,296	665,458	617,123	3,165,726	100
District-wise percentage distribution		15.0	10.1	30.4	4.2	21.0	19.3	100	

* suitable for the growing of pineapple if properly drained.

The same applies to the soils of the tidal flats which might be empoldered but where additional problems of salinity and acidification will be met with.

Among the units qualified as unsuitable for tree crop cultivation under present conditions (see Table 6-1 on page 30) there is actually only one that might be improved, viz. the unit MRG-KLG c.

With continual extra applications of fertilizer year after year this unit may become marginally suitable for the cultivation of oil palm and suitable to marginally suitable for the cultivation of rubber.

6.3.3 Possible Improvement of Unsuitable Soils for the Cultivation of Annual Crops, Pineapple and Vegetables

The soils which are considered unsuitable for the growing of annual crops, pineapple and vegetables have been grouped as follows:

- a) soils of the Low Water Plain
- b) soils of the beach ridges and troughs
- c) soils of the tidal flats
- d) soils of the peat swamps
- e) soils of the ravines and gullies (local alluvium)

The soils of the hilly and mountainous uplands have angles of slope which exceed 3 degrees, which is too steep for the growing of annual crops. Those of the tidal flats will require an expensive empoldering and reclamation programme the costs of which will not be offset by the returns to be obtained from the crops cultivated.

The soils of the beach ridges might be made suitable for the growing of vegetables by applying sprinkler irrigation and by the use of high quantities of fertilizer and manure. It will be clear, however, that even with an increased future urban consumption the prospects for profitable vegetable growing are better on soils that are suited to this cultivation by nature.

Therefore, improvement of the beach ridge soils is not recommended. The same applies to the soils of the beach ridge troughs and of the ravines and gullies which all need drainage, fertilizing and manuring.

The reclamation of the peat soils which are waterlogged to the surface will primarily require the lowering of the groundwater table by artificial drainage.

Lowering of the groundwater table to such a depth that a well-aerated root zone of 1 foot thickness is obtained is sufficient for the cultivation of pineapples.

Well-drained peat, however, undergoes shrinkage through oxidation and drying. This causes a considerable decrease in volume of the drained part of the profile and results in subsidence of the peat soils. Consequently, the depth to the lowered groundwater table decreases.

If a fixed depth to the groundwater level should be maintained as desirable for the cultivation of pineapples, renewed lowering of the groundwater table would be necessary, which, in turn, requires

deeper drainage. As soon as the latter has been effected, the process of oxidation extends to greater depth and brings about a further subsidence. When eventually the mineral sub-soil has been reached, new problems arise.

Subsidence of the mineral sub-soil might still continue since its clays are generally unripened or half-ripened. On oxidation they undergo physical and chemical changes; the decrease in soil volume is very spectacular.

Moreover, when found to underlie the coastal peat swamps, the mineral soils are subject to strong acidification as soon as they oxidize. This is the direct result of the oxidation of sulphides present in the deposits.

From the foregoing it is clear that the reclamation of the peat swamps is a complicated matter which - depending on the depth of the peat - is more or less expensive. As long as drainage to lower-lying areas or rivers is possible, the costs are relatively low. When, however, as a result of subsidence the drainage has to be effected by pumping, the cultivation of pineapples is likely to become a non-economic proposition. It seems advisable to restrict the reclamation of peat swamps to those that have a shallow depth (unit PET/s).

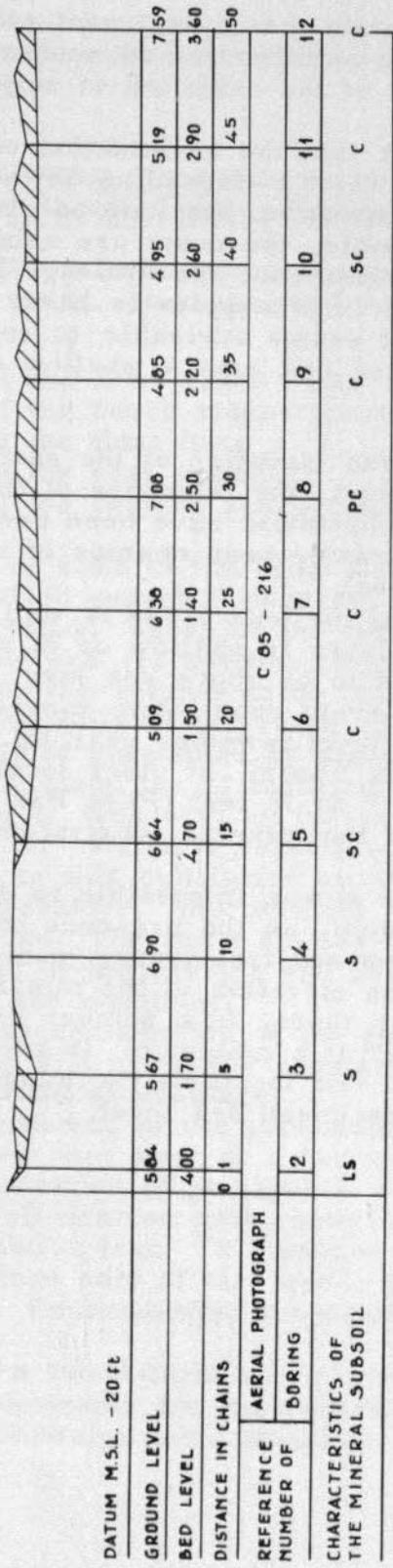
Investigations with regard to the elevation of the surface of the peat swamps above mean sea level, the thickness of the peat layers and the depth to the mineral substratum have been carried out in a number of trace lines in the major peat swamps of the country (see Figure 2 on the next pages).

It appeared that the surface of the peat layer is well above sea level at present. Where the peat layer is shallow or of medium depth the mineral substratum appeared to be above sea level. At various places the elevation of the relevant substratum ranges between 12 and 20 feet above mean sea level (swamps near Kg. Guntong, Besut; Paya Mengkuang; Paya Besar), at other localities the elevation is less and varies from 2 to 12 feet (Paya Pak Sabah; Paya Tasek Beromok). The texture of the mineral substratum may be either sandy or clayey.

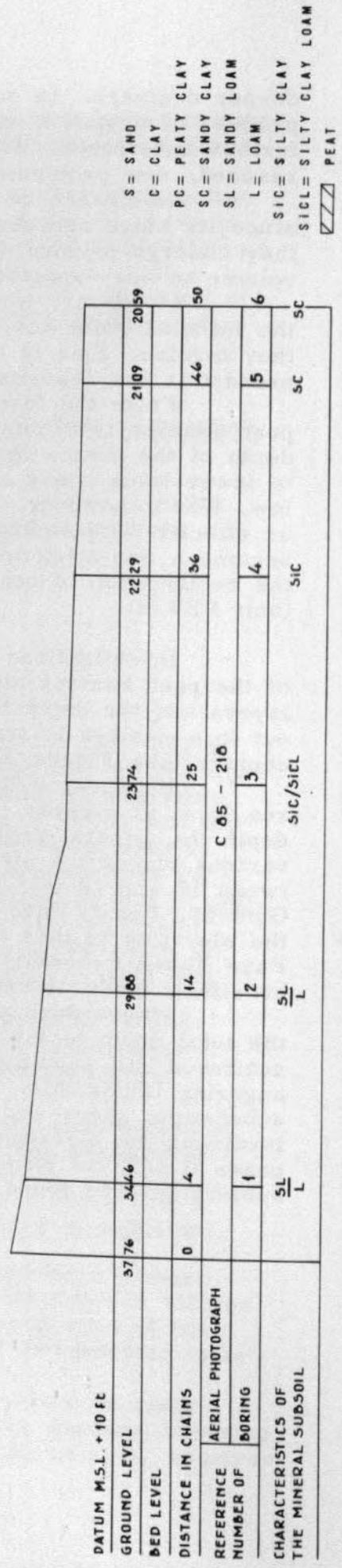
Where deep peat layers occur it was impossible to determine the total depth to the mineral substratum, as the presence of scattered half decomposed or undecomposed tree trunks made deep augering impossible. Consequently, the elevation of the mineral substratum above sea level is unknown there. In a number of instances the elevation might be 8 feet at a maximum; in other cases it will not exceed 20 feet. At a few locations the mineral substratum was found to be lying below mean sea level.

LAND AND SOILS
CROSS SECTION LINE 24
(PAYA TASEK BEROMOK)
TOP SHEET 24

SCALE
1" : 8 CHAIN/1" : 40'



CROSS SECTION LINE 25
(ANAK IKAN BESUT)



S = SAND
C = CLAY
PC = PEATY CLAY
SC = SANDY CLAY
SL = SANDY LOAM
L = LOAM
SIC = SILTY CLAY
SICL = SILTY CLAY LOAM
 PEAT

LAND AND SOILS
CROSS SECTION LINE 27
 (K.B. GUNTONG BESUT)
 TOP SHEET 25

SCALE
 1" = 8 CHAIN/1' : 40'

▨ PEAT
 C = CLAY
 SiC = SILTY CLAY
 SC = SANDY CLAY
 Gr.LS = GRAVELLY LOAMY SAND

DATUM M.S.L. - 20 ft	C 73 - 205											
	GROUND LEVEL	1485	1525	1496	1496	1476	1517	1497	1522	1572	1499	1516
BED LEVEL				1530			1450			1470		
DISTANCE IN CHAINS	0	1	5	10	14	19	26	30	36	40	45	50
REFERENCE NUMBER OF BORING	1	2	3	4	5	6	7	8	9	10	11	
CHARACTERISTICS OF THE MINERAL SUBSOIL	Gr.LS	SC/C	C/SiC	C/SiC	C/SiC	C/SiC	C/SiC	C/SiC	SiC/SC	SC	C/SiC	C/SiC

LAND AND SOILS

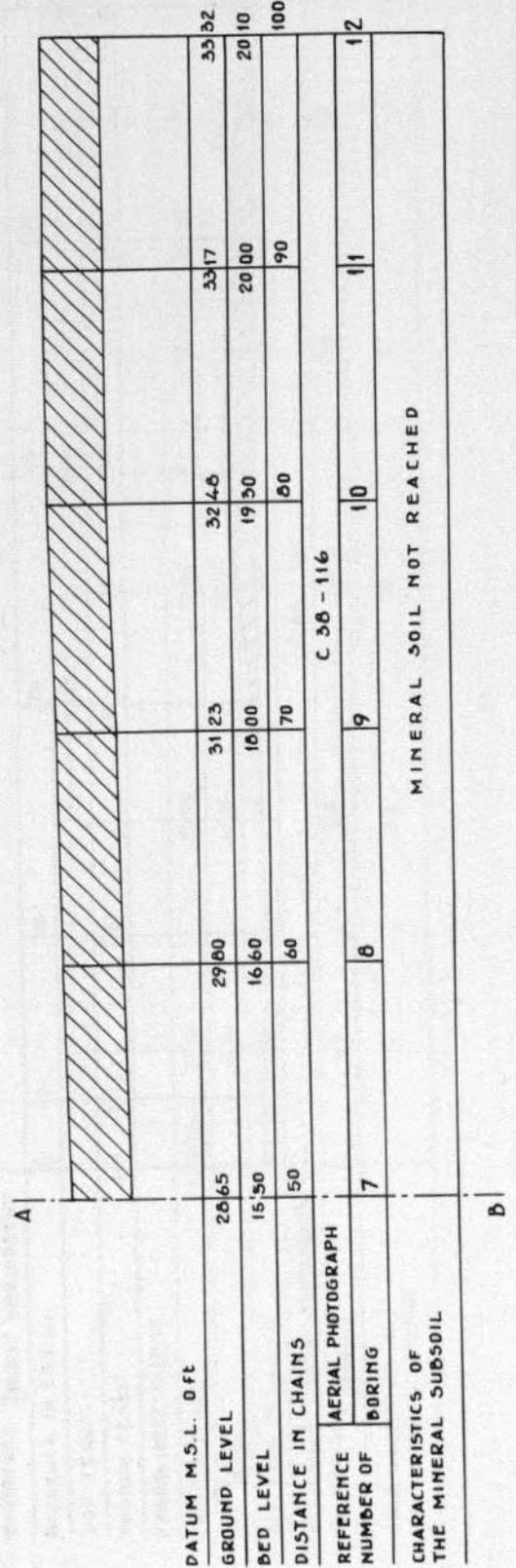
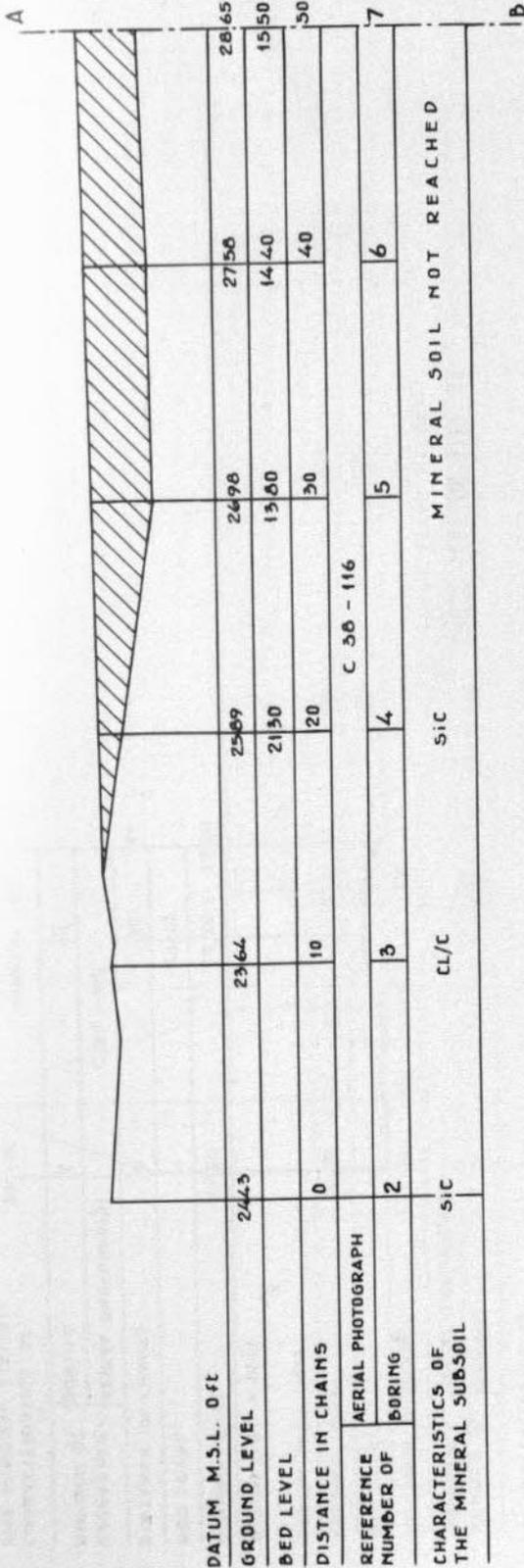
CROSS SECTION LINE 30

(PAYA HUTAN near Sg. DELONG)

TOP. SHEET 50/51

SCALE

1" : 8 CHAIN/1" : 40'



PEAT

C = CLAY

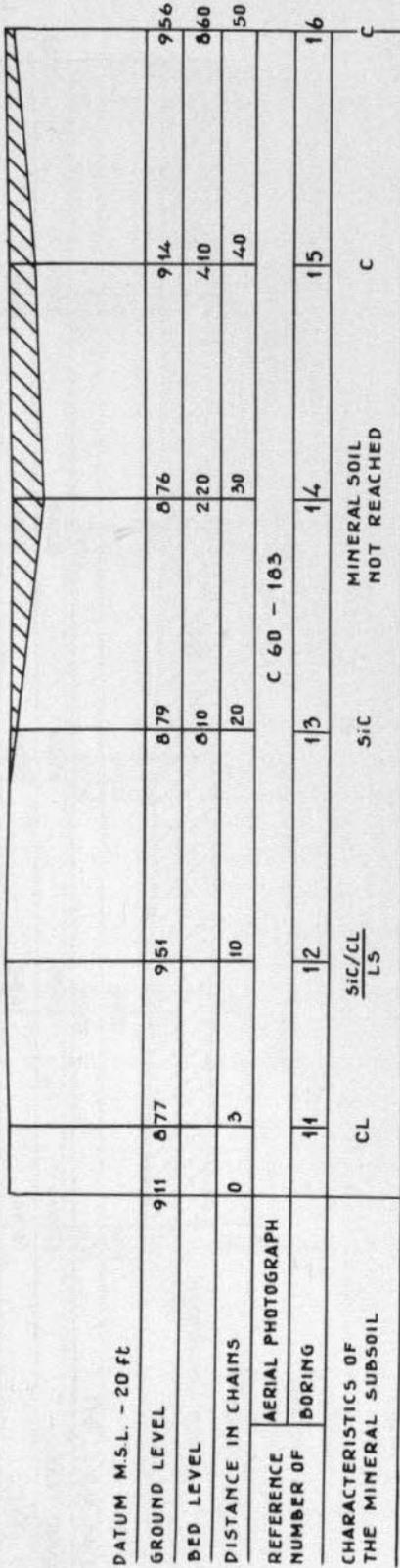
SIC = SILTY CLAY

CL = CLAY LOAM

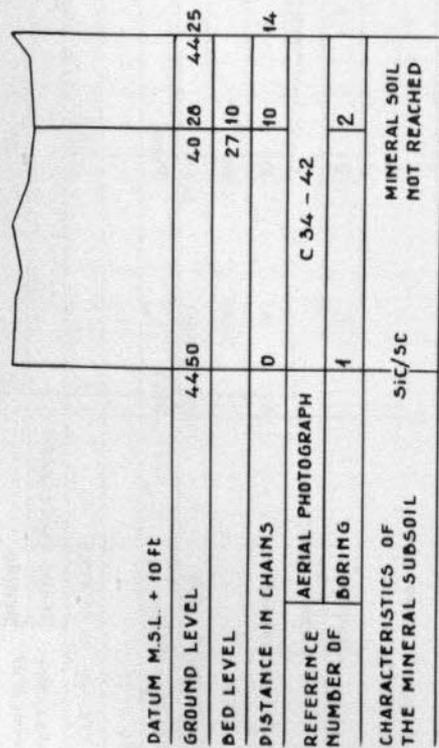
LAND AND SOILS
CROSS SECTION LINE 32
 (PAYA PAK SABAH)
 TOP. SHEET 50/51

SCALE

1" : 8 CHAIN/1" : 40'



CROSS SECTION LINE 33
 (PAYA TANAH HITAM)

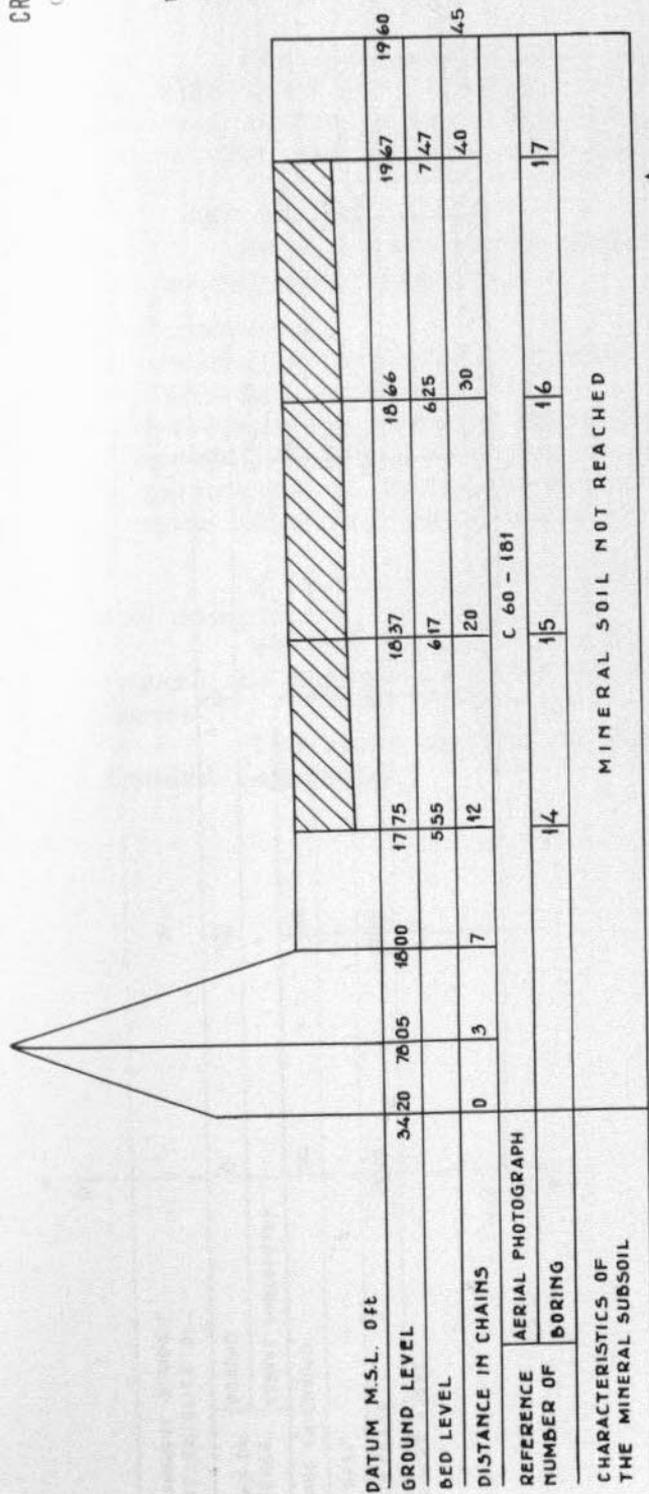


PEAT
 C = CLAY
 CL = CLAY LOAM
 SiC = SILTY CLAY
 SC = SANDY CLAY
 LS = LOAMY SAND

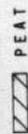
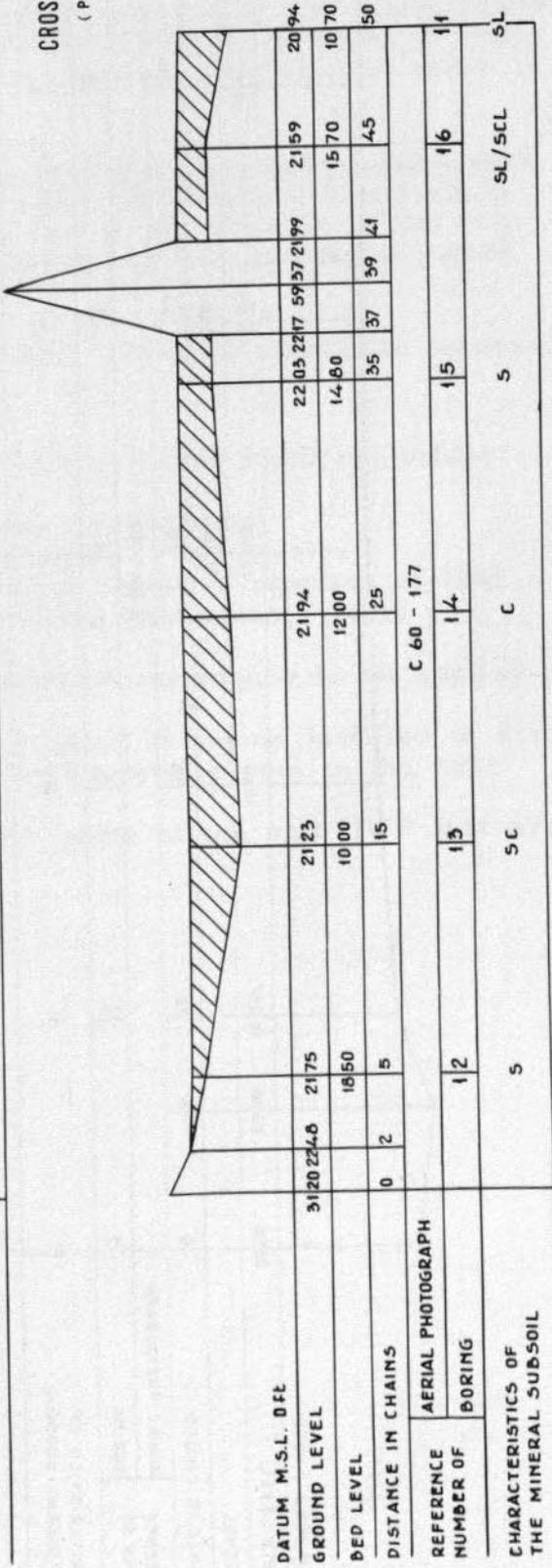
LAND AND SOILS
 CROSS SECTION LINE 34
 (PAYA TANAH HITAM)
 TOP SHEET 62

SCALE

1" : 8 CHAIN / 1" : 40'



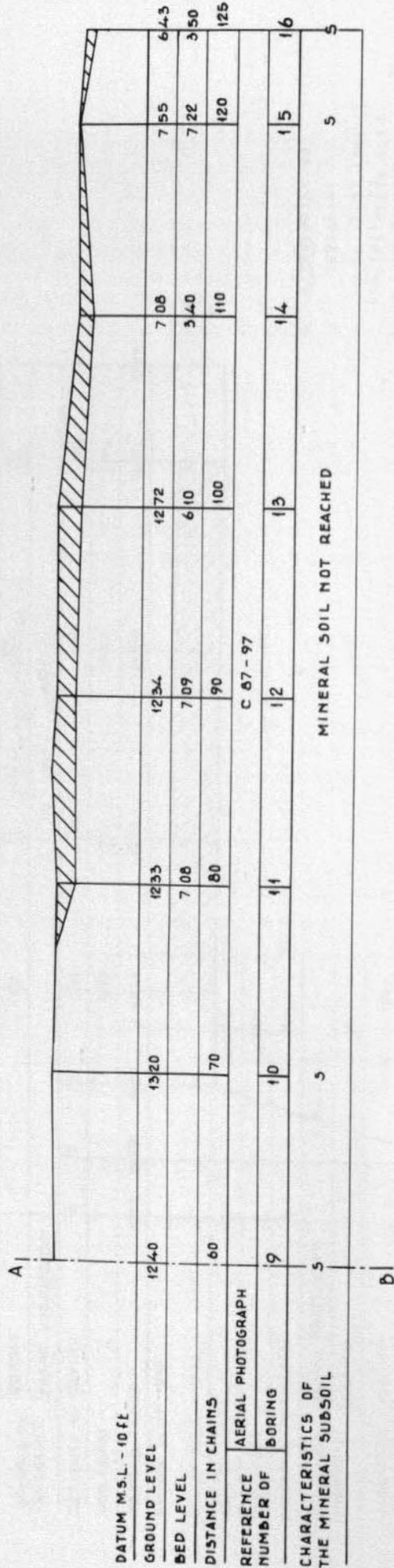
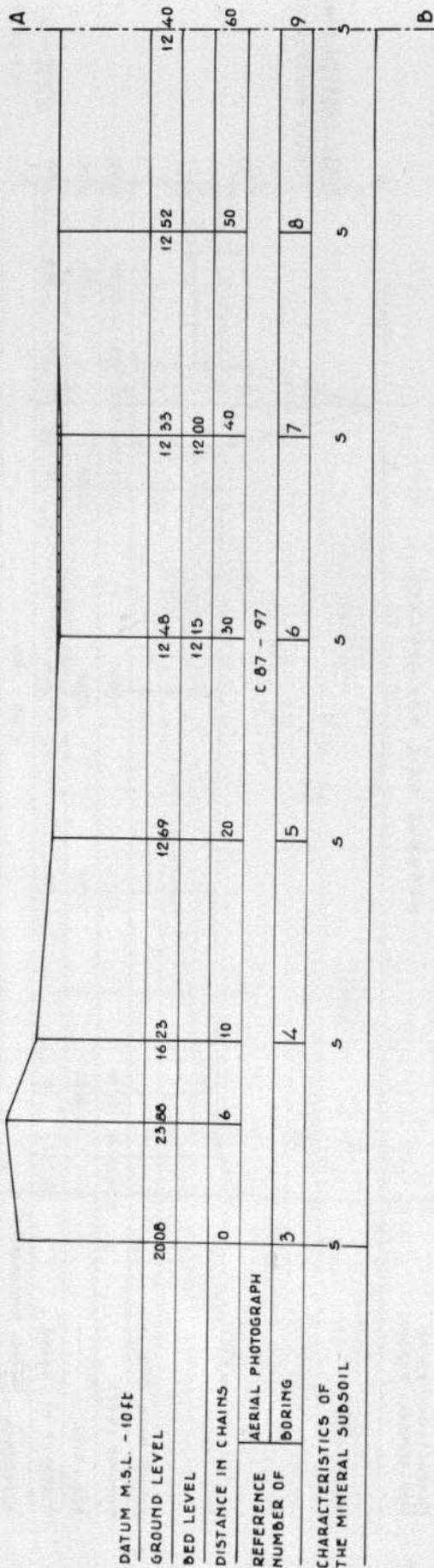
CROSS SECTION LINE 35
 (PAYA MENGUANG)



C = CLAY
 SC = SANDY CLAY
 SCL = SANDY CLAY LOAM
 S = SAND
 SL = SANDY LOAM

LAND AND SOILS
GROSS SECTION LINE 36
 (PAYA BESAR)
 TOP SHEET 62

SCALE
 1" = 8 CHAIN/1" = 40'



PEAT S = SAND

FIG 2g

6.3.4 Possible Improvement of Unsuitable Soils for the Cultivation of Sawah Padi

Of the soils considered unsuitable for the growing of sawah padi in Sub-section 7.2.4, only the units PET/de, KNJ and LWP deserve further attention.

The other units belong either to the hilly and mountainous areas which can be used more profitably for the growing of tree crops or to the terraces and valley bottoms the relief of which is too broken for sawahs.

The inaccessibility of the deep peat swamps coupled with the high costs for clearing, continuous fertilizing and periodical lowering of the groundwater table during the ripening of the crop render the unit PET/de also unsuitable for the growing of sawah padi.

Reclamation of the units KNJ and LWP should be focussed on the following aspects:

- empoldering
- removal of brackish or saline surface water from the polder
- discharge of drain water
- desalinization of the soils and the groundwater
- prevention of acidification of the soils
- subsidence of the soil surface as a result of ripening of KNJ soils after periodical lowering of the groundwater table

It is clear that the reclamation techniques to be applied are complicated and expensive.

Without going into further detail it seems justified to disregard the mentioned units for further development in the near future.

The same applies to those parts of the unit HWP that are flooded regularly.

LIST OF REFERENCES

- (1) Leamy M. L. and Panton W. P. (1966) - Soil Survey Manual for Malayan Conditions
Ministry of Agriculture and Co-operatives
Div. of Agr. Bull. no 119
- (2) Panton, W.P. (1958) - Reconnaissance Soil Survey of Trengganu
Ministry of Agriculture
Dep. of Agr. Bull. no 105
- (3) Nossin, J.J. (1964) - Geomorphology of the Surroundings of Kuantan (Eastern Malaya)
Geologie en Mijnbouw, Vol. 43
no. 5, p. 157-182
- (4) Soil Survey Staff, U.S. Dept. of Agr. (1951) - Soil Survey Manual

ANNEX IV

CROP AND LIVESTOCK PRODUCTION

CONTENTS

	<u>Page</u>
1 PRESENT PATTERN OF AGRICULTURAL PRODUCTION	1
1.1 Introduction	1
1.2 Agricultural Land Use	1
1.3 Present Agricultural Production Units	3
1.3.1 Estates	
1.3.2 Smallholdings	
1.3.2.1 General Situation	4
1.3.2.2 Fragmentation of Farm Areas	5
1.3.2.3 Land Tenure	6
1.4 Crop Yields and Related Inputs	7
1.4.1 Food Crops	7
1.4.1.1 Padi	7
1.4.1.2 Other Crops	10
1.4.2 Industrial Crops	10
1.4.2.1 Rubber	10
1.4.2.2 Oil Palm	13
1.4.2.3 Coco-nut	15
1.4.2.4 Cocoa	16
1.4.3 Fruits and Vegetables	16
1.5 Irrigation and Drainage	17
1.5.1 General	17
1.5.2 Existing Projects	18
1.6 Livestock Production	19
1.6.1 General	19
1.6.2 Types of Livestock	20
1.6.3 Natural Grazing	20
1.7 Production Volumes and Values	22
1.7.1 Crop Production	22
1.7.1.1 Crop Production of Smallholdings	22
1.7.1.2 Crop Production of Estates	22
1.7.2 Livestock Production	24
1.7.3 Contribution of Crop and Livestock Production to the Economy	24
2 AGRICULTURAL DEVELOPMENT POTENTIAL	25
2.1 Introduction	25
2.2 Intensification of the Present Land Use	25
2.2.1 Double-cropping	25
2.2.2 Intercropping	26
2.2.3 Improvement of the Land Use in Dusun Areas	27

	<u>Page</u>
2.3 New Areas suited to Agriculture	27
2.4 Yield Projections	29
2.4.1 Food Crops	29
2.4.1.1 Padi	29
2.4.1.2 Maize	33
2.4.1.3 Soy Beans	34
2.4.1.4 Groundnuts	35
2.4.1.5 Cassava	35
2.4.2 Industrial Crops	36
2.4.2.1 Oil Palm	36
2.4.2.2 Rubber	39
2.4.2.3 Coco-nut	45
2.4.2.4 Cocoa	48
2.4.3 Fruits and Vegetables	48
2.4.3.1 Cashew	49
2.4.3.2 Limau Langkat (Citrus)	50
2.4.3.3 Vegetables	51
2.5 Required Agricultural Inputs	51
2.5.1 Introduction	51
2.5.2 Inputs relating to Food Crops	52
2.5.2.1 Sawah Padi	52
2.5.2.2 Dryland Padi	55
2.5.2.3 Maize, Soy Beans, Groundnuts, Cassava	56
2.5.3 Inputs relating to Industrial Crops	56
2.5.3.1 Oil Palm	56
2.5.3.2 Rubber	59
2.5.3.3 Coco-nut	59
2.5.3.4 Cocoa	60
2.5.4 Inputs to Fruit and Vegetables	62
2.6 Irrigation and Drainage Potential	63
2.6.1 Irrigation	63
2.6.1.1 General	63
2.6.1.2 Potential Areas	63
2.6.2 Drainage	65
2.6.2.1 General	65
2.6.2.2 Potential Areas	66
2.6.3 List of Projects and Summary of Costs	66
2.6.4 Organizational Aspects	69
2.6.4.1 General	69
2.6.4.2 Construction, Maintenance and Operation	70
2.6.4.3 Staff and Budgets	71

	<u>Page</u>
3 FUTURE PATTERN OF AGRICULTURAL PRODUCTION	72
3.1 Recommended Land Use	72
3.2 Agricultural Production Units	76
3.2.1 General	76
3.2.2 The Advantages of Estate-wise Tree Crop Production during the Initial Development Period	77
3.2.3 The Flexibility of Smallholding Agriculture	78
3.2.4 The Place of the Smallholding in the Future Development of Tree Crop Production	80
3.3 The Phasing of the Agricultural Development	82
3.3.1 Introduction	82
3.3.2 Priority Ranking of and Return to Labour in Agricultural Projects	83
3.3.3 Sawah Padi Projects	85
3.3.4 Oil Palm Projects	91
3.3.4.1 Introduction	91
3.3.4.2 Benefit/Cost Calculations for and Labour Productivity of Estates	92
3.3.4.3 Implementation Schedule	97
3.3.4.4 Smallholders Income from Oil Palm Cultivation	97
3.3.5 Rubber and Coco-nut Projects	105
3.3.5.1 General	105
3.3.5.2 Benefit/Cost Ratios	108
3.3.6 Miscellaneous Crops	111
3.3.6.1 General	111
3.3.6.2 Benefits and Costs for Annual Crops	112
3.4 Total Agricultural Area Planned for Development	115
3.5 Employment	117
3.6 Animal Husbandry	117
3.6.1 Introduction	117
3.6.2 Proposals for Development	120
3.6.2.1 Broiler Production	120
3.6.2.2 Egg Production	121
3.6.2.3 Beef Production	122
3.6.2.4 Small-scale Pig Production	123
3.6.3 Recommendations for Further Action	123
3.6.4 Contribution to the Economy	124
3.6.5 Veterinary Services	124

	<u>Page</u>
4 VOLUMES AND VALUES OF PRODUCTION	125
4.1 Volumes of Production	125
4.1.1 Padi	125
4.1.2 Oil Palm	127
4.1.3 Production Volumes of Rubber	127
4.1.4 Coco-nut	128
4.1.5 Miscellaneous Crops	130
4.2 Value of Production	132
4.2.1 Prices of Agricultural Products	132
4.2.2 Gross Value Added	133
5 AGRICULTURAL RESEARCH	138
5.1 Introduction	138
5.2 Agricultural Research Programmes	138
5.3 Research Stations and their Staffing	142

LIST OF TABLES

Table 1-1 Crop Production Acreage 1966	1
Table 1-2 The Rubber Acreage (in acres x 1,000)	2
Table 1-3 Average Present Padi Yields	9
Table 1-4 Some Basic Data about the Types of Live-stock kept in Trengganu	21
Table 1-5 Crop Production and Income of Smallholdings 1966	23
Table 1-6 Crop Production Estates (1966)	22
Table 2-1 Present and Projected Future Land Use (in acres)	30
Table 2-2 Estimates of Padi Yields, 1966-1990	31
Table 2-3 Projected Maize Yields (in lbs of grain per acre)	34
Table 2-4 Projected Soy Bean Yields (in lb per acre)	34
Table 2-5 Projected Groundnut Yields (in lbs of un-shelled nuts per acre)	35
Table 2-6 Projected Cassava Yields (in tons of fresh roots per acre)	36
Table 2-7 Projected Oil Palm Yields on Estates	38
Table 2-8 Comparison of FFB-yields and Oil Extraction Rates for various Types of Production Units	39
Table 2-9 Projected Rubber Yields (in lbs of dry rubber per acre)	42

	<u>Page</u>
Table 2-10 Rubber Yields for the Reference Years in the Period 1966-1990	43
Table 2-11 Comparison of Dry Rubber Peak Yields	44
Table 2-12 Projected Yields for Present Coco-nut Plantings (in nuts per palm)	45
Table 2-13 Projected Coco-nut Yields for the Reference Years in the Period 1966-1990	47
Table 2-14 Projected Copra Yields (in tons per acre)	46
Table 2-15 Projected Cocoa Yields (in lbs of dry cocoa per acre)	48
Table 2-16 Projected Cashew Yields (in lbs of dry nuts per acre)	49
Table 2-17 Projected Yields of Limau Langkat (in tons per acre)	50
Table 2-18 Projected Inputs to Padi for the Year 1990	54
Table 2-19 Projected Inputs to Maize, Soy Beans, Groundnuts, Cassava and Sweet Potatoes for the Year 1990	57
Table 2-20 Projected Inputs to Oil Palm	58
Table 2-21 Projected Inputs to Rubber	59
Table 2-22 Projected Inputs to Coco-nut	61
Table 2-23 Projected Inputs to Cocoa	62
Table 2-24 Projected Inputs to Cashew and Citrus	62
Table 2-25 Ongoing Irrigation and Drainage Projects	67
Table 2-26 Newly Planned Irrigation and Drainage Projects	68
Table 3- 1 Irrigation Projects - Benefit/Cost Ratios and Labour Productivity	87
Table 3- 2 Drainage Projects - Benefit/Cost Ratios and Labour Productivity	88
Table 3- 3 Phasing of Irrigation Projects (Net Area in Acres)	89
Table 3- 4 Phasing of Drainage Projects (Net Area in Acres)	90
Table 3- 5 Present Values of Gross Revenues	93
Table 3- 6 Investment and Recurrent Production Costs (undiscounted values in M\$ per acre)	94
Table 3- 7 Benefit/Cost Ratios of Oil Palm Projects	95
Table 3- 8 Productivity of Labour on Oil Palm Projects	96
Table 3- 9 Net Acreages under Oil Palm for the Refer- ence Years during the Period 1966-1990	98
Table 3-10 Price Structure of Palm Oil (M\$ per ton)	101
Table 3-11 Smallholder's Price of Fresh Fruit Bunches (M\$ per ton)	102
Table 3-12 Special Smallholding Development Projects; Cost of Establishment and Recurrent Cost of Production of Oil Palm	103
Table 3-13 Smallholder's Income from Oil Palm Cultivation	104

	<u>Page</u>
Table 3-14 Net Acreages under Rubber for the Reference Years during the Period 1966-1990	106
Table 3-15 Net Acreages under Coco-nut for the Reference Years during the Period 1966-1990	107
Table 3-16 Benefits, Costs and Return to Labour (M\$ per acre)	109
Table 3-17 Benefits, Costs and Return to Labour	111
Table 3-18 Net Acreages under Miscellaneous Crops for the Reference Years during the Period 1966-1990	113
Table 3-19 Benefits and Costs for Various Annual Crops	114
Table 3-20 Return to Labour for Various Annual Crops	112
Table 3-21 Net Acreages of Cultivable Land for the Reference Years during the Period 1966-1990	116
Table 3-22 Net Acreages of Padi Producing Land for the Reference Years for the Period 1966-1990	118
Table 3-23 Male Labour Force in Agriculture (in numbers)	119
Table 3-24 Gross Value Added in Livestock Production (in M\$ million)	124
Table 4- 1 Padi Production for the Reference Years in the Period 1966-1990	126
Table 4- 2 Oil Palm Production for the Reference Years in the Period 1966-1990 (in tons)	127
Table 4- 3 Rubber Production for the Reference Years in the Period 1966-1990	129
Table 4- 4 Coco-nut Production for the Reference Years in the Period 1966-1990	131
Table 4- 5 Production Volumes of Cocoa, Maize and Soy Beans for the Reference Years in the Period 1966-1990 (in lb x 1,000)	130
Table 4- 6 Prices of Agricultural Products (in M\$)	134
Table 4- 7 Gross Value Added in Crop and Livestock Production (M\$ million)	136
Table 4- 8 Gross Value Added in Processing Oil Palm Rubber and Padi (M\$ million)	137

LIST OF PLATES AND FIGURES

Plate IV-1	scale 1 : 250,000 General Indication Present Land Use
Plate IV-2	scale 1 : 63,360 Dungun (partly) 2a Land Suitability 2b Alienation and Gazettement 2c Present Land Use 2d Future Land Use; Road Network; Socio-economic Service Centres 2e Tentative Planning Map Forestry

Plate IV-3/VIII-1/IX-3 scale 1 : 250,000

Future Land Use;
Road Network;
Socio-economic Service Centres

Figure 1 Relationship between the World Market
Prices for Palm Oil and the Small-
holder's Income

100

1 PRESENT PATTERN OF AGRICULTURAL PRODUCTION

1.1 Introduction

At present, next to mining, agriculture is yielding the greatest contribution to the economy of the State. Some 70 per cent of the State is under forest and only 9 per cent of the total area of approximately 3 million acres is used for agriculture.

Some 80-85 per cent of the soils used for crop production are more or less suitable for this purpose. The remaining 15-20 per cent are, in fact, unsuitable and comprise soils prone to water-logging or covered by a thick layer of peat in areas used for padi growing, soils in too accidented terrain and sensitive to erosion or soils with a poor water retaining capacity.

1.2 Agricultural Land Use

As per 1966 crop production activities were carried out on an area of roughly 290,000 acres. A specification of the land use for that reference year is given in Table 1-1.

Table 1-1 - Crop Production Acreage 1966

Crop	Acres x 1,000	
	(1)	(2)
rubber	160	148.6
sawah padi	55	60.8
dryland padi	15	
coco-nut	19	16.7
oil palm	10.5	3.4
cocoa	1.1	1.1
other crops	29.2	42.9
total	289.8	273.5

- (1) According to information from the Agricultural Department-Kuala Trengganu and the Department of Statistics-Kuala Lumpur.
- (2) According to information from the Canadian Colombo Plan Land Use Specialist, Department of Agriculture-Kuala Lumpur (based on interpretation of aerial photographs 1966).

In the 273,500 acres mentioned under Table 1-1 24,500 acres of newly cleared land have not been included. Very shortly after the aerial photography was flown part of the newly cleared land must have been planted with (tree) crops, bringing the total acreage of (2) in the order of 280,000 acres or higher. The differences between the figures of (1) and (2) with respect to e.g. the oil palm acreage can be explained in this way.

Of the crops grown rubber covers the largest area. It is predominantly grown on the sedentary soils of the interior part of the State, but it is also found towards the coast on the levees of the river plains and in the kampong areas. In Table 1-2 a specification is given of the rubber acreage with respect to types of plantings and production units.

Table 1-2 - The Rubber Acreage (in acres x 1,000)

	Old plantings		Replantings		New plantings		Total
	a	b	a	b	a	b	
<u>Production unit</u>							
- smallholdings	50.0	-	7.0	15.0	8.0	35.0	115.0
- estates	9.7	-	3.0	3.8	-	-	16.5
<u>Development schemes</u>							
- fringe alienation						18.8	18.8
- controlled alienation						0.5	0.5
- block new plantings						2.0	2.0
- FLDA					1.0	6.2	7.2
total	59.7	-	10.0	18.8	9.0	62.5	160.0

a = mature rubber.
b = immature rubber

Padi, the main food crop, is for the greater part grown in irrigated or rainfed sawahs and predominantly occupies the heavy clay soils of the lower river terraces that are generally found within 15 miles off the coast. Low-land dry padi (padi taboran) is usually grown on the higher river terraces. These terraces are generally found more inland. Their soils are of a lighter texture.

Shifting cultivation of upland dry padi (padi huma) is practised on undulating sedentary soils.

The crop ranking third in acreage is coco-nut; it is cultivated along the coast on the sandy soils of the beach ridges. In the interior part of the State the coco-nut plantings are nearly always confined to the dusun areas*.

* Dusun is a piece of garden land around or in the proximity of the houses in the kampongs (villages); its acreage varies from less than 0.5 to several acres.

The acreages under 'other' crops are comparatively small. Oil palm, covering 10,000 acres, has been introduced on the more fertile sedentary soils recently; on these soils, also the only cocoa estate (1,000 acres) is found. Cashew occurs in small patches on the beach ridges. Maize and groundnuts are being tried on the higher alluvial terraces.

Fruit and vegetables are almost exclusively grown in the dusun areas. The total acreage occupied by these crops is some 30,000 acres. Spacing of the trees is very irregular.

A general indication of the present land use for agriculture is given on Plate IV-1.

Rubber is rather evenly distributed over the State whilst padi growing is restricted to the alluvial plains. In the districts with substantial alluvial areas, such as Trengganu and Besut, the padi acreage almost equals the acreage under rubber; in the other districts it is definitely smaller. Very small acreages under padi are found in the districts of Kemaman and Dungun.

The crops grown in the areas registered as dusun follow broadly the distribution pattern of padi. Although also occurring around inland kampongs, coco-nut is mainly grown along the coast, particularly on the wider beach ridges in the North.

The cultivation of oil palm and cocoa is limited to four estates.

The growing of annual crops other than padi is of minor importance and is almost entirely restricted to the higher alluvial terraces near Kuala Brang (Ulu Trengganu).

After 1960 the agricultural area has been substantially extended by the introduction of rubber schemes, by the land clearing for the establishment of oil palm plantations and by legal and illegal occupation of land by smallholders. Roughly 80,000 acres of new land have been taken into cultivation during the last 10 years.

The availability of an extended acreage of productive land will not merely be the result of the development of new land. By providing irrigation facilities to rainfed padi land, thus converting it into irrigated padi land, and by introducing double cropping, the present padi production might be intensified.

1.3 Present Agricultural Production Units

1.3.1 Estates

In contrast to the situation on the West Coast of Malaysia, estate agriculture is a minor activity in Trengganu.

Apart from the recent introduction of oil palm on three large-scale production units not even 10 per cent of the total

area under tree crops is occupied by estates with an area of 100 acres or more.

As far as oil palm is concerned, almost 11,000 acres near Jerangau have been planted with this crop in the period 1963-1966 by the Federal Land Development Authority (FLDA), a federal settlement institution. An additional 1,000 acres are ready for planting at present.

Furthermore, the development of 20,000 acres at Sg. Tong and of 30,000 acres near Ayer Puteh for the cultivation of oil palm was started in 1966, whilst it is intended to also develop 15,000 acres in the Chenderong Concession. With the exception of the Chenderong estate all these estates are managed by the SEDC, the State Economic Development Corporation, or by a joint venture of the SEDC and private companies.

There are in fact only two fair-sized rubber estates, each covering about 4,000 acres, viz. one in the Jaba Valley and one near Kerteh. The acreages of most of the other estates vary from 100 to 500 acres. Management of these small estates leaves much to be desired.

The acreages of the individual coco-nut and cocoa estates are approximately 1,000 acres. The coco-nut plantings are in a completely neglected state. The only cocoa estate is European property.

1.3.2 Smallholdings

1.3.2.1 General Situation

The greater part of the agricultural production is realized on smallholdings, most of which cover less than 10 acres. In 1966, there were some 35,000 smallholdings with a total acreage under smallholders' crops of approx. 260,000 acres, or approx. 240,000 acres if the areas covered by Fringe Alienation Schemes, Controlled Alienation Schemes and Block New-planting Schemes are excluded. Hence, the average farm size is 7-8 acres.

The main crops of the smallholdings are rice and rubber. Both crops are often grown in one production unit. Furthermore, the smallholder mostly has a piece of land that is registered as 'dusun', home lot or village lot. The coco-nut plantings on the beach ridges along the coast mostly belong to families whose main means of subsistence has been sea fishery so far.

Compared with the yield levels obtained in other states of West Malaysia, the yields both per acre and per labourer, or per family unit, are rather low in Trengganu. The physical conditions of soils and climate only partly play a role in this respect.

The unacquaintance with the opportunities offered by the State and the presence of more favourable opportunities elsewhere have also been restrictive factors.

The main cause, however, is the comparatively isolated location of Trengganu which - certainly until recently - has adversely affected the interest from the outside in the economic potentials of Trengganu and this in turn has hampered the infrastructural development of the State. The cultivation of land that is, in fact, less suitable for this purpose should be also attributed to the lack of a well-developed infrastructure.

The conditions under which the population of Trengganu had to supply for its subsistence in the past are manifested in the way in which agricultural production has adapted itself to the natural, locally varying circumstances, viz.:

- sea fishery along the coast
- coco-nut production on the beach ridges along the coast
- padi production on the more level and mostly heavy alluvial river deposits, mainly in the districts of Besut and Kuala Trengganu
- production of dusun crops (tree fruits, non-tree fruits, vegetables, spices, tobacco, etc.) in or near the village areas
- rubber production on the higher-lying soils of the coastal plain and in the hilly area in between the coastal region and the steep-land more land inward
- livestock production near the houses (buffaloes and cattle are mainly found in the padi production areas).

The agricultural activities are in the first place directed to the production for own consumption. It is hampered by the relatively small area of land that is available and suitable for the cultivation of annual food crops, especially in the southern part of the State. This is probably also one of the reasons why rubber, a purely commercial crop, plays such an important role in Trengganu to provide for that part of sustenance that is not covered by the production for own consumption. The choice of this crop under the conditions as prevalent in the past is quite understandable since the method of processing of the harvested latex into a tenable and acceptable market product is simple and can be realized in small production units.

1.3.2.2 Fragmentation of Farm Areas

Considering the results of the 1960 Agricultural Census and of the farm surveys undertaken in 1967, the fragmentation of the farm areas seems to be rather strong. In most cases the farm area does not constitute one unit.

According to the 1960 Census more than 10% of the smallholdings consist of 5 or more plots separated from each other by plots of other smallholders.

It was noted that the size and type of farm have an impact on the degree of fragmentation, i.e. :

- the degree of fragmentation is higher with an increase in farm area
- a relatively higher degree of fragmentation is observed in farm areas in which no main crop is cultivated

- the degree of fragmentation in areas with wet padi as the main crop is higher than in those where rubber is grown as the main crop.

1.3.2.3 Land Tenure

The present land tenure system is based on a meticulously accurate cadastral survey of land lots coupled with a mandatory registration of all land transactions once ownership has been registered (Torrents System). Most of the land throughout Trengganu is held in perpetuity under various registration titles. It is subject to payment of an annual sum of money known as quit rent or land rent.

A large proportion of the smallholders occupy and cultivate their own land. In many cases the smallholder is, however, also a tenant cultivator, either on the basis of sharecropping or on the basis of a lease.

The sharecropping agreement might cover either a short term of 1-3 years (smallholdings, annual crops) or a longer term (estates, tree crops, long lease).

In the case of sharecropping the agreement is usually concluded for one harvesting period or one year. The short duration of the agreement is not felt to be an impediment, because :

- it can be easily extended
- it is often concluded between members of one family or with acquaintances
- the cost of capital inputs that lead to an increase in production on the long run are of little significance at this stage; in some instances the two parties have arrived at a satisfactory arrangement for the payment of these costs.

According to the 1960 Agricultural Census the smallholder is, as a rule, owner cultivator if he is growing dusun crops or if tree crops such as rubber, coco-nut, constitute his main crops. Tenant cultivators are mainly found among the smallholders growing padi as their main crop; also in this group the number of tenant cultivators is smaller than that of owner cultivators.

There is no wide difference, even not from a social point of view, between the owner cultivator and the tenant cultivator. The 1960 Agricultural Census has revealed that 25-30% of the farmers have a mixed tenure. Especially in the case of smallholdings an increase in farm area results in a shift from single tenure to mixed tenure. This shift which was confirmed by the results of the 1967 farm surveys is brought about by the present cultivation techniques and the labour potential of the cultivator's family. These factors lead to a certain equalization of the farm area as long as small farms are concerned and the family labour largely determines the production level.

1.4 Crop Yields and Related Inputs

1.4.1 Food Crops

1.4.1.1 Padi

a) Yields

A large number of padi varieties which are adapted to specific growing conditions are used. Varieties which produce a good-quality rice are often poorly yielding and vice versa. Yields are varying widely and range between less than 150 gantang^{*}/acre for hill padi and 800 gantang/acre for sawah padi at a maximum. So far, the highest yield of 800 gantang per acre was obtained from the new dwarf variety IR 8 that has been planted over a small area and grown under irrigation in the off-season. The quality of the rice obtained from this variety is rather poor. The average yields of the semi-tall varieties (Mashuri and Malinja) being planted over relatively large areas are considerably lower and do not exceed 300-350 gantang/acre. The average yield of irrigated and rainfed padi cultivated in sawahs during the main (rainy) season is about 250 gantang per acre. Predominantly local, tall Indica types of padi are planted. They have growing periods of 200-240 days and are photo-sensitive. Their yields may vary considerably owing to different external conditions.

Apart from making it possible to grow padi during the off season when the rainfall is too low, irrigation during the end of the off season serves to ensure that the land is prepared in time to permit transplanting at the most suitable moment. Additional irrigation during the growing period is seldom necessary during the main season.

In basin depressions which even during the off-season do not properly dry out the padi yields are lower than on the somewhat higher-lying basin slopes where the soils can be temporarily drained.

Low yields (150-200 gantang per acre on an average) are obtained from rainfed padi grown on the peat-covered soils of the swamps and of the troughs in between the beach ridges. The low yields are to be attributed to an inadequate water control or to unfavourable soil characteristics, or both.

The highest yields are obtained from irrigated padi grown in the off season. The varieties planted are mostly non photosensitive, semi-tall or dwarf varieties which have a rather short growing period. They are often derived from Indica x Japonica or Indica x Indica crosses.

* gantang = 5.6 lb unhusked rice

An average yield of 300 gantang per acre has been recorded for the Malinja and Mashuri semi-tall varieties grown in irrigated sawahs during the off season.

Considerably higher yields have been obtained from the dwarf variety Ria (IR 8) recently introduced from the Philippines.

Non-irrigated padi grown in alors* during the off season is called padi Mengulu. Tall Indica varieties are used which yield about 200 gantang per acre on an average in the alors. With the present farming techniques, the permanent waterlogging of the fields and the occasional flooding it is impossible to obtain higher yields.

The highest yields of rainfed and irrigated sawah padi ('wet padi') are obtained in the Districts of Besut and Trengganu. In the South of Trengganu where padi is a crop of minor importance the yields are generally lower.

The yields of wet padi grown in the main season have not changed much over the past ten years. They ranged between 225 and 275 gantang per acre. No definite quantitative trend in the padi yields could be distinguished. The lowest yields were recorded during years of heavy floods.

For irrigated off season padi an upward trend in yield quantities has been noted. The practice of growing irrigated padi during the off season has, however, been introduced only recently and does not yet permit a definite conclusion.

The main reason for the low yields of wet padi grown in the main season is the insufficient control of the water supply which prevents the use of semi-tall and dwarf varieties with their inherent good response to fertilizing. The low yields of wet padi grown in the off season are mainly the result of attacks by insects and rats.

Two types of dry land padi are found : low land padi or padi taboran and hill padi or padi huma. Seeds of padi taboran are broadcast on slightly undulating land, those of padi huma are dibbled in more rolling terrain. Both types are grown during the main season. Their yields are reasonably high as compared with those of wet padi and taking into account the low level of capital inputs. It is not likely that the yields of dry land padi will be maintained if permanent cropping as recently introduced is practised without changing the level of inputs.

The present average yields of wet padi and dry land padi are given in Table 1-3 on the next page.

* Alors are depressions (often old river courses) in the alluvial land in which even during the off season sufficient water is available for the cultivation of padi.

Table 1-3 - Average Present Padi Yields

Type of crop	Growing season	Yield*
irrigated wet padi	main season	250
rainfed wet padi	main "	250
irrigated wet padi	off "	300
mengulu wet padi	off "	200
taboran dry padi	main "	180
huma dry padi	main "	150

* Yield in gantang per acre of dry unhusked rice

b) Inputs

The varieties that are planted in the main season are without exception local types of tall varieties. Only during the off-season semi-tall and dwarf varieties are used. The acreage at present under crop in the off season is extremely small compared to that in the main season.

All wet padi is transplanted. The seedlings for the main season crop are raised in a nursery for a period of 40 days or even longer. This long period is associated with the uncontrolled water supply. Seedlings for transplanting must have a minimum height to be safeguard against too deep a submersion of the field. Five gantangs of seed are used to provide sufficient plants for one acre of field planting. Staggered sowing in the nursery is not practised. Generally, the young plants have a yellow colour because they do not receive any fertilizer. With a prolonged stay in the nursery the seedlings tend to become flabby which renders them unsuitable for transplanting.

Seedlings for the off season crop are transplanted within 25 days because water is then under control. They receive often two pounds of Ammophos per gantang of seed used.

Field preparation is mainly done with an ox-drawn plough. Recently small Japanese cultivators have been introduced.

It is often difficult to plant at the most suitable time in the main season owing to lack of water control and in the off season because the farmers are not yet used to grow two crops a year. If planting in the off season is delayed, harvesting of the crop must be postponed until some time in the rainy season which often results in yield losses. The spacing is 12 x 12 inches which appeared to be too wide under the conditions as prevailing on the East Coast.

In the districts of Besut and Trengganu nearly all wet padi is given fertilizer at the rate of 30 lb N, 30 lb P₂O₅ and

15 lb K₂O per acre. The yield response of the local tall varieties to fertilizer is not striking. The semi-tall varieties Mashuri and Malinja showed a better response.

Pest control is centred on rats. Stemborers are an increasing menace. They are difficult to combat since there are no sufficient spraying teams. The farmers themselves seldom buy pesticides. The majority of them rely on the Department of Agriculture in this respect. Yield losses due to pests and diseases are estimated at 10 and 20 per cent.

The inputs to dry land padi are negligible. Taboran padi is broadcast on slightly undulating fields prepared by hand-hoeing. The average seed rate is 15 gantang per acre. The fields are weeded only once after which the crop is not tended until the harvest. Most of the taboran padi is grown as a shifting cultivation crop. Padi huma is grown on undulating or rolling cleared forest land. The crop receives as little attention as taboran padi. The seeds are dibbled. The cultivation of padi huma easily causes erosion and should, therefore, not be promoted.

1.4.1.2 Other Crops

Food crops other than padi are grown only on a very limited scale, mostly in the dusun areas. There have been some trial plantings of maize, groundnuts and soy beans with variable success.

Recently maize has been planted on a few hundred acres around Kuala Brang. The results were promising and a possible extension of the area depends mainly on the organization of the marketing of this crop. Local maize varieties with a growing period of less than 90 days are planted on river levees which are flooded during the monsoon. The maize is sown as soon as the water has receded in February. Wherever possible, the crop is sold as green maize; the remainder is shelled. A second maize crop is sown in September and interplanted with dry land padi later. The maize is harvested before the monsoon sets in after which the padi remains on the field as the main season crop. Maize yields of some 1,500 lb of dry grain per acre are often recorded. The fertility of the soil is maintained by new river deposits. A few farmers are growing the improved variety Metro. The yields can be easily increased if the cultivation methods are improved, better varieties are used and the application of fertilizer is introduced. Most probably, the farmers will adopt these inputs as soon as there is a ready market for their maize.

1.4.2 Industrial Crops

1.4.2.1 Rubber

Climate and soils are, in general, favourable for the cultivation of rubber, although the continuous rains during the monsoon

and the locally cultivated shallow soils can act as constraints. The type of planting material, the maintenance of the plantations, the application of fertilizer, the system of tapping and the processing of the latex are as many decisive factors that determine the yield and the quality of the rubber.

a) Smallholdings

Approximately fifty per cent of the rubber trees on smallholdings are constituted of old material with a low production capacity. The remaining fifty per cent have a higher production potential. The new plantings and replantings consist only for a small percentage of budgraft material, which gives higher yields than seedlings. The latter cover the greater part of the area under newly planted or replanted rubber and consist mainly of Tirandji 1 clonal seedlings which produce reasonably well under the present cultivation practices. This material, however, gives notably lower yields than the best clonal seedlings available in Malaysia but withstands bad cultivation practices.

The maintenance of new plantings is of a low standard and fertilizers are hardly used. With replantings both maintenance and the application of fertilizers are better during the establishment period, a replanting bonus being paid then, but they still need to be improved.

The growth of young rubber on smallholdings is slow. The girth of 20 inches required to make the rubber trees suitable for tapping is reached one or even a few years later than on estates where the management is of a higher standard and the clonal material used is better.

Tapping is poorly done in most cases. The bark consumption is high, the trees are often wounded while the daily half-spiral tapping adversely affects their production. Consequently the yields are lower.

In spite of the daily tapping practised by the smallholders it was found that there are only 100-120 effective tapping days a year. This indicates that a substantial number of tapping days are lost due to rainfall, to giving temporary priority to other crops, to festivities etc. The processing of latex is done carelessly which results in a low-quality product.

The yields of old plantations, the trees of which originate from unselected seedlings, amount to about 250-300 lb of dry rubber per acre. According to the Rubber Replanting Board more than 20,000 acres under such old plantings have been replanted during the last 15 years. The recommended planting material has a notably higher yield potential than the material previously used but due to the lack of sufficient inputs the yields normally do not exceed 600 lb per acre.

The rubber yields obtained by smallholders in Trengganu are definitely lower than those recorded in other States. The main reasons are :

- the small number of large private estates in Trengganu. These estates generally function as a model;

- the remoteness of many smallholdings which adversely affects the activities of the Extension Service;
- the easy way of life of the farmers;
- the fact that rubber is often considered second in importance in obtaining an income by farmers who mainly go in for padi growing.

Intercropping in smallholder's rubber is an exception. Whenever practised bananas, pineapples and sweet potatoes are planted. The cultivation of these crops is given more attention than the main crop. Because of this the maturing of the latter is retarded and the yields are low.

b) Alienation Schemes

The level of farming on the recently started new block plantings, on controlled alienation schemes and fringe alienation schemes is even lower than on smallholdings. Particularly on the fringe alienation schemes, remotely situated as they are, the rubber is neglected. The planting material often consists of local, unselected material. Due to the fact that no establishment bonus is paid as a stimulus, the rubber trees are not taken care of. The maintenance of the plantations is poor and many a seedling is overgrown by noxious weeds. The rubber trees are expected to reach maturity two, three or even more years later than it is normally the case. The peak yields are thought not to exceed 500 lb of dry rubber per acre. In many cases the yields will even be so low that tapping is not considered worthwhile.

c) Federal Land Development Authority

The FLDA rubber schemes, four in total, are, in general, well maintained. Unfortunately, there are some areas situated on rather poor, shallow, quite steep soils of the Kuala Brang-Marang Association. The planting material consists of a mixture of clones of which RRIM 513 and RRIM 623 are the major ones. At the time of planting these two clones were recommended by the Research Institute, but recently both have been rejected because of the easily breaking of crowns.

The earliest plantings have just come into production. The yields are not expected to exceed 500 lb dry rubber per acre during the first year of tapping which is a disappointing result. Peak yields at full maturity are estimated at 1,100 lb per acre, assuming that the standard of tapping will improve. The present low yields might be partly attributed to the fact that part of the settlers are not yet accustomed to agricultural work, another reason is the relatively long difficult running-in period of the schemes.

d) Private Estates

The results obtained at the two largest private estates in Trengganu show that promising yields can be obtained with good planting material and under proper management. Yields of 1,200-1,600 lb of dry rubber per acre for ten-year old trees have been recorded. As new planting material mostly budgrafts of high-yielding clones are used. Effective weed control ensured by an excellent ground-cover of *Pueraria* and *Centrosema*. The quantities of fertilizer applied are, in general, lower than those recommended by the Rubber Research Institute. The half-spiral alternate daily tapping system is practised. Whenever possible, losses due to rainy days are recovered the next day. The standard of tapping is reasonably high. Processing has reached a satisfactory level.

Even on the two largest estates about half the acreage is still under old unselected rubber with yields varying from 450-500 lb of dry rubber per acre. On these two estates this old material will be gradually replaced by new planting material; on the smaller estates (less than 1,000 acres) replanting is not likely because of the low rubber prices.

1.4.2.2 Oil Palm

The cultivation of oil palm was introduced in the State of Trengganu only a few years ago.

Although the climatic conditions and a considerable portion of the lands are suited to the growing of oil palm, the isolated situation of the State kept private companies from investing money in oil palm estates in Trengganu until very recently.

The FLDA was the first to start large-scale plantations near Jerangau in 1963. Within a few years the SEDC followed with a State-owned and State-managed Scheme on Sungei Tong while another large estate was started near Ayer Puteh by the SEDC in joint venture with a private company. At present, plans are being prepared for an oil palm planting in the Chenderong Concession. It should, however, be noted that there the soils are far from suitable for oil palm cultivation since they are strongly sloping.

The soils of the Jerangau-Rengam Association are considered first choice for oil palm cultivation and the oil palm estates established so far are without exception laid out on these soils. Their topography, however, may be a limiting factor since with increasing slopes the demands of management and transport are higher than in the case of soils of flatter topography. This more difficult and consequently more expensive management will most likely apply to certain, relative steep parts of the Joint Venture estate.

As explained in the report "Detailed Project Evaluation S.E.D.C. Oil Palm Scheme Sungei Tong" the climate is, in general, favourable but not ideal for the cultivation of oil palm. The rainfall is often inadequate during the period February-May and it depends

on the water-retaining capacity of the soils concerned whether this will have an impact on the yields. Once every four years the lack of sufficient rainfall during this period is anyhow a constraint. The dry season is more pronounced in the South than in the North and this discrepancy is reflected in the yields obtained.

Pollination problems as a result of too heavy a rainfall have been experienced at the FLDA Scheme at Jerangau. It is expected that this problem can be partly overcome by practising assisted pollination.

The present three oil palm estates are, in general, well developed. The initial development work has been done by contractors under the supervision of the estate management. Approximately one year after planting the management took over from the contractors.

An item that has very often proved to be the bottle-neck for a timely preparation of the fields is the burning of the original vegetation. When started too late in the season big trunks remain behind, preventing the most favourable planting and rendering maintenance more difficult than necessary.

The cover crops have been planted in accordance with the recommendations made but the maintenance of the cover has been or is often neglected.

Wherever weed control is inadequate, weeds like *Paspalum*, *Mikania* and *Imperatum* suppress the cover crop. They will certainly become troublesome competitors to the oil palm plantings.

So far, little attention has been given to platforming and terracing, even on tracts of land with slopes of nearly 20 degrees. In a few instances rather small platforms have been made, but their angle of slope hardly deviates from that of the surrounding terrain. Consequently these platforms cannot function effectively to promote water retention and to control erosion.

The planting material used is practically always the best that there is available in Malaysia. The nurseries are of a high standard. The spacing used in the field results in a density of 50 to 60 palms per acre. On the most recent plantings the latter density is preferred.

Regular application of fertilizer is practised but the quantities applied are not always in accordance with the recommendations made.

Although there is still scope for improvement in the establishment of oil palm plantations the current achievements are such that fair to good yields can be expected when the palms will come into production.

As regards the yields actually obtained very little information is available.

At the end of 1966 the first bunches were harvested on the FLDA plantations at Jerangau. According to information obtained from the Jerangau Federal Experimental Station the mature palms (planted in 1953) of the station produced 8 tons of fresh fruit bunches per acre.

1.4.2.3 Coco-nut

Coco-nut palms are mainly grown by smallholders either irregularly spaced in the dusun areas or planted at regular distances in the 'kebon kelappa'.

The coco-nut palms grown on dusun land give the highest yields per tree since they benefit from the organic manure given to them in the form of house-refuse.

The production of the palms grown on dusun land within the beach ridge area is about 40 nuts per palm a year on an average. Palms in inland-dusun areas yield somewhat higher owing to the better soil moisture conditions and to the intrinsically higher nutrient level of the relevant soils.

The yields of palms grown in the kebon kelappa on beach ridge sands are considerably lower, due to the lack of organic manuring. If well kept the palms are still able to produce 20 nuts per tree a year but wherever grasses compete for moisture with the palms the annual production of nuts per tree is considerably lower.

Apart from the greater number of nuts produced by the palms in the dusuns also their copra content is higher. To obtain 1 pikul of copra, 220 nuts of dusun palms are required against 300 of palms grown in the kebon kelappa on the beach ridge sands. This demonstrates that the kernels of the nuts are thicker and larger in the case of dusun-grown palms. The nuts are bigger indeed, since the palms get more light as a result of the irregular and wider spacing and because they benefit from the application of organic manure.

The greater part of the plantings consist of the tall local varieties which come into bearing late. With good maintenance the trees will produce as from the sixth or seventh year after planting but when neglected the production starts much later.

At present the seed-nuts for new plantings are obtained from selected palms grown on estates or from locally grown trees that yield more than 100 nuts a year when mature. Hardly any interest is shown in the early-bearing dwarf varieties, the latter yielding a greater number of smaller nuts with smaller kernels, which makes the production of copra more labour-intensive.

The coco-nut plantings in the dusuns are fairly kept. Outside the kampongs they are not given much care and weeds and grasses are allowed to cover the soil in the plantations. Consequently the trees are poorly bearing there. Apart from the house refuse applied to the palms in the dusuns no manure or fertilizer are given. Pest control measures are not taken either. Harvesting by climbing takes place at two-month intervals.

The 1000-acre Kerteh estate has been abandoned. Due to negligence during World War II the 60-year old palms hardly bear any fruit. Weed competition, insect damages and inadequate supply of nutrients are as many factors that are responsible for the extremely low yields. Rehabilitation of these palms is impossible since poor growing conditions during a certain stage of the growth cause irreparable damages.

1.4.2.4 Cocoa

Trengganu is the only State in Malaysia where cocoa is grown as a mono-culture. Its cultivation is limited to an area of about 1,000 acres on the Jerangau Cocoa Estate. Smallholders do not go in for the cultivation of cocoa.

The establishment of the cocoa took place in the shade of *Glyricidia*, the latter being planted after the original forest was removed. Locally the thinned forest provides the shade required for the cultivation of this crop.

The first plantings date back to the early part of the fifties. Use was made of the Amelonado-type of seedling. In more recent plantings the higher-yielding Amazone variety has been used.

All planting material is derived from seed that is bred from high-yielding parent material. Twice a year fertilizer is applied while plant protection measures are regularly taken.

Weed control is hardly necessary after the canopy of the cocoa plantation is closed. Pruning is practised to control die-back and to promote the growth of vigorous branches. Especially with Amelonado material the die-back of branches poses a serious problem. Amazone varieties are more die-back tolerant. Fortunately this disease can be reasonably controlled by careful pruning.

The annual yields of mature cocoa as obtained on the Jerangau Estate in Trengganu at present are 600 lb and 900 lb of dry cocoa per acre for the Amelonados and Amazone types respectively.

The Amazone type comes into bearing 3 years after planting, that is 12 to 18 months earlier than the Amelonado. The former has also a higher yield potential.

1.4.3 Fruits and Vegetables

Apart from some hundreds of acres of citrus orchards and cashew plantings, tree fruits and vegetables are exclusively grown in the dusuns.

The growing of tree fruits, predominantly rambutan, durian, citrus, bananas and cashew is far more popular than the growing of vegetables.

Cowpeas and eggplants are the main vegetables grown. Both fruit trees and vegetables are often cultivated in a neglectful way. After their planting the fruit trees are not tended at all and replacement of old trees that hardly produce any fruits is done only rarely in spite of the fact that good seedlings can be obtained from the Agricultural Department.

Recently a start has been made with new plantings of limau langkat (tangerine).

The yields per acre obtained from fruit trees in dusun plantings are difficult to assess since the spacing of the trees is wide and irregular. Yields of 0.5 to 1.0 ton of fruits per acre might be a fair estimate. In limau langkat orchards with a density of 120 to 150 trees per acre, yields of 2.5 ton on an average have been recorded for mature trees. Such a yield is still to be considered low. The reasons for the low yields are : insufficient care of the planting, lack of maintenance, careless harvesting, the selection of a site with too heavy or waterlogged soils. The application of fertilizers is uncommon while neither pruning nor plant protection measures are applied.

To provide for an additional income for the fishermen, cashew has been planted on the beach ridges. The seedlings are planted at a density of 50 to 100 per acre. The collecting of nuts can start $2\frac{1}{2}$ years after planting. So far the yields have not been very high. They are not expected to exceed one quarter ton per acre with the present type of material and with the present inputs.

Pineapples are sometimes grown on inland soils. When grown on slopes this crop causes the land to become very sensitive to erosion.

The pineapple fruits are generally small, especially those of the ratoon crop. Approximately 4,000 to 6,000 suckers are planted per acre (often in uphill direction). The number of weeding rounds is very small.

1.5 Irrigation and Drainage

1.5.1 General

At present a limited area is under irrigation. Since 1960 important steps have been taken for the realization of a number of irrigation projects. In particular three larger projects should be made mention of, viz. the Besut Irrigation Scheme (Stage I acreage 5,600 acres gross), the Pulau Musang Pumping Scheme (4,700 acres) and the Nerus Pumping Scheme (6,000 acres).

There are also 15 smaller projects totalling 3,300 acres. By 1966 the total acreage provided with irrigation facilities was in the order of 9,000 acres net. By 1970 this figure will have increased to about 17,000 acres.

Apart from the above-mentioned irrigation projects the DID identifies so-called controlled drainage schemes of which so far seven, totalling some 7,000 acres net, have been implemented.

The main purpose of the application of irrigation water is the growing of a second padi crop during the off-season. In most years the rainfall at the end of this season is too low to allow an adequate preparation of the padi fields for the main season crop.

Whenever necessary irrigation water is then used to make tilling and transplanting possible.

On the drainage schemes only one crop can be grown, viz. rainfed sawah padi.

As indicated above the sole crop for which the application of irrigation water has been considered is padi. The response of the farmers to the introduction of irrigation has been satisfactory in the Besut area but disappointing in the schemes of the Trengganu River Area (see Special Study "Farm Survey in the Trengganu District").

So far, some aspects of the detailed irrigation have not received the necessary attention. There are, however, ample indications that this will change in the future. A few points that merit attention are :

the installation of devices to measure the quantity of irrigation water turned out to the fields, the introduction of field channels, the organization of irrigation in the tertiary blocks, the narrowing down of the period of the presaturation and transplanting, the improvement of drainage.

1.5.2 Existing Projects

A full description of the Besut Irrigation Scheme (Stage I) and the proposed extension (Stage II) has been presented in the Report on the "Detailed Project Evaluation Besut Irrigation Scheme" which is a part of the Report on the Regional Economic Development of the State of Trengganu.

For further information reference is made to this report.

In the Pulau Musang Pumping Scheme roughly 4,700 acres can be doublecropped; only 1,150 acres were cultivated during the off season of 1967.

The area has a flat topography and is highly suitable for padi cultivation under irrigation. Water is supplied by pumping from the Sg. Trengganu. There is enough water throughout the year for irrigation. In comparison with the Besut Scheme the use of short-stem varieties is more popular here. This might have a favourable influence on the water duty, since a water layer of only one to two inches instead of four would in this case suffice for transplanting. The Nerus Pumping Scheme was completed during 1967. No information is available on the use of irrigation water for off season padi cultivation on this Scheme.

In the small irrigation project, varying in size from 25-500 acres, only a very limited area was used for padi growing during the off season. During the main season, too, large areas are not used, but the farmers then cultivate padi in recently cleared jungle (dry land padi). For a number of schemes the catchment areas appear to be of very limited size. This involves large risks in water suppletion and renders the basis of the schemes insecure.

The controlled drainage schemes vary in size from 80 to 4,600 acres. In principle padi cultivation should be the main objective but other crops - albeit of a small scale - are grown occasionally. The investment is rather high for benefits that can be only derived from one single crop (rainfed padi). It is for this reason that the DID is making investigations into the possibility of introducing some sort of water suppletion system for these types of schemes.

1.6 Livestock Production

1.6.1 General

Animal husbandry is an integrated part of the daily lives of the rural population. Domestic animals are kept throughout the country. Poultry and goats are mainly found in towns and villages.

The rural population does not go in for animal husbandry as a direct means of income. Buffaloes and cattle are kept as draught-animals for the ploughing of the padi fields but the farmers are readily prepared to substitute mechanical land preparation for the services of their animals. Other types of farm animals are kept mainly as a security. They may be sold in times of need or otherwise utilized on special occasions. The farmers are reluctant to invest money in or spent it on livestock and its maintenance, and growing fodders and keeping more livestock are not envisaged. In meeting their feed requirements the animals are to look after themselves.

Real commercial animal production is only practised on a number of specialized poultry farms and pig farms around the larger urban areas. As a consequence livestock production is in general of limited significance compared to the number of animals kept.

Important diseases such as rinderpest, foot and mouth disease do not prevail. Major diseases affecting bovines are haemorrhagic septicaemia and tickborne diseases. Melminthiasus is rather widespread among sheep. Main avian diseases are Newcastle disease and fowl pox.

At present, the State is self-sufficient in beef production and exports slaughter animals. The present pork production is limited and imports from other States are necessary.

1.6.2 Types of Livestock

The livestock population is composed of some 50,000-60,000 buffaloes and cattle, some 10,000 goats, sheep and pigs and approximately 500,000-750,000 chickens, ducks and geese.

The predominant type of buffalo is the Malayan swamp buffalo. The Trengganu buffaloes are of a slightly smaller size than the average breed. They are dual-purpose animals used for work and for beef production.

The Trengganu cattle, indigeneous cattle with Zebu and Thai blood, is a small but compact animal, used for land preparation.

As is the case with cattle, the goat population cannot be considered a breed as such either. In view of their devastating browsing habits, few cultivators favour the presence of goats near their holdings.

Sheep are even less important than goats. The former being less hardy than the latter the lamb mortality is very high.

The breeding of pigs is only practised on a small scale by Chinese.

The chickens are to be divided into two distinct groups. The majority consist of the kampong chicken (with a fair amount of Indian Game blood) kept both in rural and urban areas. The kampong chicken is a very hardy bird but a poor layer. Modern laying breeds and broiler breeds are found on specialized farms (30 farms in 1966), where White Leghorn, New Hampshire and Australorp Hybrids are used.

Duck and geese keeping is not popular in the State and there are no duck farms.

Some basic data about the various types of livestock are given in Table 1-4 on the next page.

1.6.3 Natural Grazing

Tropical rain forest constitutes the vegetation over most of the country. On the chemically poor coastal ridges the climax is composed of low trees and shrubs. Natural grasslands are absent with the exception of a Cyperus vegetation in swamps and depressions.

If the removal of the climax vegetation is not followed by tilling and cultivation the regrowth of shrubs and weeds (belukar) and finally again of the original climax vegetation is to take place.

Although the pioneer vegetation of shrubs, weeds and grasses are poor nutriment for large ruminants, many of them are found in 'belukar', in swamps and way-off clearings to graze and browse. During the growing season of the padi the animals must do with road side grazing.

Work animals are often hand-fed with cut grasses during that period, which is a time-consuming procedure.

Table 1-4 - Some Basic Data about the Types of Livestock kept in Trengganu

Item	Type of livestock					
	buffaloes	cattle	goats sheep	pigs	kampong chickens	other chickens
* number	24,000	33,000	7,000**	2,500		600,000
calving rate (%)	50	60	100			
lactation (days)	220	180				
age of first calving (months)	45	42				
life cycle (years)	12	10	3.5			
average live weight (kg)			18		1.2	
live weight of cow (kg)	270	180	15			
live weight of bull (kg)	360	220				
dressing (%)	50	45	50	80		
weight of hide of cow (kg)	25	15				
weight of hide of bull (kg)	30	20				
age at slaughter (months)				7.5		
slaughter weight (kg)				60		
eggs/hen/year					25	
egg weight (grammes)					40	60

* The number of livestock and poultry for the year 1966/67 has been estimated on the basis of the data of the 1965 Animal Census, of the additional information from the DTAM farm survey as well as of the slaughter house statistics.

** 5,000 goats, 2,000 sheep.

The Government has gazetted a substantial number of small areas as 'grazing reserves'. These 'reserves' are supposed to function as a stock for feeding the bovine population in view of the decline in fodder quantities. In total some 9,000 acres have been gazetted as 'grazing reserves'.

1.7 Production Volumes and Values

1.7.1 Crop Production

Separate estimates have been made of the crop productions by smallholdings and by estates. They have been based on the acreages known at present and the yields obtained. For the calculation of the gross production values (GPV) the present production figures have been multiplied by the current market prices.

1.7.1.1 Crop Production of Smallholdings

Estimates of the volumes and values of production and of the smallholders' income are given in Table 1-5 on the next page. Based on a required labour input of roughly 55, 35, 20 and 50 day-units per acre for respectively the production of padi, rubber, coco-nut and other (dusun) crops, the return to labour of men and women is, on an average, in the order of M\$ 1.50-2.00 per labour day, except in the case of coco-nut, for which it amounts to M\$ 5. This means that for padi, rubber and dusun production the average reward for one labour-day of a smallholder's family is slightly more than half the daily wages of an estate labourer.

1.7.1.2 Crop Production of Estates

In Table 1-6 an estimate is given of the crop production volumes and values on the estates.

Table 1-6 - Crop Production Estates (1966)

Crop	Area (acres x 1,000)			Production volume (in lb)		GPV (in M\$)	
	non-pro- ductive	pro- ductive	total	total (in millions)	per acre	total (in millions)	per acre
rubber	3.8*	12.7	16.5	7.85	475	3.75**	225
coco-nut	1.5*	-	1.5	-	-	-	-
cocoa	-	1.1	1.1	0.45	400	0.40	350
oil palm	10.5	-	10.5	-	-	-	-
total			29.6			4.15	

* including 1,000 acres old plantings

** including replanting cess (4.5 cts per lb), export duty (1.5 cts per lb) and research cess (1 ct per lb).

Table 1-5 - Crop Production and Income of Smallholdings 1966

Crop	Area (acres x 1,000)		Production volume			GPV (in M\$)			Income (in M\$)		
	total (in millions)	per acre	per small-holder ⁵⁾	total (in millions)	per acre	per small-holder	total (in millions)	per acre	per small-holder		
rice	70.0 ¹⁾	245 gt	490 gt	8.55	120	245	6.70	95	190		
rubber	143.52 ²⁾	175 lb	715 lb	10.60 ⁶⁾	75	305	8.45 ⁷⁾	60	240		
coco-nut	17.53 ³⁾	1,235 nuts	615 nuts	1.95	110	55	1.85	105	55		
other crops	29.2			2.50	85	70	2.30	80	65		
total	260.2			23.60	90	675	19.30	75	550		

1) 67,500 acres single cropped and 2,500 acres double cropped

2) Including 77,500 non-productive acres

3) Including 1,500 non-productive acres

4) 1 gt = 5.6 lb

5) Average production; the total number of smallholders is estimated at 35,000

6) Including replanting cess (4.5 cts/lb), export duty (1.5 cts/lb) and research cess (1 ct/lb)

7) Excluding replanting cess, export duty and research cess; including replanting subsidy estimated at M\$ 1,500,000

The GPV of rubber per acre is much higher for estates than for smallholdings since the former cover a larger production area (75-80% as against 45% of the total area under rubber), have a higher production per acre (600-650 lb as against 350-400 lb) and fetch a higher price because of the better quality of the rubber produced (45-50 cts/lb as against 40-45 cts/lb).

1.7.2 Livestock Production

Due to the lack of accurate data on the size, composition and productivity of the animal population as well as on the use of the surplus production and the inherent producers' prices, it has been difficult to estimate the present GPV and the income derived from animal husbandry.

Based on the results of the 1967 farm surveys the present annual income from buffalo and cattle keeping is estimated at M\$ 10-20 per animal and from poultry keeping at M\$ 1-2 per animal. In making these estimates neither the possible alternative use of capital and labour nor the cost of the services rendered by the Veterinary Department have been taken into account.

With an animal population of 50,000-60,000 buffaloes and cattle and 500,000-750,000 poultry and based on the aforesaid income figures the total annual income works out at approximately M\$ 2,000,000. In addition, the income obtained from sheep, goats and pigs is estimated at M\$ 100,000-150,000; the greater part of this income is derived from the Chinese-owned pig-fattening establishments.

The total annual income from livestock production is estimated at slightly over M\$ 2,000,000. It represents for some 80-90 per cent the income of the small-scale farmers and their families and works out at M\$ 50 per family a year. Hence, the present total family income as estimated should be increased from M\$ 550 to M\$ 600 a year on an average.

1.7.3 Contribution of Crop and Livestock Production to the Economy

The Gross Value Added (GVA) of crop and livestock production in 1966 has been calculated at M\$ 31.6 million (for detailed information reference should be made to Table 4-6, Section 4).

2 AGRICULTURAL DEVELOPMENT POTENTIAL

2.1 Introduction

In the next decades an increase in the standard of living of the population of Trengganu will have to be realized by a rise in the agricultural productivity.

The basic considerations underlying this starting-point are :

- It is quite possible to extend the agricultural area in Trengganu and to increase the production per acre.
- Roughly 60 per cent of the male workers are employed in agriculture inclusive fisheries and forestry at present. Even if economic progress in the next decades is to take place at a balanced and satisfactory rate, the percentage of male workers in agriculture will drop relatively slow. This implies that in the next 10-15 years some 50 per cent and in the following 10-15 years a little less than 50 per cent of the increased population must be offered employment opportunities in the agricultural sector.
- The rather isolated location of Trengganu and the relatively small number of inhabitants necessitate the stepping up of the production in the primary sector to such an extent that surpluses, preferably in the form of finished products, can be produced to meet the demand both within and outside Trengganu.
Only when this goal has been achieved on a sufficiently large scale will it be possible to promote the production in the secondary and tertiary sectors.
- To prevent too great an economic dependence and to strengthen the economic competitive power there is a tendency towards a high degree of self-sufficiency, especially as far as the supply of food stuffs is concerned.
This is the more applicable to Trengganu because of its isolated location.

The agricultural production can be stepped up in different ways :

- By intensification of the present land use
- By increasing the level of production through the choice of suitable crops and varieties; application of fertilizers and pesticides; adequate land preparation, etc.
- By developing new agricultural areas.

2.2 Intensification of the Present Land Use

The intensification of the present land use can be achieved by promoting the system of double-cropping and intercropping (wherever justified) and by improvement of the present system of crop cultivation in the dusun areas.

2.2.1 Double-cropping

The most important prospect for double-cropping lies in the growing of two padi crops, one during the main season and the

second - under irrigation - during the off season (for further details see Sub-section 2.6 - Irrigation and Drainage Potential).

Double-cropping is also possible without the construction of an irrigation system, but main season sawah padi should then be succeeded by e.g. maize, soy beans or other field crops. This is not regarded a very promising proposition. The yields of the field crops mentioned will be rather low due to the inadequate availability of moisture in the soil while the costs involved in the cultivation will be comparatively high especially as far as land preparation and weed control are concerned.

Of the acreage to be double-cropped with padi it is estimated that approximately 85 per cent will be actually cultivated. This estimate is based on the response already shown by the farmers in Stage I of the Besut Irrigation Scheme and on the supposition that an increase in the occupation co-efficient will be attained as a result of future agricultural extension activities and of adequate project management in the case of controlled irrigation schemes.

Double-cropping without irrigation on non-sawah land will be mainly concentrated on the high-lying river terraces situated inland. Both the quantities of rainfall and the soil conditions are more favourable there. The main crop to be cultivated in the wet season should be dryland padi. As a second crop maize, soy beans or groundnuts could be grown.

As the higher-lying terraces are also very suitable for the cultivation of oil palm, it is advisable to reserve these areas, if they form contiguous blocks of sufficient acreage, for the growing of this crop with a view to its high income earning capacity.

2.2.2 Intercropping

Intercropping will be restricted to flat areas intended for the cultivation of tree crops. The interest in this system of cropping that aims at interplanting tree crops such as rubber and oil palm with annual crops, sometimes even with semi-perennial crops e.g. bananas, is increasing.

The purpose of the system is to provide the farmers and the estates with an income from the catch crops planted during the first 2-3 years when the perennial crops are not yet in production.

During the first three years of the development period the intensity of the light is high enough in the plantations to permit a fair production of a catch crop. Such catch crops are : dryland padi (rainy season), maize (dry season), bananas and fodder crops. However, in view of the conditions prevailing in Trengganu the system of intercropping will not be practised on a large scale. The relief of most of the terrains suitable for the cultivation of rubber and oil palm is such that the soils would easily erode should intercropping be practised.

Moreover, the low moisture content of the soils during the dry season may certainly prove a limiting factor, the more so as the main crop might be adversely affected.

In areas without erosion hazard intercropping can be more successfully practised in rubber plantations than in oil palm plantings. The overall spacing in rubber plantations is more favourable and the shade produced by young rubber trees is less intense than in oil palm plantations. However, new plantings of rubber are not likely to be established on such terrains, since preference will be given to oil palm. Besides, the total acreage under rubber trees of less than 3 years old amounts to about 10 per cent, which implies that the acreages suitable for intercropping are practically negligible, the more so as this percentage includes steep parts of hilly terrains.

The system of intercropping has been often mentioned in relation to coco-nuts. The crops considered were cocoa and fodder crops. As a result of the low water-retaining capacity of the beach ridge sands where the majority of the coco-nut trees are found, the competition between the coco-nut trees and the other crops will be extremely keen during the dry season. Therefore, intercropping on the beach ridge soils will not be a profitable proposition.

2.2.3 Improvement of the Land Use in Dusun Areas

At present the dusun areas are not fully utilized. The trees have been planted haphazardly resulting in a considerable loss in acreage of suitable land. The tree population can be easily increased by spacing the trees properly and planting the additional acreages thus made available.

2.3 New Areas suited to Agriculture

Of the total area of 3,100,000 acres of the State of Trengganu about 60 per cent is not considered suitable for agricultural development. This land is covered by peaty swamps, soils liable to frequent flooding, waterlogged soils, shallow soils and soils with a slope gradient of more than 20 degrees.

The remaining area of about 1,260,000 acres can be divided into areas with a varying degree of suitability for agriculture, viz. :

suitability
category

- 1 Soils highly suitable to suitable for the growing of a great variety of tree crops (170,000 acres)
- 2 Soils suitable to marginally suitable for the growing of a great variety of tree crops; highly suitable to suitable for the growing of rubber (160,000 acres)
- 3 Soils marginally suitable for the growing of a great variety of tree crops; suitable for the growing of rubber (80,000 acres)
- 4 Soils marginally suitable for the growing of rubber (60,000 acres)

suitability
category

- 5 Soils locally suitable for the growing of a great variety of tree crops and locally suitable for the growing of sawah padi (350,000 acres)
- 6 Soils highly suitable for the growing of a great variety of tree crops and annual crops (160,000 acres)
- 7 Soils marginally suitable for the growing of cashew and coco-nut (90,000 acres)
- 8 Soils highly suitable for the growing of sawah padi; suitable to marginally suitable for the growing of annual crops (60,000 acres)
- 9 Soils marginally suitable for the growing of sawah padi (130,000 acres)

The area used for agriculture at present amounts to roughly 290,000 acres, of which 235,000-240,000 acres can be considered to be really suitable.

Rubber is the major crop grown on unsuitable soils, some 35,000 acres; besides padi and miscellaneous crops are sometimes cultivated on these soils.

After deduction of the 235,000-240,000 acres of more or less suitable soils used for agriculture at present, an area of roughly 1 million acres is left for future agricultural development. One third of this total acreage is concentrated in units of at least 1,000-2,000 acres. These units should be given priority in future agricultural development plans.

Within the potential project areas as distinguished there are scattered small areas which have also been considered for future development.

Table 2-1 shows the potential agricultural area classified according to soil suitability categories for crops grown in Trengganu.

As shown in Table 2-1 the agricultural area might be extended considerably, but the possibilities for such an extension should not be overestimated. A large portion of the more or less suitable soils consists of fragmentary small patches which are intermingled with unsuitable soils. Therefore, these dispersed patches, a small acreage in the close vicinity of the above indicated larger tracts of land excepted, have - for the time being - not been considered for development, neither the rest of the soils that are predominantly marginally suitable and the development of which is not considered economically justified at this stage.

The land suitability map, scale 1:63,360, as well as the land use map, scale 1:63,360, have been of paramount importance in selecting the agricultural areas to be developed during the plan period.

Next, the land alienation and gazettelement map as well as the mining potential productivity map, both maps also to a scale of 1:63,360 have served as a guideline.

Areas already alienated for agricultural development purposes but still under forest have been included in the planning if such areas were covered by suitable soils; with regard to the mining potential productivity map the classes 1, 2 and 3 have not been considered for agricultural development.

Finally, the forest potential productivity map, scale 1:63,360, has served as a basis in determining the logging potential of the areas to be converted from forest land into agricultural land (see Annex V-A : Forestry).

By superimposing the maps shown in Plate IV-2 the ultimate areas intended for agricultural development in the Dungun District have been arrived at.

Areas which according to the land use map and the land alienation and gazettelement map were under illegal occupation, have been included in the planning

As indicated in Table 2-1 the total area to be used for agriculture by 1990 is estimated to cover some 625,000 acres. In this acreage 20,000-25,000 acres of unsuitable soils are included, since it has been assumed that the present use of unsuitable soils for agriculture will reduce by about 50 per cent.

2.4 Yield Projections

Yield projections have been made for all crops that seem promising in the context of crop diversification.

The projections for the various reference years represent average yields expected to be obtained throughout the State. They are related to realistic inputs (fertilizers, pesticides, new varieties) and to factors such as soil conditions, climate and hydrology. Besides, the experience of the farmers has been taken into account in estimating the future yields.

For perennial crops the projections have been made for either planted material or material to be planted in the near future (up to 1980). It is anticipated that in the coming 15 years so much progress will be made in the breeding of oil palm and rubber that the yields of these crops (planted after 1985) will be at a higher level.

2.4.1 Food Crops

2.4.1.1 Padi

Yield projections have been made for both irrigated and rainfed sawah padi as well as for dryland padi. Padi huma is likely to disappear from the cropping pattern since its cultivation is to be dissuaded in connection with erosion problems. The projections (see Table 2-2) for both irrigated and rainfed padi grown during the main season are based on the average yield as obtained from tall and semi-tall varieties grown on well-oxidized soils and on soils

Table 2-1 - Present and Projected Future Land Use (in acres)

Soil suitability classification	Land use 1966	Development areas	Remaining dispersed areas	Total
soils highly suitable/suitable/marginally suitable for the growing of tree crops; soils highly suitable for the growing of annual crops - classes 1, 2, 3, 4 and 6 -	139,000	244,000	247,000	630,000
soils locally suitable for the growing of a great variety of tree crops and locally suitable for the growing of sawah padi - class 5 -	23,000	59,000	268,000	350,000
soils highly suitable/marginally suitable for the growing of sawah padi; suitable/marginally suitable for the growing of annual crops - classes 8 and 9 -	56,000	31,000	103,000	190,000
soils only (marginally) suitable for the growing of cashew and coco-nut - class 7 -	20,000	30,000	40,000	90,000
total	238,000	364,000	658,000	1,260,000

Note
total land use planned on suitable soils : 238,000 + 364,000 = 602,000 acres approximately
on unsuitable soils : 23,000 acres "

total : 625,000 acres approximately

Table 2-2 - Estimates of Padi Yields, 1966-1990

Type of padi cultivation	Average yield of dry padi per acre in gantang (= 5.6 lb)*							
	1966	1970	1975	1980	1985	1990		
irrigated	irrigation projects	main season	250	275	300	375	425	500
		off season	300	350	425	500	575	675
sawah	drainage projects	main season	250	275	300	400	450	450
		other projects	250	275	300	350	400	450
dryland	-	main season	180	200	225	250	300	350
		upland	160	175	200	225	250	275

* where two averages are given the lowest applies to the southerly situated areas and the highest to areas situated in the North.

which cannot properly dry between two crops. Dwarf varieties are not included in the above-mentioned yield average. The latter are not expected to be grown in the main season since they are very liable to submerging after heavy and intensive rainfall.

The recently introduced semi-tall varieties with shorter stalks respond better to high fertilizer applications than the original local tall cultivars. This better response is the main reason why substantially higher yields are anticipated from the semi-tall varieties in the future; moreover, they are less liable to lodging. Tall varieties, however, cannot be entirely excluded from the planting programme since they are needed for the lower-lying areas where surface water levels may rise considerably during the month of December.

Where drainage problems occur due to high groundwater levels, drying of the soil between the main season padi and the off season padi is not possible. Consequently, the resulting yield reductions for either crop are estimated at 20 per cent at least.

Although the present yields of rainfed padi and irrigated padi do not differ widely, the future rainfed padi yields are assumed to be lower for various reasons. As a result of the conversion of rather large areas where rainfed padi is cultivated into irrigated padi land, the remaining rainfed padi will be grown to a relatively greater extent in the wetter basin depressions. As a consequence the percentage of tall varieties with their inherent lower yield potential to be planted becomes higher. The fact that the water supply is totally dependent on the precipitation will sometimes affect the time of planting and thus the yield. Shortage of water during the growing season occurs seldom and will therefore not influence the yield.

The increase in the yields for both irrigated and rainfed main season padi likely to take place until 1985 are mainly the result of a shift from tall varieties to semi-tall varieties wherever possible and of the use of larger quantities of fertilizer, a better water control and of timely planting. It is not likely that plant protection will strongly contribute to the improvement in yields in the initial period, since it will take some time before the co-ordination of control measures necessary for effective results will be fully realized.

The yields of irrigated off season padi are projected 15-20 per cent higher than those of the main season crop since in the off season solely dwarf varieties can be grown and a greater number of sunshine hours is available to the crop. The big jump in yields between the years 1967 and 1975 is brought about by the replacement of the present semi-tall varieties Malinja and Mashuri by the dwarf variety Ria (IR 8) or similar planting material. The disadvantage of the high-yielding Ria variety is that its properties for consumption are not appreciated by the local population.

The further increase in yields after 1975 may be attributed to the effect of the inputs which are virtually the same as for the main season crop. It is anticipated that by further breeding the quality of the dwarf varieties will improve over time by progress made in selection and that finally they will be able to compete with the present Siam varieties as far as quality is concerned.

There is considerable scope for improving the quality of the main season dryland padi. With the introduction of more suitable dryland padi cultivars from Congo, Madagascar and the Philippines, with adequate fertilizer applications and with effective weed control, yields of at least 350 gantang per acre may be realized.

It is, however, understood that initially farmers will be sceptic to this method of more intensive dryland padi cultivation. They will only gradually adopt the recommended inputs.

2.4.1.2 Maize

The only information available in Trengganu on which yield projections for maize have been based originated from Kuala Brang. Here the crop is cultivated on the higher-lying river terraces. Local, short-growing varieties planted in the off season are doing reasonably well, producing 1,000-1,500 lb grain per acre.

For its water supply the crop relies on rainfall and on residual moisture stored in the soil after the latter has been flooded. With better-yielding varieties, proper land preparation, the application of fertilizers and the control of diseases and pests, an average yield of about 3,000 lb grain per acre is likely to be obtained on the fertile alluvial inland soils with slopes below two degrees towards the end of the planning period (see Table 2-3).

As the annual rainfall is very irregular, in some years the precipitation may be adequate to permit higher yields. In other years the rainfall is inadequate to meet the consumptive use requirements of the crop and yields will be lower. Hence, the yields are thought to vary from 2,500-4,500 lb of grain per acre.

The growing of maize as an irrigated crop on sawahs in rotation with padi has not been considered mainly because it cannot compete with the off season padi crop (for further reasons see the Report on the Detailed Project Evaluation Besut Irrigation Scheme). The yields would be slightly lower than for maize on rainfed higher-lying river terraces. Maize grown in rotation with wet padi but entirely depending on rain will give substantially lower yields. The moisture retained by the sawah soils after the harvest of the padi is inadequate to make up for the shortage of water brought about by insufficient rainfall.

Therefore the projected yields for maize grown on rainfed sawahs during the off season are estimated to be about 30 per cent lower than those for maize on the terraces (see Table 2-3).

So far, most of the farmers are unfamiliar with the cultivation of maize. It is therefore anticipated that they will try out

this crop first before expensive inputs are applied. Hence, before 1975 no increase in production is to be reckoned with. The various yield projections are given in Table 2-3 below.

Table 2-3 - Projected Maize Yields (in lbs of grain per acre)

Year	Maize grown in rotation with padi on rainfed sawahs during the off season	Maize grown on rainfed, higher-lying river terraces
1966	-	1,300
1975	1,400	1,700
1980	1,650	2,200
1985	2,000	2,900
1990	2,200	3,300

2.4.1.3 Soy Beans

At present, soy beans are grown in Malaysia on a very limited scale. They are cultivated around Ipoh on the West Coast but the results obtained with the available varieties is not promising. Yet the growing of soy beans as a diversification crop is thought to be a good proposition.

Intensive research should be undertaken to select varieties which are high-yielding under Trengganu conditions. The crop can be only grown during the dry season, the monsoon period being too wet for it.

In Trengganu the most suitable soils for soy beans are situated on the high-lying river terraces where the texture of the soils is not too fine. The sawah soils of the lower terraces are definitely less suitable since they consist of heavy and dense clay.

Grown on sawahs in rotation with padi but only benefiting from residual soil moisture and from rainfall during the off season, soy beans are expected to yield relatively better than maize grown in this way, as the soy bean is more drought-tolerant. This is reflected in the yield projections (see Table 2-4 below).

Table 2-4 - Projected Soy Bean Yields (in lb per acre)

Year	Soy beans grown in rotation with padi on rainfed sawahs during the off season	Soy beans grown on rainfed higher-lying river terraces
1966	-	-
1975	500	650
1980	600	850
1985	900	1,300
1990	1,200	1,700

So far no research on soy beans has been carried into practice. Consequently, it will take some time before material

that is suited to the local conditions will be available. It must be possible, however, to release good strains as from 1980.

2.4.1.4 Groundnuts

Groundnuts are grown in Trengganu on a very small scale at present. The yields obtained are fairly good and are estimated at about 1,200 lb unshelled nuts per acre. On the West Coast near Ipoh much larger areas are under groundnuts. The average yield obtained there is 1,600 lb per acre.

The yield projections for Trengganu (see Table 2-5) are based on the latter figure. As the rather high yields at Ipoh suggest that good-quality planting material is available there, the use of this material should render it possible to obtain similar good yields in Trengganu.

The level of inputs required at the introduction of the crop is rather high. Therefore, the yields will only show a gradual increase over time.

The crop should be preferably grown on not too heavy-textured higher-terrace soils. Sawah soils are unsuitable.

Table 2-5 - Projected Groundnut* Yields (in lbs of unshelled nuts per acre)

Year	Yields
1966	-
1975	1,600
1980	1,800
1985	2,200
1990	2,500

* in shell : shelling percentage 60

2.4.1.5 Cassava

Sweet cassava is grown locally in Trengganu, predominantly in the dusun areas. Its average yield amounts to about two tons of fresh tubers per acre. The sweet cassava is grown as a relief food crop to replace rice. Its yield potential is lower than that of industrial (bitter) cassava which, e.g. produces seven tons of tubers per acre near Ipoh on the West Coast. It is expected that with a careful introduction of this crop the response of the farmers will be favourable and that similar productions as on the West Coast may be obtained. Taking into account that the present yield level is rather low, improvement in the yields can be easily obtained over time.

Cassava should be preferably grown on the lighter soils of the high-lying terraces. The heavy sawah soils are only

marginally suitable for the growing of root crops.

Only the yield projections for bitter cassava are given in Table 2-6 below, since the cultivation of this crop might be envisaged in the future.

Table 2-6 - Projected Cassava Yields (in tons of fresh roots per acre)

Year	Yields
1966	-
1975	7.0
1980	10.0
1985	14.0
1990	16.0

2.4.2 Industrial Crops

2.4.2.1 Oil Palm

The main factors that limit an optimum production of oil palm in Trengganu are climate and relief.

Once every four years there is less than ten inches of rain during 90 days in the dry season in the North of Trengganu; in the southern part of the State this amount is even less than six inches.

Based on an 'available moisture' percentage of 15 (a root zone of 4-5 feet) and an evapo-transpiration of 6.5 inches per month, the yield reductions to be expected as a result of a temporary moisture deficit are about 20 per cent in the North and 40 per cent in the South once every four years*.

Heavy and continuous rainfall as occurring during the main season makes it necessary to practise assisted pollination. But even this does not guarantee that optimum fruit setting will take place. As a consequence, reductions in yield are to be reckoned with. The heavy rainfall also adversely affects the yields by rendering it impossible to timely evacuate the fruit bunches because of the bad conditions of the roads during the period of peak harvesting, which coincides with the rainy season.

Not only the climatic conditions but also the configuration of the terrain is more favourable in the northern part of the State

* R. A. Bull - Relation between Water Deficit and Fruit Yield. Oil Palm News no 3, 1965.

than in the South (angle of slope less often exceeding 12 degrees). Terracing the stronger sloping soils apparently does not result in storage of the same quantities of rainwater as in similar soil in flatter terrain. Therefore, oil palm grown in rolling terrain will more readily suffer from lack of moisture during dry spells than those on undulating or flat areas. Apart from a decrease in production due to less favourable moisture conditions losses in yields may also occur as a result of fruit bunches or loose fruits rolling down the slopes.

It should be stressed that the projected yields will be only obtained if erosion is fully under control, i. e. if terracing and platforming are carried out in the appropriate way and the cover crop is established before the monsoon rains set in.

a) Estate Projects

On the East Coast large-scale oil palm cultivation is of a very recent date and the first plantings are just coming into production. The yields obtained from small-scale experiments with D x D (Dura x Dura) and D x T (Dura x Tenera) material at the Jerangau Station indicate that peak yields of about eight ton F.F.B./acre are feasible.

Extensive information is available on the oil palm cultivation on the West Coast. There, D x P (Dura x Pisifera) palms on inland soils of good quality are estimated to produce between 9 and 10 ton F.F.B./acre ten years after transplanting*. This estimate is based on yield trends observed for D x P material up to eight years after transplanting. The yield projections of the (D x P) oil palms to be planted in Trengganu, had, however, to be extrapolated from the yields recorded for D x D material since the level of the yields of D x P material during its entire productive period is not yet known.

The yields in fresh fruit bunches (FFB) to be obtained in the State are projected somewhat lower than those attained on the inland soils of the West Coast where the rainfall is more evenly distributed and the estates are situated on relatively flat land.

The projections (see Table 2-7) are valid for the present Dura x Pisifera material, as released by seed producers who follow a sound selection and seed production programme which is guided by a qualified staff. New material is not expected to be available for planting within the next 10-15 years.

* R. A. Bull - Relation between Water Deficit and Fruit Yield. Oil Palm News no 3, May 1965.

Table 2-7 - Projected Oil Palm Yields on Estates

Age as from transplant- ing (years)	FFB (tons per acre)	Oil extraction (%) (1)	Oil production (tons per acre) (2)	Kernel production (tons per acre)
4	2.9	12	0.35	0.12
5	5.0	15	0.75	0.20
6	7.0	17	1.19	0.28
7	7.8	19	1.48	0.31
8	8.5	20	1.70	0.34
9	8.8	20	1.76	0.35
10	8.8	20	1.76	0.35
11	8.8	20	1.76	0.35
12	8.7	20	1.74	0.35
13	8.5	20	1.70	0.34
14	8.3	20	1.66	0.33
15	8.0	20	1.60	0.32
16	7.8	20	1.56	0.31
17	7.6	20	1.52	0.30
18	7.4	20	1.48	0.30
19	7.2	20	1.44	0.29
20	7.0	20	1.40	0.28
21	6.8	20	1.36	0.27
22	6.6	20	1.32	0.27
23	6.4	20	1.28	0.26
24	6.2	20	1.24	0.25
25	6.0	20	1.20	0.24

- (1) The present research work on breeding concentrates on the improvement of the oil content. The material available for large-scale plantings by 1985 is supposed to have an oil content of 22-24 per cent.
- (2) Average oil production over the period of economic production roughly 1.5 ton per acre a year.

The peak yield for palms planted before 1980 averaged for the whole of Trengganu (on going projects and newly to be developed projects) is 8.8 ton FFB per acre. The individual peak yields from 8.0-9.6 ton and decrease from the North to the South due to a less favourable rainfall and steeper slopes. The kernel production is estimated to amount to 4 per cent of the FFB weight.

The anticipated quantities of oil to be extracted are based on the performance of D x P material available at present. During the first year of harvesting the oil extraction percentage is about 12. It increases gradually to 20 per cent.

Yields to be obtained at FLDA-plantations will greatly depend on the way the schemes are ultimately set up. If the settlers are working as 'labourers' which means that they work

under close supervision in maintenance and harvesting gangs, similar yields as obtained on private estates may be reckoned with. If, however, they work as 'individuals' on their own plots the yields obtained are expected to be only 85 per cent of those obtained on the plantations run with labour gangs.

b) Special Smallholding Development Projects

As these new projects will be situated in the vicinity of the large estates, it is supposed that they will benefit from the management and facilities of the latter and will obtain similar yields.

The establishment of independent smallholder oil palm development projects might be considered (see Table 2-8) but their introduction is not propagated and has not been taken into account in the planning. In Table 2-8 the projected FFB-production and oil extraction by estates and by smallholders have been compared. The large estate production has been taken as reference level (index 100).

Table 2-8 - Comparison of FFB-yields and Oil Extraction Rates for various Types of Production Units

Type of production unit	FFB-yield	Extraction rate
estates (FLDA 'labourers')	100	100
special smallholding development projects (under close supervision of estates)	100	100
estates (FLDA 'settlers')	85	95*
smallholder development projects (independent of estates)	85	95**
independent smallholders	70	90*

* extraction on estate mills; extraction rate low because of fruits of poorer quality

** smaller mills (less efficient)

2.4.2.2 Rubber

Yield projections in terms of dry rubber inclusive of scrap and lumps have been made for rubber grown on estates as well as for rubber grown on FLDA-schemes, Fringe Alienation Schemes and on smallholdings. Separate projections have been made for old rubber occupying existing plantations, for rubber recently replanted and for rubber which will be planted within

the next 10-15 years. First, the various factors that determine the latex production are briefly discussed.

The climatic conditions of the East Coast allow, in general, a reasonable latex production. The heavy rainfall during the morning hours in the rainy season, however, hampers the timely tapping of the rubber trees. Quite a number of tapping days are thus lost.

The yield losses as a result of the non-productive days might be partly balanced by practising double tapping, i. e. during both morning and afternoon of a day that follows on a rainy day. Thus it remain still possible to tap 300 times a year. On private estates this number of tapping times is actually made.

The occasional occurrence of prolonged dry spells in Trengganu during the period February-May is likely to have an unfavourable influence on the latex production. On the other hand the great number of sunshine hours will probably balance this effect. Therefore it is thought that there will be no virtual difference between East Coast and West Coast productions.

From a physico-chemical point of view and also in terms of depth a considerable part of the soils of Trengganu are suitable for the growing of rubber. Unfortunately, parts of the FLDA-rubber schemes, viz. Belara and Seberang Tayor, are situated on rather shallow soils with an low nutrient status and a low water-retaining capacity. This has been taken into account in projecting the yields of the current FLDA-schemes.

The quality of the planting material chosen, too, has a great impact on the latex production.

At present, a large number of old rubber trees on both estates and smallholdings originate from unselected seedlings. The yields obtained from these old trees do not exceed 450 lbs of dry rubber per acre on estates and 300 lb per acre on smallholdings.

The planting material used in replantings and in new plantings varies widely in production potential.

The planting material provided for by the Rubber Replanting Board is of fair quality and is largely confined to Tjirandji I seedlings. Their yield potential is, however, considerably lower than that of the material used by smallholders on the West Coast. The reason why this type of seedling is supplied and recommended is that the standard of tapping in Trengganu is lower than on the West Coast. When poorly tapped Tjirandji I is not a spectacular producer but it is sturdy and withstands maltreatment surprisingly well.

Although the settlers of Fringe Alienation Schemes could have the same planting material as provided by the Rubber Replanting Board to the individual smallholders, the collecting of the material is often so poorly organized that the seedlings have died before arrival. To replace such losses, unselected seedlings are collected from old rubber holdings. Improvements in the quality of the planting material are hardly to be expected in this way.

On estates and FLDA-schemes where the standard of tapping is higher than on smallholdings, budgrafts are in use instead of seedlings. The former, however, suffer more of bad tapping practices. Budgrafts produce up to thirty per cent more than the best seedlings provided the standard of tapping is high.

Large acreages of FLDA-schemes have been planted with RRIM 513 and RRIM 623, since these clones have been recommended by the Research Institute in the past. When it was found that they were easily damaged by wind the clones have been withdrawn from the list of recommended planting material.

On private estates the variety of the clones used is larger so as to guarantee a higher security.

Recently the clone RRIM 600 has been released, which combines a high-yielding capacity with favourable secondary characteristics.

The poor establishment of many smallholder's plantations and of practically all the Fringe Alienation plantations has been taken into account in projecting the yields.

The use of stimulants to keep the latex production from regenerated bark as high as that from virgin bark is only expected to be practised on large private estates.

The yield projections for rubber are shown in the Tables 2-9 and 2-10.

The highest peak yields (1,800 lbs of dry rubber per acre) are expected from the new plantings on the large, well-managed estates which are situated on soils suitable for both rubber and oil palm e.g. the Jabor Valley and Kerteh Estates. These estates make use of the most up-to-date clonal material. Material that has been planted during the last ten years is not likely to give peak yields that exceed 1,500 lbs of dry rubber per acre on an average.

The yields to be obtained from the present FLDA-schemes in Trengganu will be lower than those from the estates mentioned. The number of tapping days are lower (double tapping after rain is not a standard practice) and the tappers are less qualified. The soils of the Schemes are, in general, less suitable.

The maximum yields from virgin bark are estimated at 1,100 lbs of dry rubber per acre. As soon as regenerated bark will be tapped the yields are supposed to decrease since it is not expected that stimulants will be applied.

Whenever the establishment of new FLDA-rubber schemes would be considered for Trengganu, the yield projections for these schemes might turn out higher since higher-yielding material would be planted, more experience would have been gained and, moreover, only suitable soils would be selected.

The yields of recently planted rubber on smallholdings are not expected to exceed 750 lbs of dry rubber per acre. The soils of the smallholdings - it is true - are generally of a higher

Table 2-9 - Projected Rubber Yields (in lbs of dry rubber* per acre)

Age as from planting (years)	Large estate		FLDA schemes		Small estates		Small-holdings		Fringe alienation schemes	
	R**	F**	R	F	R	F	R	F	R	F
6 1/2	600	650	500	600	450	550	-	450	-	350
7 1/2	900	1000	700	900	650	800	350	650	-	500
8 1/2	1200	1300	850	1200	800	950	450	800	200	650
9 1/2	1400	1600	950	1400	900	1100	600	900	250	750
10 1/2	1500	1800	1050	1500	1000	1200	700	1000	300	800
11 1/2	1500	1800	1100	1500	1000	1200	750	1000	350	800
12 1/2	1500	1800	1100	1500	1000	1200	750	1000	400	800
13 1/2	1500	1800	1100	1500	1000	1200	750	1000	450	800
14 1/2	1500	1800	1100	1500	1000	1200	750	1000	450	800
15 1/2	1400	1700	1000	1400	950	1100	700	950	450	750
16 1/2	1400	1700	1000	1400	950	1100	700	950	450	750
17 1/2	1400	1700	1000	1300	900	1100	650	900	450	750
18 1/2	1400	1700	900	1300	900	1000	650	900	400	700
19 1/2	1400	1700	900	1200	850	1000	600	850	400	700
20 1/2	1400	1700	900	1200	850	1000	600	850	400	700
21 1/2	1300	1600	800	1100	700	900	550	700	350	650
22 1/2	1300	1600	800	1100	700	900	550	700	350	650
23 1/2	1300	1600	800	1100	700	900	500	700	350	650
24 1/2	1300	1600	700	1000	600	800	500	600	350	500
25 1/2	1300	1600	700	1000	600	800	450	600	350	500
26 1/2	1300	1600	700	1000	600	800	450	600	350	500
27 1/2	1500	1800	900	1200	800	1000	600	800	450	650
28 1/2	1300	1600	800	1050	700	900	500	700	400	600
29 1/2	1100	1400	700	900	600	800	400	600	350	550
30 1/2	900	1200	600	800	500	700	350	500	300	500
31 1/2	750	1000	500	700	400	600	300	400	250	400
32 1/2	500	800	400	600	300	500	250	300	200	300

* dry rubber : 85 per cent from latex, 15 per cent from scrap and lumps

** R = recent plantings
F = future plantings

Table 2-10 - Rubber Yields for the Reference Years in the Period 1966-1990

Type of production unit	Average yield of dry rubber in lb per acre*				
	1966	1970	1975	1980	1985-1990
<u>Smallholdings</u>					
- established plantings of unselected material	350	350	350	350	-
- established replantings and future plantings	550	650	700	750	900
- established plantings on new land and future plantings on new land	350	400	450	450	550
<u>Smallholdings Development Schemes</u>					
- fringe alienation schemes	-	query	query	query	query
- controlled alienation	-	"	"	"	"
- block New Planting schemes	-	"	"	"	"
- FLDA	800	900	1,000	1,100	1,200
<u>Estates</u>					
- established plantings of unselected material	500	500	500	500	-
- established replantings and future replantings	1,000	1,100	1,200	1,300	1,500
- established plantings on new land and future plantings on new land	-	-	-	-	1,200

* productive area

quality than those of the FLDA-schemes but the seedlings used for replanting are of the Tjirandji I type and the standard of tapping is rather poor.

For future replanting and new planting GT I seedlings with a higher yield potential are now available. As long as the production of this material is not hampered by unskillful tapping, yields of 1,000 lbs of dry rubber per acre may be obtained. Nevertheless, the yields obtained from rubber smallholdings will, also in the future, remain notably behind those of the estates. As in the past the larger portion of the planting material will consist of seedlings and the quantities of fertilizer applied will remain small. Maintenance will be less good than on the estates and stimulants will be rarely used.

The Fringe Alienation plantings are entirely neglected at present. A considerable portion of the material planted consists of unselected seedlings. The average peak production is estimated at 450 lbs of dry rubber per acre. Even if these Fringe Alienation Schemes are replanted with better material, the future yields are not expected to rise very much since the farmers on these schemes generally live at a rather wide distance from their plantations. Moreover, they have to divert their efforts to other activities as well.

In new areas it is recommended to establish Special Smallholding Development Projects in order to guarantee an economic production on smallholdings. The yields to be obtained from these development projects are expected to be similar to those obtained on the private estates that will supervise these projects. In the development programme it has been assumed that these projects will be established on soils which are only suitable for rubber. The yields obtained on these soils will be lower than those to be achieved on soils that are suitable for both oil palm and rubber. The peak yields are estimated to be 1,500 lb per acre for plantings established before the period 1980/85. The yields of plantings to be established later on all types of soils suited to rubber are expected to be 10-20 per cent higher as a result of the progress made in breeding.

A comparison of future peak yields as obtained by the various production units is given in Table 2-11 below. The productions of the private estates are taken as reference level and fixed at 100.

Table 2-11 - Comparison of Dry Rubber Peak Yields

Types of production units	Yield index
private estates	100
special smallholding development projects	100
FLDA-schemes	80
individual smallholders	55

2.4.2.3 Coco-nut

The conditions for the production of coco-nuts seem to be best in the kampongs.

The factors which limit a good production of the coco-nut trees grown outside the kampong areas on the beach ridges are manifold. The poor way in which the plantings are tended have resulted in the establishment of a grass vegetation that strongly competes with the palms for nutrients and moisture.

Next, there are the low nutrient level of the beach ridge soils and the inadequate rainfall during the dry season in areas where the groundwater table is too deep below the surface. Finally, unselected planting material is being used.

When grown in dusun areas on the beach ridges the use of unselected planting material is the main factor which limits the production. The supply of nutrients has been and is being notably improved by the application of organic manure in the form of house refuse. The latter practice contributes also to an increased water-retaining capacity of the sandy beach ridge soils.

The coco-nut plantings in and around the kampongs are generally well tended. As a consequence of the better edaphic conditions in the kampong areas the yields of coco-nut palms grown there are higher than of the palms found outside these areas. Apart from this the higher yields have to be attributed indirectly to the irregular spacing of the trees in the kampong areas which permits them to benefit more from the light intensity.

The main factor that limits the production of coco-nut trees in the dusun areas situated inland is the use of unselected planting material.

The widest scope for increasing the production of established coco-nut plantings is found outside the dusun areas on beach ridges. With clean weeding and the application of fertilizers and/or manure the average yields may be increased substantially.

The yield projections for established plantings are given in Table 2-12 below.

Table 2-12 - Projected Yields for Present Coco-nut Plantings (in nuts per palm)

	On beach ridge sands		On inland soils
	plantation*	dusun	dusun
present	5-10	40	50
future**	25-30	55	60

* plantings outside the kampong

** with adequate fertilizer applications

Yield projections for the reference years in the period 1966-1990 have been made also for new plantings on estates and on smallholders' schemes in coastal and inland areas (see Table 2-13).

The peak productions obtainable on estates are estimated at roughly 60 and 70 nuts per palm in coastal and inland areas respectively, provided 55 palms are planted per acre and selected planting material is used and high quantities of fertilizer are applied. Clean weeding on the establishment of an appropriate cover crop should be promoted. The yields obtained by smallholders are assumed to be 25 per cent lower than those of the future estates. The palms on smallholdings are likely to come into production about one year later than those on the estates.

The projected high yields of mature palms on beach ridge sands are only justified if the required nutrients are supplied as heavy fertilizer dressings.

The projections for the copra production are given in Table 2-14 below, whilst the projections of the coco-nut yields per type of production unit are given in Table 2-13 (on page 47) for the various reference years.

Table 2-14 - Projected Copra Yields (in tons* per acre)

Age as from planting (years)	On marine sands		On inland soils	
	(1)	(2)	(1)	(2)
6	-	-	.15	-
7	.15	-	.25	.10
8	.20	.05	.35	.15
9	.30	.15	.40	.25
10	.40	.25	.45	.35
11	.45	.30	.55	.40
12	.50	.40	.60	.40
13	.55	.40	.65	.45
14	.60	.45	.65	.50
15	.60	.45	.65	.50
16	.60	.45	.65	.50
17	.60	.45	.65	.50
18	.60	.45	.60	.50
19	.55	.45	.60	.45
20	.55	.40	.60	.45
21	.55	.40	.60	.45
22	.55	.40	.60	.45
23	.55	.40	.55	.45
24	.45	.40	.55	.40
25	.45	.35	.55	.40
etc.				

* 5,000 nuts per ton of copra

(1) estates and smallholder development projects

(2) individual smallholders

Table 2-13 - Projected Coco-nut Yields for the Reference Years in the Period
1966-1990

Type of production unit	Average yields in nuts per acre					
	1966	1970	1975	1980	1985	1990
<u>Smallholdings:</u>						
- established plantings of unselected material	1,350	1,350	1,350	1,350	1,350	1,350
- replantings of selected material	-	-	-	1,125	1,350	1,575
<u>Estates:</u>						
- established plantings of unselected material	-	1,200	1,350	1,500	1,500	1,500
- replantings of selected material	-	-	-	1,500	2,250	3,000
<u>Development projects:</u>						
- smallholdings	-	-	-	-	1,500	2,250
- estates	-	-	-	1,500	2,250	3,000

No yield projections for dwarf varieties have been made, since the present material is too variable and a good selection is required before seedlings are to be issued to the farmers. It is believed that dwarf palms can give the same yields as the tall local types. They come into bearing earlier and the number of nuts produced is higher but the kernels of the nuts are thinner. The higher labour requirements involved in the copra production have to be considered a disadvantage.

2.4.2.4 Cocoa

The climate of Trengganu seems to be favourable for the cultivation of cocoa. As long as the crop is grown on deep soils with a high water-retaining capacity the short dry season is not likely to have a limiting influence on the yields.

The yield projections for estates (see Table 2-15 below) are based on the data obtained from the Jerangau Estate. It is expected that future cocoa plantations will entirely be planted with the sturdier Amazone varieties with a higher production potential but with fruits of a somewhat lower quality.

When grown by smallholders in the future the yields will be in the order of 600 lbs of dry cocoa per acre provided die-back is under control.

Table 2-15 - Projected Cocoa Yields (in lbs of dry cocoa per acre)

Age as from planting (years)	Amelonado	Amazone	
	estates	estates	smallholdings
4	-	200	150
5	100	350	250
6	150	550	400
7	350	700	450
8	500	800	500
9	600	850	550
10	600	900	600
11	600	900	600
12	600	900	600
13	600	900	600
14	600	900	600
15*	600	900	600

* yields start to decline at the age of 25 years

2.4.3 Fruits and Vegetables

If extension of the area for commercial fruit growing is considered it will be possible to grow cashew and limau langkat

outside the kampong area. The growing of other fruits, mainly for home consumption, will be confined to the dusun.

It is expected that the present very low yields of dusun fruit can be doubled by 1985 if the fruit trees are better tended and the old unselected material is gradually replaced by improved material from the Department of Agriculture.

The yield projections for possible orchard crops are dealt with below.

2.4.3.1 Cashew

On the beach ridge sands of the East Coast cashew has been planted to provide an additional income to the fishermen.

The yields (330-500 lbs of small nuts per acre) are not high since unselected planting material of unknown origin is used and no fertilizer is applied.

The quality of the nuts is poor. Yields of 750 lb per acre may be obtained by applying fertilizer to the crop and by better tending practices.

Further improvements in yield are only to be obtained when high-quality planting material is tested and used to replace the present stock. Yields will, however, vary from year to year. Many showers during the dry season may adversely affect flowering and fruit setting.

The beach ridges can sustain a reasonable good crop of cashew but much depends on the depth to the groundwater.

Yield projections are given in Table 2-16 below.

Table 2-16 - Projected Cashew Yields (in lbs of dry nuts per acre)

Age as from planting (years)	Current material		Selected material*
	(1)	(2)	
3	50	50	150
4	75	100	300
5	150	200	500
6	300	400	900
7	400	650	1,400
8	450	700	1,700
9	500	750	1,900
10	500	750	2,000
11	500	750	2,000
12	500	750	2,000

* if an immediate start is made with the introduction and the testing of selected material, better planting material will be available from 1980 onwards

- (1) continuation of the present level of cultivation plus ring weeding
 (2) application of fertilizer and better weed control

2.4.3.2 Limau Langkat (Citrus)

With the exception of coco-nut and the recently introduced limau langkat nearly all the fruit crops have been exclusively planted in the dusun areas so far. The yields of limau langkat orchards established outside the dusuns are higher than those obtained from trees within the dusun but they still remain below the level expected. The main reason for this is the fact that the trees have been often planted on poorly drained soils. Moreover, the crop is poorly tended and fertilizers are hardly applied. After a period of 10 years the yields begin to decrease.

Possibly, yield improvements can be obtained by establishing the limau langkat orchards on the well-drained soils of the higher-lying river terraces.

Proper pruning should be carried out and the essential annual application of the quantities of fertilizer recommended for this crop should be adhered to. In this way the production of the mature plantings might be raised from the present 2.5 tons of fruits per acre to 5 ton per acre.

The yields to be obtained from new plantings on well-drained soils are expected to be in the order of 10 ton per acre. Improvement of the quality of the fruits is also necessary.

The yield projections are given in Table 2-17.

Table 2-17 - Projected Yields of Limau Langkat (in tons per acre)

Age as from planting (years)	Present plantings		Future plantings
	(1)	(2)	(3)
3	0.1	0.2	0.5
4	0.4	0.8	1.5
5	0.8	1.6	3.0
6	1.6	3.2	7.5
7	2.2	4.5	9.0
8	2.4	4.8	9.5
9	2.5	5.0	10.0
10	2.5	5.0	10.0
11	2.2	5.0	10.0
12	2.0	4.5	10.0
13	1.5	4.0	9.5
14	1.0	3.5	9.5
15	-	3.0	9.0
16	-	2.5	9.0
17	-	-	8.5
18	-	-	8.5
19	-	-	8.0
20	-	-	8.0

(1) no improvement in the present levels of inputs

(2) crop better attended; fertilizer application

(3) crop planted on highly suitable soils and receiving the required care

2.4.3.3 Vegetables

It is assumed that vegetable growing will continue to be concentrated in the dusun areas. Large-scale field plantings of vegetables are not expected with the exception of perhaps sweet potatoes. The yields of vegetables will gradually increase over time; these crops will be better tended since they will constitute a greater part of the future diet. Doubling of the present low yields must be possible within the next 15 years.

At present sweet potatoes are occasionally grown in the off season on the drier parts of the sawahs. The yields do not exceed 2 ton per acre. Sawah soils are, in general, too heavy for root crops and better productions can be expected when these types of crops are grown on the lighter soils of the higher terraces.

Yield projections for sweet potatoes grown on well-drained terrace soils are as follows:

Year	Yield
1966	-
1975	3.0
1980	3.5
1985	4.5
1990	6.0

2.5 Required Agricultural Inputs

2.5.1 Introduction

Except for a few large rubber and oil palm estates and the FLDA-schemes the level of inputs relating to the cultivation of tree crops is generally low. On the estates and the FLDA-schemes a ground cover of leguminous crops has been established, the plantations are well cared for and high amounts of fertilizer are often applied. So far, plant protection has not been given much attention. Fortunately, both pests and diseases do not pose a serious problem; only a small number of incurable root diseases occur.

On the small estates and the smallholdings which grow rubber the ground cover consists mostly of natural vegetation; the application of fertilizer is seldom practised whilst the tapping is often done in a careless way and the collecting of latex is carried out improperly.

The levels of inputs applied in the cultivation of coco-nut and cashew under semi-wild growing conditions on the beach ridges are also low. Those relating to coco-nut and fruits grown in the dusun area are slightly higher since these crops receive house refuse as manure.

Of the food crops only wet padi is reasonably tended. Much time is spent on land preparation to combat weeds and fertilizers

are commonly applied; yet, the response of the yields to these inputs is unsatisfactory due to a series of limiting factors such as an inadequate water control and the occurrence of pests. Pest control is hardly practised.

Dry padi and other food crops are poorly taken care of: after sowing one cultivation round is applied, for the rest they are neglected until the harvest.

It is clear that there is considerable scope to raise the level of inputs in the future, especially with regard to the crops grown on smallholdings and small estates (less than 1,000 acres).

The increase in inputs expected on large estates (over 1,000 acres) will be predominantly confined to the use of improved planting material and to practising better maintenance and harvesting methods.

The levels of inputs ultimately anticipated are dealt with per individual crop.

2.5.2 Inputs relating to Food Crops

2.5.2.1 Sawah Padi

a) Irrigation and Drainage

These input factors will be dealt with in Sub-section 2.6.

b) Varieties

Wherever possible the local tall varieties should be replaced by semi-tall and dwarf varieties. The two last mentioned have a substantially higher yield potential.

During the main season the greater part of the sawahs should be planted with semi-tall varieties. The planting of dwarf varieties is too risky then because large fluctuations in the depth of the water layer on the padi fields might occur.

The growing of tall varieties should take place only in the low-lying fields that are liable to flooding.

In the off season only semi-tall and dwarf varieties should be planted.

c) Seed

The quantities of seed to be sown in the nursery to obtain seedlings for one acre of padi field will be increased from 4 to 6 gantang over time because the spacing of the padi plants will be closer in the future than hitherto.

The use of certified seed treated against soil-born diseases and pests should become normal practice.

d) Nurseries

Seedlings should preferably not be allowed to stay more than 25 days in the nursery. At present they remain there 40 days

or more depending on the availability of water for field preparation.

When they stay in the nursery for a 25-day period, the application of fertilizer (2 lbs of ammonium phosphate per gantang of seed) to the seedlings is recommended as they will then produce a large number of tillers after transplanting which promotes the production of high yields.

e) Transplanting

Experiments conducted on the East Coast have shown that the yields can increase substantially if a closer spacing is practised. At present the spacing is 12 x 12 inches. Reducing it seems therefore an important factor to raise the yields. As closer spacing involves a higher labour requirement it will be adopted only gradually.

f) Fertilizer

The present recommendations on the quantities of fertilizer to be applied are 30 lbs of N, 30 lbs of P_2O_5 and 15 lbs of K_2O per acre. The proposed ultimate fertilizer input is indicated in Table 2-18 on the next page.

Although it is generally accepted that in Malaysia only small amounts of potassium have to be applied to padi, the applications should be increased over time in view of the fact that substantial quantities of this element will be removed from the soil as a result of double cropping.

g) Pest and Disease Control

So far, plant protection has been almost neglected. It should receive due attention in the near future (see Table 2-18) since it constitutes one of the factors which is likely to increase the yields substantially.

Pests are more troublesome than diseases; fungal and bacterial diseases have not been frequently reported so far. There are indications that the dwarf varieties are more sensitive to diseases and pests than the local varieties used at present.

h) Weed Control

The change-over to a double cropping system requires the farmers to shorten the land preparation period in order to promote timely planting and to permit the sawah soils to dry and to aerate.

Shortening of the land preparation period implies i. a. that the number of ploughing rounds which contribute to the eradication of weeds must be reduced. On the other hand, recommended use of smaller seedlings will promote weed growing. As a consequence, more time and efforts will have to be spent on weed control (see Table 2-18).

Table 2-18 - Projected Inputs to Padi for the Year 1990

Type of padi cultivation	Fertilizer (lb per acre)	Plant protection (number of applications)	Weed control* hand weeding (number of weeding rounds)	chemical weeding (number of applications)
sawah; main season, irrigated	80 N-60 P ₂ O ₅ -30 K ₂ O	3	2-3	1
sawah; off season, irrigated	100 N-60 P ₂ O ₅ -30 K ₂ O	3	2-3	1
sawah; main season, rainfed	60 N-50 P ₂ O ₅ -25 K ₂ O	2-3	2-3	1
dryland; main season; rainfed	40 N-40 P ₂ O ₅ -20 K ₂ O	1-2	2-3	2

* Chemicals are not likely to be used for sawah padi.

For dryland padi herbicides will be important in the future; two applications plus one additional round of hand weeding.

i) Mechanization

To ensure the realization of a shortened and timely land preparation mechanized tilling is strongly recommended for sawah padi. As to harvesting and threshing, a gradual mechanization of these activities is expected.

2.5.2.2 Dryland Padi

To increase the yields of dryland padi the following inputs will be required :

a) Varieties

Dryland padi varieties introduced from all over the world should be tested.

b) Seed

Per acre 15 gantang of good-quality seed are recommended for sowing. The seed should be disinfected against soil-borne diseases and pests. Seeds have to be sown in lines after the land has been prepared well.

c) Fertilizer : see Table 2-18.

d) Pest and Disease Control

In comparison with areas where padi is grown throughout the year the pest problem is likely to be less serious (see Table 2-18).

e) Weed Control

The control of weeds in fields with dryland padi is far more difficult than in sawahs since no permanent water layer is available to check the weeds.

Neither hand weeding nor mechanized weeding can be effectively carried out in the rainy season during which the dryland padi is grown (see Table 2-18). Therefore the use of herbicides will be necessary.

f) Green Manure

If dryland padi is intensively grown on undulating terrain it will be necessary to maintain a high organic matter content in the soil to prevent soil erosion and to keep the water-retaining capacity of the soils at the same level. Green manuring, therefore, is of paramount importance to obtain the projected yields. *Crotalaria*, *Sesbania* and *Vigna* species can be used as green manure crops.

2.5.2.3 Maize, Soy Beans, Groundnuts, Cassava

a) Planting Material

The recommended seed rates are given in Table 2-19. All the planting material has to be disinfected against soil-borne pests and diseases.

It is assumed that seed of high quality will be commonly used.

b) Planting

Line sowing or line planting on well-prepared soils is essential in order to get an even spacing and to facilitate weed control.

c) Fertilizer : see Table 2-19.

d) Plant Protection : see Table 2-19.

e) Weed Control

The weed control in cassava is easiest because the canopy of this crop closes quickly. In maize, weeds are a nuisance and far more difficult to combat (see Table 2-19).

The combating of weeds by pre-emergency spraying is possible but a total eradication will not be achieved and an additional round of hand weeding will be required.

f) Mechanization

Off season crops should be preferably grown on ridges, in any cases after sawah padi. This, together with the essential and proper land preparation, will require the use of tractor-drawn implements.

2.5.3 Inputs relating to Industrial Crops

2.5.3.1 Oil Palm

The recommended levels of inputs for oil palm cultivation on estates, FLDA-schemes and Special Smallholding Development Projects have been dealt with in detail in the Report on the Detailed Project Evaluation SEDC Oil Palm Scheme Sg. Tong. In general, the levels of inputs required for these production units will be of the same order.

A summary of the projected inputs is given in Table 2-20. As indicated previously oil palm cultivation by completely independent smallholders is not envisaged. Should such a development materialize the levels of inputs would in all likelihood be lower than for the above-mentioned types of production units, especially with regard to platforming and fertilizer application.

Table 2-19 - Projected Inputs to Maize, Soy Beans, Groundnuts, Cassava and Sweet Potatoes for the Year 1990

Crops	Planting material (quantity per acre)	Fertilizer (lb per acre)	Plant protection (number of applications)	Weed control*	
				hand weeding (number of weeding rounds)	chemical weeding (number of applications)
<u>Maize</u> sawah; off season, rained	20 lbs of seed	40 N-40 P ₂ O ₅ -40 K ₂ O	2	2	1
dryland; off season, rained	20 lbs of seed	60 N-60 P ₂ O ₅ -60 K ₂ O	2-3	2-3	2
<u>Soy beans</u> sawah; off season, rained	30 lbs of seed	15 N-30 P ₂ O ₅ -45 K ₂ O	1-2	2	1
dryland; off season, rained	30 lbs of seed	20 N-40 P ₂ O ₅ -60 K ₂ O	1-2	2	1
<u>Groundnuts</u> dryland; off season, rained	80 lbs of seed (in shell)	30 N-60 P ₂ O ₅ -30 K ₂ O	1-2	2	1
<u>Cassava</u> rained	4,000 cuttings	60 N-60 P ₂ O ₅ -90 K ₂ O	-	2	1
<u>Sweet potatoes</u> rained	8,000 cuttings	20 N-40 P ₂ O ₅ -80 K ₂ O	-	2	1

* Chemical weed control is not likely to be applied since it is expensive and sufficient labour is available.

If herbicides are used one additional round of hand weeding is required.

Table 2-20 - Projected Inputs to Oil Palm

Inputs	Estates, FLDA-schemes, Special Smallholding Development Projects.	
cover crop	4 lb mixed Pueraria and Centrosema seed 200 lb rock phosphate per acre 80 lb compound A per acre (1)	
seed/seedlings	germinated D x P seed from private seed producers; 60 seeds per acre + 20 per cent allowance for failures per acre 0.25 lb compound A per palm 0.25 lb compound B per palm (2) fortnightly sprayings with fungicides and pesticides	
fertilizer	<u>age of palm</u>	<u>application per acre</u>
	0-1 year	50 lb compound A 40 lb compound B
	1-2 years	180 lb compound A 60 lb compound B
	2-3 years	350 lb compound A 60 lb KCl
	3-4 years	400 lb compound A 160 lb KCl
4-5 years etc.	500 lb compound A 200 lb KCl	
plant protection	when necessary	
assisted pollination	regular rounds when palms are young and during monsoon months	

(1) compound A : 12 N- 6 P₂O₅-22 K₂O-3 MgO

(2) compound B : 11 N-18 P₂O₅- 4 K₂O-3 MgO

2.5.3.2 Rubber

As a large amount of data on field preparation, planting material, fertilizer application, plant protection, maintenance and tapping are available at the Rubber Research Institute these items are not dealt with in this Annex.

It is expected that the levels of inputs for FLDA-schemes and Special Smallholding Development Projects will be similar to those for the well-run private estates.

For the individual smallholders the levels of inputs will be lower (use of seedlings instead of budgrafts, less accurate tapping, limited application of fertilizers).

For the present Fringe Alienation Schemes the levels of inputs might be even lower owing to their remote location and the poor infrastructure of the area where they are situated. In Table 2-21 a summary is given of the projected inputs for FLDA-schemes and Special Smallholding Development Projects.

Table 2-21 - Projected Inputs to Rubber

Inputs	FLDA-schemes and Special Smallholding Development Projects	
cover crop	4 lb mixed Pueraria and Centrosema seed 200 lb rock phosphate per acre 80 lb compound A per acre	
planting material	160 budgrafts per acre	
fertilizer	<u>age (years)</u>	<u>amount (lb per acre)</u>
	0-3	250 compound B
	4-7	300 compound C (1)
	more than 7	300 compound D (2)
stimulant	nil	
plant protection	fomes and oidium control	

(1) compound C : 18 N-11 P₂O₅- 4 K₂O-3 MgO

(2) compound D : 15 N- 7 P₂O₅-13 K₂O-4 MgO

2.5.3.3 Coco-nut

A summary of the input figures is given in Table 2-22.

a) Field Preparation

The land preparation for coco-nut should be similar to that for oil palm if its cultivation is envisaged on inland soils. The establishment of a cover crop is then necessary.

On marine sands the clearing of the land will be easier as only shrubs have to be removed. Planting of a cover crop is desirable but not necessary if weeding is done properly. If planted it might be recommendable to slash the cover crop during the dry season to avoid competition for moisture with the coco-nut (see also Subsection 5.2). The advantages of establishing a cover crop on the marine sands are the control of weeds, regulation of the soil temperature and improvement of the water-retaining capacity of the soil.

b) Planting Material and Planting

High-yielding selected planting material can be obtained from estates on the West Coast.

Well-selected planting material of dwarf types is not yet available. At present there is no great interest in the cultivation of these cultivars. As they produce a larger number of smaller nuts than the tall varieties the preparation of copra will be more labour-intensive.

c) Fertilizer

To shorten the non-productive period a liberal application of fertilizer is necessary. The palms will then come into bearing six years after field planting. If no fertilizer is applied the period of immaturity will be prolonged by two to three years.

2.5.3.4 Cocoa

a) Fertilizer

The application of high amounts of fertilizer (see Table 2-23) will pay only if other limiting factors are eliminated. Fertilizers are largely wasted when shading, pest and disease control, and pruning are neglected.

b) Plant Protection

Cocoa is a crop which is seriously attacked by fungi and insects.

The problem of die-back in cocoa has not yet been solved. This disease is responsible for a retardation in growth, a poor plant development and reduced yields. Careful pruning could keep die-back under control to a certain extent.

On individual smallholdings pruning will not be given the same attention as on estates. As a result of this the yields will lag behind those attained on the estates. Under the prevailing circumstances fertilizer applications of more than 200 lb per acre are not recommended.

Table 2-22 - Projected Inputs to Coco-nut

Type of production unit	Area	cover crop	seed/seedlings	fertilizer
Estates, FLDA-schemes and Special Smallholding Development Projects	inland	4 lb mixed Pueraria and Centrosema seed per acre	55 selected nuts + an allowance of 10 per cent for failures	period (years as from planting)
		200 lb rock phosphate per acre 80 lb compound A per acre	fertilizer applications : nursery 0.15 lb compound A per palm and 0.15 lb compound B per palm	application per acre 300 lb compound A 300 lb compound B 6 years and onward (per annum)
	coast	ditto	ditto	period (years as from planting)
		ditto	ditto	application per acre 400 lb compound A 400 lb compound B 7 years and onward (per annum)
Individual small-holders*	inland	4 lb mixed Pueraria and Centrosema seed per acre	ditto	period (years as from planting)
		100 lb rock phosphate per acre	ditto	application per acre 175 lb compound A 175 lb compound B 7 years and onward (per annum)
	coast	ditto	ditto	period (years as from planting)
		ditto	ditto	application per acre 250 lb compound A 250 lb compound B 7 years and onward (per annum)

* The inputs relate to coco-nut planted by smallholders after 1980 when the extension service will be well functioning.

Table 2-23 - Projected Inputs to Cocoa

Inputs	Levels of inputs	
	planting material	450 clonal seedlings per acre, Amazone type
fertilizer	age (in years)	amount
	0-3 (over total period)	250 lb compound A per acre 250 lb compound B per acre
	4 years and onward (per annum)	350 lb compound A per acre
plant protection	4 applications a year	

2.5.4 Inputs to Fruit and Vegetables

The crops concerned are cashew, citrus (limau langkat) and sweet potatoes.

An increase in yields can be obtained by using better planting material (cashew) and fertilizers (citrus), by pruning (citrus) and weed control (sweet potatoes).

Data on levels of inputs to cashew and citrus are given in Table 2-24.

Table 2-24 - Projected Inputs to Cashew and Citrus

Input	New plantings (controlled smallholdings)	
	cashew	citrus
planting material	initially 100 trees/acre finally 50 trees/acre	budgrafts (120-150 trees/acre)
fertilizer	<u>age : 0-3 years</u> application per acre over total period : 200 lb compound A 200 lb compound B	<u>age : 0-3 years</u> application per acre over total period 150 lb compound A 150 lb compound B
	<u>age : 4 years and onward</u> application per acre per annum : 200 lb compound A	<u>age : 4 years and onward</u> application per acre per annum : 250 lb compound A

2.6 Irrigation and Drainage Potential

2.6.1 Irrigation

2.6.1.1 General

The demand for rice in Trengganu is covered for hardly 50 per cent by the State's own production. As the population is expected to double in the next 25 years, it will be clear that an increase in the production of the main food crop, padi, should be realized. Land suitable for padi cultivation being rather scarce the increase in production should be realized by a rise in the production per acre rather than by an extension of the acreage.

The primary objective of the application of irrigation is the growing of a second padi crop during the off season. Irrigation will also promote the timely planting of the padi for the main season crop. The irrigation of crops other than padi has been considered but for reasons as explained in the Report "Detailed Project Evaluation Besut Irrigation System", the irrigation of padi offers better prospects. An important criterion in determining the areas suitable for irrigated padi cultivation is the quality of the soil. Foremost consideration should be given to fluvio-alluvial soils, in particular those that are flat. In general, these soils are fine-textured and their topsoil has a low permeability which renders them highly suitable for padi growing and less suitable for crops like maize, groundnuts, etc.

Of importance for irrigation is the availability of water. The off season months of April and May in which rainfall is comparatively low, coincide with the period of presaturating the fields and of transplanting. This is the period of peak water demand which is in the order of one cusec of diverted flow per 55-60 acres of net irrigable land (see Report "Detailed Project Evaluation Besut Irrigation Scheme"). As soon as this period is over the water demand drops to a value of 1 cusec per 70-80 acres of irrigable land. These data on water requirements can be made use of to the fullest extent only when data on discharges of rivers and streams are at hand. With exception of the Sg. Besut and the Sg. Trengganu, data on river discharges are scarce. This item has not been gone into further since the acreages of soils suitable for irrigated padi cultivation are not excessively large and the discharges of the rivers from which they will be irrigated are, in general, high.

2.6.1.2 Potential Areas

Irrigation is an important tool in obtaining an increase in agricultural production. The selection of areas suitable for irrigated padi cultivation and the steps required for the implementation of irrigation projects should therefore be given full attention.

Below a number of irrigation projects are mentioned, the development of which has been planned for the period 1970-1990.

Stress should be laid on the fact that a number of the projects mentioned have already been identified by the DID; to a larger or smaller extent preparatory steps have been taken by the DID for their realization.

- The identification of the projects has been based on
- the soil suitability map
 - the general reconnaissance of the major fluvio-alluvial areas in the State
 - discussions with the DID about the possibility of implementing potential projects and the costs involved.

It is clear from the data as given in this Annex that the realization of the relevant projects will be an important contribution to the general development of Trengganu.

The limited time available for the field study did not allow to collect the information required for a thorough evaluation of the irrigation possibilities. Perforce, the character of this evaluation had to be a very general one and the DID should devote much attention to the collecting of additional data in the near future.

Before presenting a list of the ongoing projects and the selected project areas as well as a rough estimate of the development and Maintenance and Operation costs, a short outline of the projects per district will be given.

a) In the Besut District three large project areas are distinguished :

- the Besut Irrigation Scheme
- the Sg. Setiu Irrigation Project (Ir 1)*
- the Pelagat Irrigation Area (Ir 3).

There is also one small project, viz. Chalok (Ir 2).

The Besut Irrigation Scheme (stages I + II) allows the irrigation of a total net area of 12,600 acres.

For the Sg. Setiu Irrigation Project the DID has tentatively estimated the net area suitable for irrigation at 9,000 acres. The area is very flat and can adequately be provided with water. As, however, in certain parts the soil conditions are not favourable for irrigated padi cultivation (texture, permeability, acidity) it has been considered appropriate to limit the area for irrigation to about 3,300 acres net.

The Pelagat Irrigation Area (Pelagat and Pengalan Nangka Areas) with a total net area of 4,600 acres suitable for irrigation, originally formed part of the Besut Irrigation Scheme. Owing to lack of hydrological data the area has been excluded from the Besut Scheme project evaluation.

Further studies are required with respect to the availability of

* Ir 1 refers to the symbol used on the map showing the irrigation projects (Plate IV-3).

irrigation water and the possible construction of a dam in the Sg. Pelagat (see also Report "Detailed Projection Evaluation Besut Irrigation Scheme").

b) In the District of Kuala Trengganu the prospects for irrigated padi cultivation are rather limited, notwithstanding the presence of a large acreage of alluvial soils and the availability of sufficient water. The main reason for this is the very irregular relief and consequently the lack of sufficient, contiguous areas of flat land. The costs of land levelling would run very high and would - in general - deem the project economically unfeasible. This holds particularly true for the region west of the road Kuala Trengganu-Kuala Brang. East of this road at least 2,100 acres (Ir 4) are suitable for irrigation. A disadvantage is the large distance between this area and the Sg. Trengganu.

Another area that merits consideration for irrigation is the controlled drainage scheme Batu Rakit with a net area of some 4,600 acres. Its topography is favourable, but water suppletion and salinity problems will have to be coped with.

c) In the Districts of Ulu Trengganu, Dungun and Marang, about 9,000 acres (Ir 5 - Ir 11) have been selected for irrigated padi cultivation. A crucial problem might be the water suppletion, since little or no information at all is available about the river discharges and the quality of the water during the off season in these areas.

d) The District of Kemaman also offers an opportunity of extending the irrigated padi area of the State. It has been estimated that at least 3,000 acres of forest land (partly mangrove) can be reclaimed and provided with irrigation water (Sg. Chukai plain - Ir 12). The area is subject to tidal movement and salt intrusion.

It should be noted that in a number of the above-mentioned projects the area is partly occupied by padi growers (main season padi only). The land in the project areas Ir 8 - Ir 12 is not yet occupied.

2.6.2 Drainage

2.6.2.1 General

The purpose of the implementation of drainage works can be twofold :

- the construction of a complete drainage project (reclamation of peat swamps, of tidal areas and of riverain alluvium for the establishment of padi projects)
- the general improvement of drainage conditions in established areas.

The second purpose should deserve much attention not only in existing irrigation and drainage projects but also in e.g.

the small valleys of the oil palm estate areas. Here, it will thus be possible to produce a much better crop provided a good system for the evacuation of excess rainfall water is installed. With good drainage the production in such areas might be even better than that on sloping parts of the estate. The costs of such drainage works are in most cases rather small.

To cultivate padi during the rainy season drainage is essential. This will allow the planting of the higher-yielding semi-tall varieties which can then replace the tall, lower-yielding ones. It is also very important to evacuate water from the sawahs just before the harvesting period, not only to obtain better harvesting conditions but also to allow the crop to ripen off and to promote drying out of the soil in between two padi crops (main season and off season crops).

2.6.2.2 Potential Areas

Mention should be made of the drainage projects totalling roughly 11,000 acres net indicated by the symbols Dr 1 - Dr 8 on Plate IV-3. Two of these projects form part of the rubber projects RU 4 and RU 5. The area of the project Dr 3 (1,600 net acres) forms the prolongation of the Ir 12 project area downstream the Sg. Chukai.

The above-mentioned areas are the only projects that have been specifically indicated. There are, of course, other areas that require drainage facilities.

For example the soil suitability map indicates that some 25,000 acres of peat swamps might be reclaimed for agriculture in a not too distant future. Furthermore, some 19,000 net acres of river valley soils might be reclaimed. In both cases further investigations are required. The work required for implementing these potential projects will be very exacting and it is therefore recommended that in the planning period priority should be given to other projects.

2.6.3 List of Projects and Summary of Costs

In the Tables 2-25 and 2-26 the ongoing irrigation and drainage projects, i.e. the irrigation and drainage projects of which the implementation has already been initiated by the DID, and the newly planned irrigation and drainage projects (construction period 1970-1990), together with cost estimates, are listed.

The capital costs for the new projects include the costs for clearing, earthmoving, construction of structures and for indirect items such as engineering, contingencies, etc. Not included are the costs of land acquisition. The capital costs for the ongoing projects refer to the actual costs for the completed projects and to costs as per 31 December 1965 for the schemes that were not yet completed.

It is not quite possible to make a comparison between the per acre costs of the 'ongoing' projects and those of the 'newly planned' projects, since insufficient information is at hand concerning the basic items included in the cost estimates for the former projects.

For the calculation of the foreign exchange component and the labour component mentioned in Table 2-26, the following data have been used :

- excavations	: foreign exchange component	25 per cent
	labour	5 per cent
- clearing	: foreign exchange component	25 per cent
	labour	50 per cent
- mechanical part of irrigation and drainage structures	: foreign exchange component	100 per cent
- steel structures	: foreign exchange component	100 per cent
- concrete part of irrigation and drainage structures	: foreign exchange component	25 per cent
	labour	30 per cent
- consultants costs	: foreign exchange component	75 per cent
- contingencies	: foreign exchange component	25 per cent
	labour	20 per cent

The costs for fuel, oil, grease, etc. have been excluded from the foreign exchange component.

The input of mechanical equipment will be small and has, therefore, been disregarded in the maintenance and operation costs.

Table 2-25 - Ongoing Irrigation and Drainage Projects

Projects	District	Net area (acres)	Capital costs (M\$)
<u>irrigated projects (a)</u>			
- Besut Irrigation Scheme (stage I)	Besut	3,500	2,042,000
- Pulau Musang	Kuala Trengganu	4,700	1,193,000
- Nerus Pumping Scheme	Kuala Trengganu	6,000	2,989,000
- 15 small projects		3,300	998,000
		17,500	7,222,000
<u>drainage projects (b)</u>			
- Batu Rakit	Kuala Trengganu	4,600	300,900
- Sg. Ibai	Kuala Trengganu	800	107,400
- 5 small projects	Kuala Trengganu	1,400	71,400
		6,800	479,700

(a) In total 18 projects of which 2 large (Pulau Musang and Nerus) and 8 smaller projects were under construction by 1966.

(b) In total 7 projects of which 1 large project (Batu Rakit) and 2 smaller projects were under construction by 1966.

Table 2-26 - Newly Planned Irrigation and Drainage Projects

Projects	District	Net area (acres)	Cost estimate (M\$)			M and O costs (M\$ per acre)
			capital costs	foreign exchange component	labour costs component	
<u>Newly planned irrigation projects</u>						
- Besut Irrigation Scheme (stage II)						
- Ir 1 (Setiu)	Besut	9,100	10,400,000*	4,800,000	2,500,000	15
- Ir 2 (Chalok)	Besut	3,300	2,700,000	950,000	650,000	15
- Ir 3 (Pelagat)	Besut	500	400,000	130,000	80,000	15
- Ir 4 (Lower Trengganu)	Besut	4,600	4,600,000	1,500,000	1,105,000	15
- Ir 5 (Manus M.)	Kuala Trengganu	2,100	2,500,000	1,100,000	550,000	23
- Ir 6 (Westb. Trengganu)	Ulu Trengganu	200	140,000	60,000	20,000	25
- Ir 7 (P. Panchor)	Ulu Trengganu	1,000	700,000	350,000	90,000	25
- Ir 8 (Marang)	Dungun	400	310,000	150,000	50,000	20
- Ir 9 (Jerangau)	Marang	1,600	1,920,000	690,000	450,000	15
- Ir 10 (Sg. Paka)	Dungun	3,800	4,900,000	1,600,000	1,200,000	15
- Ir 11 (Durian Mas)	Dungun	800	560,000	260,000	75,000	17
- Ir 12 (Chukai)	Dungun	1,000	1,150,000	400,000	260,000	15
	Kemaman	3,200	4,160,000	1,420,000	940,000	12
		31,600	34,440,000	13,410,000	7,970,000	
<u>Newly planned drainage projects</u>						
- Dr 1 (Bt. Temiang)	Marang	2,200	440,000	100,000	140,000	7
- Dr 2 (Ajil)	Ulu Trengganu	2,400	960,000	250,000	350,000	6
- Dr 3 (Chukai)	Kemaman	1,600	1,040,000	280,000	410,000	6
- Dr 4	Dungun	800	240,000	65,000	80,000	7
- Dr 5 (Chador)	Dungun	1,000	300,000	80,000	110,000	7
- Dr 6 (Tertak Batu)	Marang	2,500	1,100,000	280,000	390,000	7
- Dr 7 (Kijal)	Marang	200	40,000	10,000	15,000	6
- Dr 8 (Kijal)	Kemaman	200	40,000	10,000	15,000	6
		10,900	4,160,000	1,075,000	1,510,000	

* these costs refer to the 'with the project' case as indicated in the Report 'Detailed Project Evaluation Besut Irrigation Scheme'.

2.6.4 Organizational Aspects

2.6.4.1 General

The expansion of the acreage under irrigation and drainage as planned for the period 1970-1990 can be only realized if the DID enlarges its organization. As much preparatory work will be required before the actual implementation of the projects can be carried through, the enlargement should take place at an early stage.

As is the case at present, the set up of the organization will have in principle to be based on one sub-division per district. In the final stage (1985-1990), besides the head office in Kuala Trengganu, four district offices should be operational, viz.

- one in Kg. Raja, comprising the Besut District
- one in Kuala Trengganu, comprising the Districts of Kuala Trengganu and Marang
- one in Kuala Brang, comprising the District of Ulu Trengganu
- one in Dungun or Chukai, comprising the Dungun and Kemaman Districts.

The staff for each office could be best divided into two groups :

- staff members who are to be committed to a project (irrigation inspectors, operators and others)
- those who are members of the permanent staff, e.g. clercks, survey teams and emergency crews.

The costs of the staff of the first group should be charged to the operation costs of the project. Those relating to the second group are to be included in the budget of the DID.

As a rule projects will be designed by the DID Headquarters in Kuala Lumpur or by consultants.

The investigations required for the design work will be generally carried out by survey teams from either the State or the District offices. This is considered to be a good system.

As nearly all the survey work in the State will be carried out by local survey teams, the DID organization should comprise a number of such teams. Special hydraulic surveys will be undertaken by survey teams from the DID Research Station at Ampang.

If these teams were incorporated in the DID Head Office in Kuala Trengganu this would result in a heavy burden on the DID-budget (allowances for temporary assignments elsewhere). Taking into account this fact and the quantity of work to be carried out in the districts it is suggested that they should be incorporated as follows :

at the DID Head Office in Kuala Trengganu	3 teams by 1975 and 2 teams by 1985
at the Besut District Office	2 teams by 1975 and 1 team by 1985
at the Kuala Trengganu District Office	1 team by 1975 and 1 team by 1985
at the South Trengganu District Office	2 teams by 1985

each survey team will comprise 1 technician, 1 mandur and 3 labourers.

2.6.4.2 Construction, Maintenance and Operation

Up till now the construction of the irrigation and drainage works has constituted one of the many tasks of the Government itself. It might, however, be worth while to try to engage contractors for such work. In view of the large amount of construction work to be carried out during the plan period, the establishment of a number of firms of contractors in the State will be of importance. Moreover, it will be difficult for the Government, without additional capacity, to cope with the required rate of implementation of the irrigation and drainage projects which has been fixed at 2,000 acres annually. Buying new equipment implies high investment with a considerable amortization period which is undesirable in the case of a Government organization budget.

The number of contractors on the East Coast are limited at present. It will be necessary to arouse the interest of some additional firms of contractors for work on the East Coast to increase competition.

At present maintenance is carried out by the DID organization itself.

It is recommended that maintenance should be undertaken by contractors and emergency crews.

There is a wide variation in the types of irrigation projects in the State. The following types are distinguished :

- large projects with gravity irrigation
- large projects with pump irrigation
- small projects with gravity irrigation
- small projects with pump irrigation.

In the large projects (covering more than 1,000 acres) the staffing should be as follows : the lowest rank is to be that of 'irrigation overseer', a man who supervises an area of 1,500 to 2,500 acres, depending on the topography of the area. Four or five of these overseers are to be supervised by an 'irrigation inspector', who, in turn, may be placed under a 'chief irrigation inspector' if the size of the area requires to do so. The inspectors are direct responsible to the district engineer.

At each main structure there will be at least one operator, or more if there is a pump house to be manned.

In small projects (covering less than 1,000 acres) the following staffing is proposed :

- in gravity-irrigated projects - one man
- in pump-irrigated projects - two men of whom one will be the pump operator.

Some four or five projects are to be supervised by one overseer depending on the total acreage of and the distance between these projects.

Some three or four overseers will be placed under an irrigation inspector.

Almost every year during the months of November, December and January, there are periods with heavy rainfall followed by more or less severe flooding.

It will be very useful to have some 'emergency crews' standing by during the above-mentioned months to assist in protecting the projects from flooding hazards.

Two emergency crews are thought to be needed in Besut and three at the DID Head Office in Kuala Trengganu.

During the months of February up to November, the crews can take part in the maintenance work.

Each crew will comprise 1 mandur and 6 labourers.

2.6.4.3 Staff and Budgets

As per 1975 only the Districts of Besut and of Kuala Trengganu will comprise a sufficiently large acreage of ongoing projects or projects in the planning stage justifying the establishment of a district office under the supervision of a district engineer.

It is advisable to establish offices in Ulu Trengganu and South Trengganu as well at that time but initially a technical assistant could act as head of the office.

It has been assumed that by 1985 three district offices (Besut, Kuala Trengganu and South Trengganu) will be under the supervision of a district engineer, while in Ulu Trengganu a technical assistant may be in charge of the office.

Apart from the State DID Engineer the following personnel force has been envisaged for the department by 1975 :

2 engineers, 2 technical assistants, 16 technicians (of whom one technician A, six technicians B and nine junior technicians), 4 chief clerks, 6 clerks, 51 additional staff.

For the year 1985, the personnel force is supposed to comprise 3 engineers, 4 technical assistants, 18 technicians (of whom 1 technician A, 6 technicians B and 11 junior technicians), 6 chief clerks, 8 clerks and 60 additional staff.

The estimated budgets for the years 1975 and 1985 are :

- M\$ 1,100,000 of which M\$ 370,000 for personal emoluments in 1975,
- M\$ 1,600,000 of which M\$ 470,000 for personal emoluments in 1985.

3 FUTURE PATTERN OF AGRICULTURAL PRODUCTION

3.1 Recommended Land Use

In areas newly chosen for agricultural development the land should be intended for the cultivation of the most suitable and economically most justified crops; special attention should be given to crop diversification.

The cultivation of sawah padi should be given first priority. In view of the limited availability of suitable land, the extension of the padi production will have to be achieved to a large degree by double cropping, use of better varieties and application of fertilizers and insecticides.

As regards tree crops the situation is different. Much more land is available for the cultivation of this type of crop but only a relatively small acreage is required to meet the domestic and other demands. The extent to which tree crop production might be increased, greatly depends on the quantities that can be sold at competitive prices outside Trengganu. Besides small surpluses of cocoa, coco-nuts and fruit, rubber has been the most significant export product in the past. The present relatively low price level of rubber, coupled with the less favourable expectations as far as its price is concerned, has made it necessary to look for other products suitable for export.

This is the main reason why in West Malaysia the planting of a second lowland tree crop, i.e. oil palm, has been started at a relatively large scale recently. The opportunities for further diversification of a tree crop production which aims at future exports of copra, cocoa, cashew and fruit, are considered rather limited as yet.

It is expected that by 1990 the production of annual crops, including sawah padi, will be of such an order that the demands of the population of Trengganu can be roughly met. The yields per acre should then be doubled.

In the following, the recommended land use in the areas to be developed is shortly discussed.

- As the soils of the beach ridges (soil suitability class 7) are only suitable for the cultivation of coco-nut and cashew, the selection of crops for this type of soils does not pose a problem. Although the conditions of the soil permit the growing of cashew, the unfavourable distribution of the rainfall over the year will often lead to yield reductions. It is clear that the low and fluctuating production level of the crop does not stimulate the establishment of a factory and this in turn makes large-scale cashew growing not a sound proposition for the time being. The production potential of coco-nuts grown on the beach ridges is fair. The production is more or less uniformly distributed over the year. It is thought appropriate to reserve the non-

cultivated beach ridges for an extension of the coco-nut growing.

- The combined effect of heavy rainfall and heavy, rather impervious soils causes the land of the low-lying river terraces (classes 8 and 9) to be exclusively suitable for the growing of sawah padi during the main season.

The poor drainage conditions prevailing during this season (poor internal drainage, waterlogging) render the cultivation of all other crops extremely difficult.

Although the conditions for other crops than padi are somewhat better during the dry season, the cultivation of padi is still preferred for technical as well as economic reasons. Double cropping of padi, however, implies the availability of irrigation facilities. If such facilities are not available, maize or soy beans can be grown. Preference should be then given to the cultivation of soy beans as this crop is better adapted to the prevailing ecological conditions than maize. The heavy texture of the soils of the low-lying terraces makes them practically unsuitable for the growing of root crops or tobacco, and it is not likely that either of these cultivations would ever prove economically feasible.

- With the exception of the inland dusun areas and the recently established oil palm and cocoa estates, the sedentary soils (classes 1, 2, 3 and 4) in use at present, are planted with rubber.

As the prospects for natural rubber are not very bright on the world market, it is highly important to determine whether the agricultural development of new areas on sedentary soils could be based on the cultivation of other, economically more profitable crops. The climate prevalent in the areas concerned permits the cultivation of oil palm, cocoa, coco-nut and fruit trees. Annual crops should be excluded from cultivation in these areas as the relevant terrains are undulating and hilly and will be strongly liable to erosion as a result of such a cultivation.

It is likely that the production of fruits will remain chiefly confined to the dusun areas. This production will be sufficiently high to meet the local demand and that of the large population centres. The present poor tenability of the fruits makes this produce unsuitable for exports to countries outside the Federation.

It is expected that it will take a considerable time before the quality and the tenability of the fruit crops can be improved. It is, therefore, anticipated that the area under fruit trees will be extended very gradually only.

As a result of the unstable world market prices for cocoa and of the frequent occurrence of the die-back disease in the crop, only a slight interest in the cultivation of cocoa is shown at present. Moreover, the cultivation of the crop requires more tending than that of rubber. Reasonable yields are only to be obtained after the die-back problem has been solved.

The production level of coco-nut grown on inland alluvial or sedentary soils is expected to be somewhat higher than that of coco-nut grown on the beach ridges. The difference being only

slight, it is recommended to reserve the inland soils for more profitable crops.

Considering the prospects of marketing and profitability as the main criteria in determining the type of crop to be grown on the sedentary soils, it would seem that the cultivation of oil palm is the best proposition.

Its possible contribution to the economic growth is larger than that of any other tree crop.

An economic production of palm oil, however, is only possible if a regular and adequate supply of fruit bunches can be relied on. To serve one palm oil mill, a minimum area of about 4,000 acres should be in production (oil palm estate). Areas smaller than 4,000 acres may be cultivated with oil palm, but in that case growers should make use of mills of neighbouring estates.

If not used for oil palm the areas are likely to be planted with rubber. If the recommended RRI clones are planted and provided good management is practised, it should be possible to arrive at an economic production level. Their soils are also suitable for the growing of cocoa and fruit trees.

Generally speaking, the economic results obtained with palm oil production are better than those obtained from rubber. If, however, the area under consideration has relatively steep slopes and is remote or of a small size, rubber production is more economic.

- As the configuration of the higher-lying river terraces (class 6) is flat and their soils are of a medium texture, they are highly suited to the growing of both tree crops and annual crops.

In view of the foregoing, it is expected that even better results can be obtained with oil palm on these terraces than on the undulating and hilly sedentary soils.

As the evacuation of fruit bunches will be cheaper here, the cost of production will also be lower. Should it, therefore, be decided to use the terraces for the growing of tree crops, priority should be given to oil palm.

As stated above, the terrace soils are also suitable for the growing of annual crops.

During the main season, dryland padi might be planted followed by maize, soy beans or groundnuts in the off season, whilst it is also possible to grow cassava which crop occupies the land throughout the year.

In the land use planning as recommended, the terrace soils are intended for oil palm cultivation, because the production of palm oil is economically more attractive than double cropping of annual crops. Moreover, by giving priority to the cultivation of oil palm, the desired rate of agricultural growth can better be realized.

- The soils which are locally suitable for the growing of tree crops and of sawah padi (class 5) constitute a difficult category. Many of these soils occur in widely dispersed small patches. It is expected that a small portion of the dispersed areas will be used for agriculture, i.e. the patches situated in the proximity of existing or potential agricultural areas. Here, rubber and padi will be the main crops, since they are or will be cultivated in the adjacent areas. The majority of these patches, however, will not be considered for cultivation because of their remoteness, their scarce population, the fact that they are locally completely unsuitable for agriculture and the inherent problems of marketing and crop selection.

Apart from the soils of the five categories mentioned, a special category is constituted by the peat soils of the swamp areas. The greater part of these peat soils are not considered suitable for agricultural development since this would involve high costs for reclamation (clearing of forest, drainage, possible empoldering) and fertilizing (see also Annex III - Land and Soils).

With a view to the envisaged projects on more suitable soils it is advised to postpone the development of the peat soils. More detailed research will be required to determine whether agriculture on the latter soils will be a feasible proposition, when the other projects will have been completed.

The selection of crops for the categories mentioned has been based on economic considerations (marketing opportunities) and on agro-economic calculations. The latter have been made by using the projected yields and their required inputs as discussed in the Sub-sections 2.4 and 2.5 and the producers prices as reported in Annex VII - Markets and Prices of Agricultural Commodities.

Changes in the present land use pattern are desirable but cannot always be realized easily. For example, double cropping with padi is likely to be accepted readily, but a change-over from rubber to oil palm in areas considered suitable for such a conversion will meet with difficulties. The area should have a size of at least a couple of thousand acres and form a contiguous block. Apart from purely economic considerations, problems of land ownership, age of the rubber to be converted, etc., will play a part.

At present, high-quality soils are used for the cultivation of poor-yielding unselected rubber. Wherever large areas are concerned, a changeover to oil palm growing should be stimulated.

A comparison of the present and the recommended land use (see Plates IV-1 and IV-3) reveals that extension of the oil palm area is the main objective of the agricultural development planning; ultimately, the acreage under oil palm will exceed that under rubber.

Annual and perennial crops which are not considered suitable for the purpose of diversification are tobacco, sugar-cane, pineapples, bananas, coffee and forage crops.

Malaysia is not conditioned to produce a good crop of flue-cured tobacco and therefore most of the raw material for the cigarette industry has to be imported. Only small quantities of local tobacco can be used as admixture. These quantities are produced on 4,000 acres in Kedah and Kelantan at present, where the soil and climatic conditions, although far from ideal, are better than in the other States. A possible extension of the tobacco area will never cover large acreages and is likely to be confined to Kedah and Kelantan.

The absence of a reliable pronounced dry season excludes sugar-cane as a potential crop for diversification.

As explained in Annex VII - Markets and Prices of Agricultural Commodities - the economic prospects for an expansion of the pineapple industry are not bright.

Both yield and quality of local bananas are poor. Although Trengganu's environmental conditions are such that with some effort an acceptable produce may be obtained, the location of the State is unfavourable for the export of bananas. Apart from production and transport difficulties, also the competition on the world market has to be taken into account. Moreover, considerable technical skill and risks of loss of capital are involved in a banana venture.

Bananas for local consumption should be obtained from dusun plantings and occasionally from interplantings in young rubber.

The acreage under coffee in West Malaysia is sufficiently large to meet domestic demands. A substantial increase in the present 12,000 acres is not anticipated.

The growing of fibre crops is not recommended because of their marginal profitability even under high standard farming practices.

3.2 Agricultural Production Units

3.2.1 General

The present agricultural production in Trengganu is mainly originating from smallholdings where labour still dominates capital as a production factor.

Part of the production of the smallholdings is intended for the smallholder's own consumption or use.

Agricultural production in larger production units is restricted to estates where tree crops, such as rubber, cocoa, coco-nut and oil palm, are exclusively grown for marketing purposes.

It is likely that the cultivation of padi and other annual crops will be almost exclusively confined to rather small production units in the next 20-30 years. The conditions of soil and climate in Trengganu do not permit direct sowing of padi, the major annual crop. No large and flat areas with homogeneous soils prevail, whilst, without a fixed pattern, heavy showers occur in the main season, which may cause much damage to the direct-sown seedlings. Hence, a financially and economically sound production as may be obtained from relatively strongly mechanized large-scale padi farming is not very well possible. The only areas where mechanized large-scale padi farming might be introduced in the future, are the irrigation and drainage projects Ir 12 and Dr 3 in the South of Trengganu to be implemented in the period 1980-1985. These projects will cover approximately 5,000 acres and will be situated in an area where the cultivation of sawah padi is hardly practised at present.

With regard to other annual/seasonal crops, the possibility of the cultivation of cassava by small production units on the high river terraces should be given attention.

Although oil palm will give higher returns, it might be worthwhile to earmark 6,000 acres (required acreage for a modern cassava processing unit) for this crop.

3.2.2 The Advantages of Estate-wise Tree Crop Production during the Initial Development Period

The large extension projected in tree crop cultivation will cause a change in the ratio of the area occupied by smallholdings to that covered by estates.

The estate is considered the most preferable unit of production for the development of tree crops for the following reasons.

- The rate at which the area under oil palm and other commercial tree crops should be extended in Trengganu to arrive at such an income growth that the difference between the per caput income in the State and the rest of West Malaysia will diminish.
- The rate at which the production and productivity of the existing agricultural production units should be raised, to realize the desired increase in income.
- The estate, being a large-scale unit of production, guarantees a socio-economically justified use of new land for tree crop production. For, if the expected benefits are promising, it is easier to ensure that adequate management and funds are available for one large production unit with an acreage of e.g. 10,000 acres than for 1,000 small production units with acreages of 10 acres on an average, the more so if the introduction of a new crop such as oil palm is concerned.

- Heavy demands will have to be met by the Public Service Departments, in particular by the Agricultural Department and the Drainage and Irrigation Department to realize the envisaged increase in production and productivity of the existing smallholdings. The smallholding area in newly to be developed lands should be extended gradually since otherwise the above-mentioned institutions will be unduly burdened and the development as planned endangered.

Preference is given to the estate as a production unit for the extension of the agricultural area in the period 1966-1990 because of the ambitious targets that have been set and which have to be realized with rather scarce managerial skill, especially during the initial development period.

Apart from the above-mentioned considerations, there are other factors which favour the extension of estate-farming, such as a larger labour productivity and the lower costs of processing and marketing. Moreover, the estates might serve as a nucleus estate for smallholders and provide for the necessary training, demonstration and guidance to improve the standard of their farms.

3.2.3 The Flexibility of Smallholding Agriculture

Notwithstanding the foregoing motivations favouring estate development, small and medium-sized units will also take part in the future development of non-cultivated lands for tree crop production on a commercial scale. It is not strictly necessary for the production per acre and the quality of the produce of the smallholding to fall behind those of the estate. The labour productivity attained on the estates, however, will be certainly greater because of the possibility of more efficient management. For, a single unit and a single crop are concerned and capital (means of production such as infrastructure, internal transport, etc.) and labour can be utilized better.

On the other hand, the smallowner attaining the same production level and quality of produce as the estate will be satisfied with a lower price per unit of produce as long as he and his family are not in a position to earn a higher income in another way. The elasticity in this respect is smaller on the estate where labour and management will have to be paid to an increasing extent on the basis of the generally applied rates.

If the estate has to cope with a decreasing trend in prices, there will be three possibilities open to them to avoid financial losses or at least to maintain the rate of return on a lower, but still acceptable level, viz.:

- a restriction of the activities
- an increase in productivity by a less intensified maintenance
- replacement of the crop grown by another, more profitable, crop.

Actually, the rubber estates of West Malaysia are already confronted with this problem since for some time the margin between benefits and costs has been rather small; a further drop of the rubber price and less favourable marketing prospects by a further increase in the production of rubber, have to be reckoned with.

In the case of a plantation in production, labour, management and overhead constitute approximately 90 per cent of the production costs, processing included.

The ratio of the cost of labour to the cost of management is 2-3 : 1, the labour costs relating for 80-90 per cent to the tapping of latex. These costs can hardly be lowered; this especially applies to the cost of labour because it is impossible to increase the labour productivity at a rapid rate.

The only way in which an efficiently managed rubber estate might successfully cope with increasing labour cost nowadays is to annually replace approximately 3-4 per cent of the area under crop by new, higher-yielding rubber trees and adopting less labour-intensive tapping systems, such as the 4-day full spiral system (S1/d4).

In view of the recent development in West Malaysia, the estate holders do not show much confidence in the future of large-scale rubber holdings. This lack of confidence is apparent from the facts that not only old, but also rather young rubber plantations are converted into oil palm estates and that some large foreign companies tend to concentrate their estates within a relatively small area. Such a concentration offers the opportunity to reduce the costs of processing and transportation, as well as those involved in management and overhead. It would seem that the chances for concentration, especially as far as oil palm is concerned, are not very favourable in Trengganu which might weaken the interest of foreign companies in the establishment of oil palm estates in the State. The comparatively rapid development of the oil palm cultivation as planned for Trengganu, would then form an extra heavy burden for the Government in respect of both financing and adequate management (FLDA, SEDC).

As already indicated, the small production unit can cope better with declining prices - at an equal per acre production level - than the large production unit, as the latter is subject to the high costs of labour and management to be recruited from outside. Even when the estate is working at a loss the smallholding can as yet have some compensation since labour and management are provided by the farmer and his family. The elasticity of the small production unit is greatest under proper management and with the labour potential of the smallholder's family being used to the fullest extent. The latter has not been realized in Trengganu so far. An important improvement is as yet possible for both the level of management and the labour input, especially in the case of the numerous and economically important rubber smallholders. This

group is threatened by a serious drop in income because their plantings have not been sufficiently tended in the past, a negligence that can be only partly made up for.

3.2.4 The Place of the Smallholding in the Future Development of Tree Crop Production

To realize the development of tree crop production on a commercial basis on economically strong smallholdings, it should be investigated why it has not been possible to do so in the past, in spite of the many attempts made on the part of the Government mainly with regard to rubber smallholdings.

The information obtained locally and derived from the farm surveys for padi and rubber smallholdings indicates that the poor condition of the rubber plantings on smallholdings, the low acre-yields obtained and the low quality of the rubber produced are mainly attributable to the following.

- The narrowness of the economic goal.
For many smallholders the production of rubber represents an additional income in cash. This income is needed to buy those articles that cannot be produced by the smallholder himself. So far, this cash income has proved sufficiently high to cover the purchase of such articles, because, owing to the relatively high rubber prices (and the rather large acreage of land available) it was unnecessary either to obtain a high acre-yield or to market a high-quality product. Moreover, the cash income thus obtained could easily satisfy the needs of the smallholders, which anyhow are relatively small at present.
- Lack of knowledge of and experience in the cultivation of rubber. It is still a common belief in Trengganu that rubber is a crop that can be planted and left untended till it comes into production and then serves as a supplier of cash income. It is not sufficiently realized that the yield level will depend on the way in which the rubber trees are looked after in the period of immaturity, nor is it taken into account that the non-productive period will be extended if the plantings are unsufficiently taken care of. Moreover, the maintenance of latex-producing plantings, the tapping of the trees, and the processing of latex leave much to be desired.
- The lack of cash income during the non-productive period of the rubber trees.
After planting, it will take at least six years before the girth of a rubber tree justifies tapping. The costs involved in adequate care of the plantings in this period are not offset by any benefits. To bridge the financial gap, the smallholder must try to obtain cash income from other sources to cover both his cash expenses and the costs involved in tending the young rubber plantings. If it were possible for the smallholder to regularly renew part of his old plantings, the continuity of his production and thus a certain cash income would be ensured.

In practice, the establishment of age classes for rubber trees to be grown on smallholdings is difficult, not in the last place because in many cases the rubber plantings on smallholdings have not yet reached the stage that regular replacement of old trees by new and higher productive ones can be realized without endangering the continuity of the production.

- The lack of combined action. Even if the relatively wide dispersion of the rubber smallholdings is considered an impediment, it is felt that the possibilities to save on labour and capital expenditure and to improve the quality of the product by combining the efforts of the farmers, have been inadequately utilized so far. This especially holds true for the supply of production means, the processing of latex, and the marketing of rubber. For a number of scattered areas intrinsically suited to smallholding cultivation of padi, rubber, and dusun crops, the pros and cons of a more rational division of labour might be considered; the possibility of land consolidation might be given attention as well.

Only in a few exceptional cases have the problems described above been rather successfully tackled. This does not apply to the schemes of the Rubber Industry (Replanting) Board, the Fringe Alienation Schemes, the Controlled Alienation Schemes, and the Block Newplanting Schemes. The major cause of the disappointing results obtained on the above-mentioned development projects is that the problems met with have not been treated in an integrated way. Such an approach has been actually followed in the FLDA-Schemes. In these schemes the solution has been found in having the settlers guided by a project management that essentially is similar to that of an estate. The differences that can be observed between an FLDA-Scheme and an estate are:

- the settlers of an FLDA-Scheme are subject to less rigid management than the labourers of an estate
- a less rational division of labour on FLDA-Schemes since here the settlers tend their own lots
- the guidance of a settler on an FLDA-Scheme will be taken over by the relevant Government Services in course of time
- the settler on an FLDA-Scheme is more concerned with the achievements made by his own skill than the estate labourer.

The development of the FLDA-Schemes in Trengganu has not yet reached such a stage that a definitive judgement about the results of the applied approach can be made.

Considering the present stand and the way of tending of the mainly young plantings, the FLDA rubber schemes can very well compare with an average estate in Trengganu but they fall definitely behind the well-managed Jabor and Kerteh estates. The FLDA oil palm schemes that are not yet in production will be able to compete with the private estates on the West Coast of Malaysia.

It might be of importance to try to integrate the future estate development with the smallholder settlement development. To this end, smallholdings situated within so-called Special Smallholding Development Projects which are to cover 1,000-3,000 acres should be allocated to especially selected capable labourers, mainly originating from the estates. These projects should be guided by the management of the estate from which the majority of the settlers originate. The selection of settlers who have been trained on the estate for a number of years will offer better guarantees for a successful implementation of the project. Moreover, the essential guidance to be given by the management of the estate will turn out cheaper as a result of this selection and of the interwoven interests of settlers and estate management. The establishment of Special Smallholding Development Projects, therefore, has been given due attention in the plans for development of the future tree crop production (oil palm, rubber, coco-nut and cocoa).

3.3 The Phasing of the Agricultural Development

3.3.1 Introduction

The agricultural development in the period 1966-1990 will comprise both the improvement of the production of land cultivated at present and the establishment of satisfactorily producing new agricultural production units.

The efforts to improve the output of the present agricultural production will be primarily focused on the padi producing fluvio-alluvial lands. There the increase in production should be realized by the installation of an irrigation and drainage system that will render a better control of the water possible. The improvement of the present output of these padi lands should be mainly seen in the light of making Trengganu self-sufficient in rice. The establishment of new agricultural production units, however, will chiefly serve the purpose of increasing the exports of agricultural products. The rate at which these developments are to take place will have its influence on the rate of growth of the economy of the State and also on the rate at which the difference between the per caput income in Trengganu and that in Malaysia will diminish.

The DID is considered to be capable of implementing the drainage and irrigation works at the planned rate of 2,000 acres during the period 1967-1985.

The planned annual extension of the acreage under oil palm is fixed at 12,000 acres during the period 1972-1986. This rate is also being aimed at by the management of the ongoing projects for the period 1969-1972. It is clear that a rate of 12,000 acres annually does not mean that the financing for the oil palm development for the next 20 years has already been ensured.

The financing and provision of sufficient managerial and technical skill are a *conditio sine qua non* for the realization of

this rate of implementation.

The planned extension of the acreages under rubber, coco-nut and dusun crops is expected not to meet with any special difficulties. The reason for this is that these extensions relate to ongoing FLDA Rubber Schemes and to rubber and dusun areas in the neighbourhood of the newly planned irrigation and drainage projects where smallholders mainly go in for the growing of padi as well as to future rubber smallholdings in the so-called dispersed areas, and to areas of Special Smallholding Development Projects. With the implementation of the above-mentioned programme of agricultural development the labour force available will meet the demand for manpower. Timely availability of funds as well as the recruiting of managerial and technically skilled staff will be essential.

The areas considered suitable for agricultural development - either by improving the present situation or by establishing new production units - have been arranged in groups of projects e.g. sawah padi projects, oil palm projects, etc. (see Plates IV-3/VIII-1/IX-3).

3.3.2 Priority Ranking of and Return to Labour in Agricultural Projects

In order to determine the priority ranking of the projects to be set in operation they have been grouped according to decreasing benefit/cost ratios.

Both the benefits and the costs have been converted into present values and valued in the macro-economic sense. This implies that the influences which subsidies and taxes on specific commodities have on the streams of costs and benefits have not been taken into account.

The benefits do not include the net revenues obtained from logging prior to clearing. Forestry has its own working programme and it is not possible to predict accurately when timber will be extracted from the project areas. It is, therefore, very difficult to indicate the phasing of these benefits over time. This, in turn, renders impossible their inclusion in terms of present values in the sum total of the benefits of the project. If such an inclusion were to be considered it will be only a very arbitrary one.

In converting the different values of costs and benefits to present values the rate of discount used has been 10 per cent. It has been assumed that this percentage reflects the opportunity cost of capital in the Federation.

When judged by economic criteria only, the establishment of projects which render the highest benefit/cost ratio should be given first priority. Other criteria, however, have to be applied sometimes to determine the priorities. Such criteria are e.g. the

geographical situation of the project and the distribution of income within the region where the project is located. Too great a dispersion of promising projects should be avoided and the establishment of a project should not result in an unbalanced distribution of income within the region where the project is to be implemented.

Each project has been judged on its merits with regard to size, climate, soils, topography and on its distances from main roads and harbours.

Wherever appropriate the yield and cost estimates have been adjusted. The accuracy of the adjustments depends on the exactness of the available data.

For areas that are remote or poorly accessible the data are less precise and need to be checked before a feasibility study can be undertaken. It goes without saying that contrary to the detailed project evaluations for the Sungei Tong Oil Palm Project and for the Besut Irrigation Scheme the benefit/cost calculations referred to in this Section should not be considered to replace feasibility studies.

There are, however, also certain limitations to be set to the use of the B/C ratio as a criterion for the determination of the economic feasibility of a project. The B/C ratio of a certain project has value only in relation to the ratios of other projects in the same field of production rather than an absolute value of its own. Present value calculations are sensitive to the time phasing of benefits and costs respectively and also to the life of a project. Moreover, B/C ratios greatly depend on the definition of project costs and associated costs. Therefore, projects which individually differ in the timing of benefits and costs, in duration and in purpose, should be considered separately.

Strictly speaking, the B/C ratios of oil palm, irrigation and forestry projects are not comparable. If this is done, the differences should be wide enough to allow the drawing of conclusions.

Nevertheless, the development programme needs i. a. economic criteria to determine the relative importance of the various crops for the regional economy. As one of the criteria, the magnitude of the difference between the present values of benefits and costs per acre have been taken. In converting the benefits and costs to their present values the rate of discount used has been also 10 per cent.

To eliminate the discrepancies in evaluation periods for the various crops these differences have been converted into equivalent annual amounts. Both project costs and associated costs are taken exclusive of the costs of agricultural labour. In other words, the difference between benefits and costs per acre represents the per acre productivity of agricultural labour, because all other inputs including capital have been costed.

The per acre productivity of agricultural labour, the number of acres a labourer can handle, and the total number of acres available for development in the State enable an assessment of the relative importance of a particular crop for the regional economic development.

3.3.3 Sawah Padi Projects

The establishment of irrigation and drainage projects aims at the development of the production of sawah padi. For the projects concerned the yields, the cropping intensities, and the investment costs may vary widely, resulting in differences in the B/C ratios calculated for these projects.

Generally, the projects that are most attractive from an economic point of view are found in the North. The projects in the South call for a later implementation since there the land is less suitable and the farmers are less familiar with the growing of sawah padi.

The estimates of the investment required are necessarily rough since for a great number of areas detailed information was lacking.

The period over which the projects have been evaluated has been taken at 30 years. The yields after 1990 have been projected by making use of graphical extrapolation assuming a certain continuous 'natural' growth as a result of the availability of better seed and new techniques over time.

Maintenance and operation costs have been estimated at M\$ 20 per acre a year for the irrigation projects and at M\$ 10 for the drainage projects. The cost of additional project supervision has been estimated at M\$ 10 per acre a year during the first five years of the project

Not all potential irrigation and drainage projects have been evaluated individually.

The potential irrigation and drainage projects have been grouped according to their geographical location. From each group the project with the least favourable prospects has been taken as a basis for the evaluation. Next the projects studied have been classified according to decreasing B/C ratios to arrive at the desired priority ranking.

Attention is drawn to the fact that by delaying the establishment of expensive projects such as irrigation projects the magnitude of the B/C ratio may turn out higher by assuming higher benefits through the use of higher-yielding padi varieties. E.g. in the case of Chukai (I 12; Table 3-1) the B/C ratio would have been lower if an earlier date of implementation were chosen. This aspect has been duly taken into account in the priority ranking.

The data pertaining to the projects studied are summarized in the Tables 3-1 and 3-2.

The B/C ratios for the irrigation as well as the drainage projects are approximately 3 for the areas in the North and about 2 for the areas in the South.

The returns to labour per acre differ more widely. For the irrigation projects they are M\$ 300 per acre a year in the North and M\$ 150 per acre a year in the South. For drainage projects the values vary from M\$ 150 to M\$ 110. The much higher returns in the case of irrigation are caused by the double cropping. The values of the second crop in drainage projects have not been included. Their inclusion would mean that the returns to labour would increase by thirty to forty per cent.

Soils suitable for sawah padi are less suitable for other crops. The return to labour relating to the cultivation of such crops instead of padi is definitely much lower.

The return to labour is higher in the case of drainage project Dr 2 than that for project Dr 1, though the latter is planned for implementation at an earlier date. The reason for this is that projects which start later will need a shorter running-in period and will, therefore, benefit from new rice varieties sooner after their implementation.

In the Tables 3-3 and 3-4 the phasing of the future irrigation and drainage development projects over the period 1966-1990 is shown.

Apart from those to be realized in the period 1968-1990 there are a number of irrigation and drainage projects which might be carried into effect after 1990. The information available was too scanty to allow their inclusion in the planning period 1986-1990.

Table 3-1 - Irrigation Projects - Benefit/Cost Ratios and Labour Productivity

Project	Ir 1 (Setiu) 1970/75	Ir 8 (Marang) 1975/80	Ir 12 (Chukai) 1980/85
period of implementation	2,300	1,600	3,200
net cultivable acreage			
<u>Padi yields 15 years after start of project</u>			
main season (gantang per acre)	625	625	650
off season (gantang per acre)	800	800	820
<u>Present values (at 10 per cent) per starting year</u>			
<u>per cultivable acre (in M\$)</u>			
<u>benefits</u>	4,120	3,300	3,030
<u>costs</u>			
- capital costs	1,020	1,370	1,370
- maintenance and operation costs	190	190	190
- project supervision	40	40	40
total	1,250	1,600	1,600
<u>labour productivity</u>			
annual equivalent amount of labour productivity	2,870	1,700	1,430
per cultivable acre (in M\$)	304	180	152
B/C ratio	3.3	2.1	1.9

Table 3-2 - Drainage Projects - Benefit/Cost Ratios and Labour Productivity

Project	Dr 1 (Bukit Temiang)	Dr 2 (Ajil)	Dr 3 (Chukai)
period of implementation	1975/80	1980/85	1980/85
net cultivable acreage	2,200	2,400	1,600
<u>Padi yields 15 years after start of project</u> (gantang per acre)	550	620	665
<u>Present values (at 10 per cent) per starting year per</u> <u>cultivable acre (in M\$)</u>	1,910	2,000	1,900
<u>benefits</u>			
<u>costs</u>			
- capital costs	475	475	740
- maintenance and operation costs	95	95	95
- project supervision	40	40	40
total	610	610	875
<u>labour productivity</u>	1,300	1,390	1,025
annual equivalent amount of labour productivity per cultivable acre (in M\$)	138	147	110
B/C ratio	3.1	3.3	2.2

Table 3-3 - Phasing of Irrigation Projects (Net Area in Acres)

Projects	1966	1970	1975	1980	1985	1990
<u>ongoing</u>						
Besut I	3,500	3,500	12,600	12,600	12,600	12,600
Besut II	-	-	4,700	4,700	4,700	4,700
Pulau Musang	4,500	4,700	6,000	6,000	6,000	6,000
Nerus	-	5,500	3,300	3,300	3,300	3,300
other projects (15 in total)	1,500	3,000				
<u>planned</u>						
Ir 1	-	-	2,300	2,300	2,300	2,300
Ir 2	-	-	500	500	500	500
Ir 3	-	-	-	4,600	4,600	4,600
Ir 4	-	-	-	2,100	2,100	2,100
Ir 5	-	-	-	200	200	200
Ir 6	-	-	-	1,000	1,000	1,000
Ir 7	-	-	-	400	400	400
Ir 8	-	-	-	1,600	1,600	1,600
Ir 9	-	-	-	-	3,800	3,800
Ir 10	-	-	-	-	800	800
Ir 11	-	-	-	-	1,000	1,000
Ir 12	-	-	-	-	3,200	3,200
other projects	-	-	-	-	-	query
total	9,500	16,700	29,400	39,300	48,100	48,100 + query

Table 3-4 - Phasing of Drainage Projects (Net Area in Acres)

Projects	1966	1970	1975	1980	1985	1990
<u>ongoing</u>						
Batu Rakit	4,600	4,600	4,600	4,600	4,600	4,600
S. Ibai	800	800	800	800	800	800
other projects (5 in total)	1,400	1,400	1,400	1,400	1,400	1,400
<u>planned</u>						
Dr 1	-	-	-	2,200	2,200	2,200
Dr 2	-	-	-	-	2,400	2,400
Dr 6	-	-	-	-	-	2,500
Dr 7	-	-	-	-	-	200
Dr 8	-	-	-	-	-	200
Dr 3	-	-	-	-	1,600	1,600
Dr 4	-	-	-	-	800	800
Dr 5	-	-	-	-	1,000	1,000
other projects	-	-	-	-	-	query
total	6,800	6,800	6,800	9,000	14,800	17,700 + query

3.3.4 Oil Palm Projects

3.3.4.1 Introduction

At present there are four ongoing projects which will cover approximately 77,000 acres net when they will be fully implemented by 1971-1972. The part of the Chenderong Area that is intended for oil palm development is included in this acreage. As from 1972, new oil palm projects will be started.

The new projects have been sub-divided into large-scale production units, i.e. estate development projects (FLDA-Schemes included) and Special Smallholding Development Projects. Of the latter, a great part seems to be apt to have their development integrated with that of the large-scale production units. As the smallholdings are situated in the proximity of the latter units, their development might be supervised and guided by the management of the estate. Those small-scale production units that because of their remoteness cannot be supervised by the estate management, should be run as a co-operative unit under a project management that should organize and co-ordinate processing and marketing.

Apart from the 77,000 acres of the four ongoing projects, the total area intended for large-scale production (estate) development covers approximately 140,000 acres. The size of each production unit will be at least 4,000 acres.

Next to the acreage intended for estate development, about 30,000 acres net have been reserved for the development of the small-scale production units which are situated close to the large-scale production units. The average acreage of these small development units will be less than 4,000 acres.

The ongoing projects included, the total area under oil palm will thus be in the order of 250,000 acres. In addition, there are other areas that are considered suitable for oil palm cultivation. For example, there is a significant acreage of good-quality land that is mainly under smallholders' rubber at present. It is, however, questionable whether these areas will be converted since for this the unanimous decision of the smallholders concerned is required. For contiguous areas are required to make this conversion an economic proposition.

Furthermore, there is an acreage of suitable soils in the interior that is under forest at present. This land might be used for oil palm cultivation after 1986. The acreage concerned has not been included in the development programme, because it is thought more realistic to postpone its inclusion in the development plan until more is known about the general situation by 1985/1990.

Therefore, these areas will not come into production before the end of the planning period.

On the basis of the magnitude of benefit/cost ratios, a sequence of priority for development of the large-scale production units could be established (see Table 3-7).

3.3.4.2 Benefit/Cost Calculations for and Labour Productivity of Estates

The B/C ratio for estates has been calculated on the basis of an average estate size of 10,000 acres and an average peak yield of 8.8 tons of FFB per acre. Investment and recurrent cost projections for such an estate have been derived in principle from the report on the detailed project evaluation for the oil palm scheme Sungei Tong Project.

For plantings having a size of more or less than 10,000 acres, the factory investment costs have been adjusted. For each 1,000 acres increment in size the investment costs per acre have been assumed to increase by two per cent and for each 1,000 acres reduction to decrease by one per cent.

As mentioned in Sub-section 2.4.2.1 the individual peak yields vary from 8.0 to 9.6 tons of FFB per acre and decrease from the North to the South as a result of less favourable rainfall and steeper slopes. The recurrent production costs are assumed to increase (decrease) with the yields. The projects have been grouped according to their location. The difference in acre-yield between each of the three groups of projects distinguished has been taken at 0.8 ton which is thought to make a difference of 10 per cent in the relevant recurrent production costs.

To assess B/C ratios and thus the priority ranking, has been assumed that all projects would deliver the first oil by 1970. This year has also been taken as the basis for discounting the benefits and the costs. All project costs incurred before the first year of oil production have been capitalized to the beginning of that year. All the costs incurred after this year have been also discounted to the beginning of that first year. After the assessment of priorities, the starting date for each project has been determined taking into account a maximum implementation capacity of 12,000 acres a year.

New B/C ratios were then calculated for the envisaged projects taking into account their actual phasing over time. This has been done to conceive whether improved cultivation and processing techniques and the possible availability of higher-yielding varieties would counteract the expected fall in price of oil palm products on the world market and to determine whether the initial priority ranking holds true even under the changed conditions. It was found that since benefits and costs of all the projects are influenced to the same extent, the timing of the projects did not affect the initial priority ranking.

The Tables 3-5, 3-6 and 3-7 give a summary of the results of the calculations. The ongoing projects Jerangau, Sungei Tong, Joint Venture, and Chenderong have been excluded from the ranking.

Table 3-5 - Present Values* of Gross Revenues

Year	Years after start of oil production	Yields (in tons of oil per acre)	F.o.b. prices Trengganu harbour before deduction of export duties (M\$ per ton of oil)**
1970	0	.35	520
1975	5	1.70	480
1980	10	1.70	455
1985	15	1.48	430
1990	20	1.28	413
1995	25	-	404

Present values as per first year of production (1970)

palm oil	3,645 M\$ per acre
palm kernels	455 " " "
total	<u>4.100 M\$ per acre</u>

* discount ratio 10 per cent; productive life 25 years.

** Prices are equivalent to the f.o.b. ocean port prices (see Annex VII - Markets and Prices of Agricultural Commodities) minus
M\$ 18 per ton for handling and bulking at ocean port,
M\$ 14 per ton for shipping from Trengganu harbour to seaport,
M\$ 4 per ton for handling, bulking and storing in Trengganu harbour,
M\$ 4 per ton for local transport.

Table 3-6 - Investment and Recurrent Production Costs
(undiscounted values in M\$ per acre)

Year	Investment costs		Recurrent costs
	factory	total	
1		110	
2		622	
3		282	
4	150	515	99
5		15	130
6		8	163
7		8	170
8	25	33	174
9	150	158	176
10	50	58	176
11	25	30	176
12			172
13			172
14			169
15			169
16			169
17			169
18			166
19			162
20			162
21			162
22			158
23			158
24			155
25			155
total	400	1,839	3,562

Note : The costs include the value of agricultural labour

Table 3-7 - Benefit/Cost Ratios of Oil Palm Projects

Nos of project	Size in acres	Peak yields in tons FFB/acre	First years of production	Present values *		B/C ratios
				benefits	costs	
standard	10,000	8.80		2,699	1,442	1.87
OP 1	17,000	9.25	1975/76/77	2,536	1,364	1.85
OP 2	11,500	9.25	1977/78	2,516	1,370	1.83
OP 3	27,500	9.00	1978/79/80	2,332	1,402	1.66
OP 4	8,800	8.80	1980/81	2,188	1,451	1.51
OP 5	16,000	8.50	1981/82	2,020	1,507	1.34
OP 6	15,000	8.50	1982/83/84	1,960	1,504	1.30
OP 7	8,500	8.50	1984	1,940	1,509	1.29
OP 8	7,700	8.50	1985	1,930	1,513	1.28
OP 9	8,000	8.25	1986	1,802	1,565	1.15
OP 10	7,500	8.00	1987	1,690	1,595	1.06
OP 11/12/13**	6,700	9.00		2,205	1,430	1.54
OP 11/12/13**	6,000	8.50		1,975	1,517	1.30
OP 11/12/13	7,000	8.00		1,690	1,600	1.06

* in M\$ per acre

** The start of the productive period is not listed. In view of the prospects for oil palm cultivation elsewhere in the State the cultivation of rubber might be more profitable here.

Labour productivity calculations for a number of projects are presented in Table 3-8.

Table 3-8 - Productivity of Labour on Oil Palm Projects

Project	OP 1	OP 3	OP 4	OP 6	OP 9
start of production	1975/76	1977/79	1979/80	1981/82	1984
B/C ratios	1.85	1.66	1.51	1.30	1.15
present values* of: benefits (in M\$/acre)	2536	2332	2188	1960	1802
costs (in M\$/acre) available for labour (in M\$/acre)	1364	1402	1451	1504	1565
annual equivalent amount of labour pro- ductivity per acre (in M\$)	129	102	81	50	26
labour costs included in recurrent production costs** of FFB (in M\$/acre/year)	120	120	120	120	120
total labour productivity (in M\$/acre/year)	249	222	201	170	146

* at an interest rate of 10 per cent

** per 10 acres one labourer is earning M\$ 4-4.50 a day (including social overhead) during 250-300 days a year.

In comparison with other crops, oil palm seems to offer the highest returns to labour : at least M\$ 150 per acre a year for the marginal projects and M\$ 250 per acre a year at a maximum for the most promising projects.

It should be noted that the labour productivity is very sensitive to improvement in the oil content of the bunches. Such improvement is difficult to quantify at present, but might materialize within the next 10 to 15 years. The following example may illustrate the above-mentioned sensitivity.

If by 1980/85 the oil/bunch ratio is raised by 15 per cent, the total gross production value will increase by about 13 per cent (the output of kernels is assumed to remain unchanged). By that time, with the recurrent costs of production of about 60 per cent of the original gross production value*, the benefits would increase

* See Report "Detailed Project Evaluation SEDC Oil Palm Scheme Sg. Tong"(page 72).

by almost 30 per cent.

In the case of project OP 9 the benefits as well as the sum available for the remuneration of labour would be raised by some M\$ 540 per acre, measured in total present values. The annual equivalent amount for the labour productivity - which would then be M\$ 86 - added to the labour costs included in the recurrent production costs of M\$ 120, would result in M\$ 206 for the total labour productivity per acre a year instead of M\$ 146.

With 10 to 12 acres oil palm per smallholders family the return to family labour (expressed in annual equivalent amounts) is M\$ 2,500 to 3,000 a year on oil palm projects with a high priority for implementation and M\$ 1,500 to M\$ 1,800 on the projects that are to be implemented by 1984. If the oil/bunch ratio can be improved by 15 per cent the amount may be M\$ 2,100 to 2,500.

It should be borne in mind that with an area of 10 to 12 acres the family members of the smallholder will not be fully occupied with oil palm cultivation throughout the year. In their spare time they can obtain earnings from other activities.

No separate B/C calculations for the Special Smallholding Development Projects have been made. As they are dependent on the services to be rendered by the large-scale unit by which they are supervised, they cannot have a priority of their own. Moreover, their priority ranking would not differ very much from that of the neighbouring large units.

3.3.4.3 Implementation Schedule

In Table 3-9 the timing is given of the implementation of oil palm projects together with the relevant acreages under oil palm in the reference years during the period 1966-1990.

It should be noted that the acreages of the projects specified are not yet definitive. It will therefore be necessary to make a more detailed investigation in the course of time.

It may be seen from the Tables 3-7 and 3-9 that some 16,000 acres to be developed in the period 1980-1990 have not been allocated to specific projects. This acreage refers partly to remotely situated projects of which it is difficult to specify the sequence of development, and to rubber areas which are potentially suitable for conversion into oil palm land and partly to an acreage of not identified projects which may be considered for development of smallholdings. It should be noted that the areas under rubber on first class sedentary soils which might be used for oil palm in the future, comprise at least 70,000 acres.

3.3.4.4 Smallholders Income from Oil Palm Cultivation

The income that smallholders on the Special Smallholding Development Projects can obtain from supplying bunches to a

Table 3-9 - Net Acreages under Oil Palm for the Reference Years during the Period 1966-1990

Projects	1966	1970	1975	1980	1985	1990
<u>Ongoing</u>						
Jerangau/Bukit Bading	10,500	12,000	12,000	12,000	12,000	12,000
Sungei Tong	query	12,000	20,000	20,000	20,000	20,000
Joint Venture	-	24,000	30,000	30,000	30,000	30,000
Chenderong*	-	6,000	15,000	15,000	15,000	15,000
<u>Planned estate development</u>						
OP 1, OP 2, OP 3, OP 4	-	-	38,000	65,000	65,000	65,000
OP 5, OP 6, OP 7, OP 8, OP 9	-	-	-	29,000	55,000	55,000
OP 10, OP 11/12/13 (partly) or unspecified estate development	-	-	-	-	15,000	20,000
sub-total	10,500 + query	54,000	115,000	171,000	212,000	217,000
<u>Special Smallholding Development Projects</u>						
SH 1 (OP 2), SH 2 (OP 3), SH 3 (OP 4)	-	-	-	4,000	15,000	15,000
SH 4 (OP 5), SH 5 (OP 6), SH 6 (OP 7)	-	-	-	-	6,000	6,000
unspecified smallholding development	-	-	-	-	-	9,000
sub-total	-	-	-	4,000	21,000	30,000
total	10,500 + query	54,000	115,000	175,000	233,000	247,000

* The cultivation at the Chenderong Estate is to start in 1967/68; the development of the totally projected 15,000 acres depends on the results to be obtained from the first 3,000 acres to be developed in 1970.

large-scale production unit depends in fact on the world market prices for oil and kernels. Therefore, the relationship between export prices and values of bunches had to be estimated in the first place. The results are shown in Table 3-10.

The large-scale production units are supposed to render services to the smallholders schemes in their vicinity. Certain assumptions have been made as to the remuneration of these services. By deducting the charges for these services from the value of bunches, the sales prices of bunches are obtained. The calculations are summarized in Table 3-11.

The cost of establishment and the recurrent costs of production are specified in Table 3-12; yields and resulting smallholders incomes in Table 3-13.

The relationship between the world market prices for palm oil and the smallholders incomes is presented in graphical form in Figure 1. For the sake of clarity, the years in which certain export prices are expected to prevail, have been shown between parentheses*.

It appears that by the end of the planning period, the smallholder's family income is expected to be not less than M\$ 1,400 a year. Oil palm is as yet one of the best paying crops, though it is less attractive than before 1980. For large-scale oil palm projects to be implemented by the end of the planning period when export prices for oil will be at a level of M\$ 450, the internal rate of return is about 10 per cent, after the then valid wages have been paid.**

The fall in export prices has an impact on the smallholder's income. For the average remuneration of the workers per family unit on oil palm schemes is not to exceed M\$ 1,500 between 1966 and 1990.

Much attention should be paid to the efficiency of the operations in the field as well as in the mill. It is, also, of paramount importance to develop high yielding varieties to ensure an increase in income of the smallholders after 1985.

With an export price for palm oil of M\$ 450 per ton, an extraction rate of 21 instead of 20 per cent will result in a rise of the smallholder's income by M\$ 190 a year. An average yield of 7.5 ton FFB per acre instead of 7.0 ton will produce the same effect.

* Long term price projections for palm oil are given in Annex VII - Markets and Prices of Agricultural Commodities.

** See Report of the Detailed Project Evaluation SEDC Oil Palm Scheme Sg. Tong (page 71).

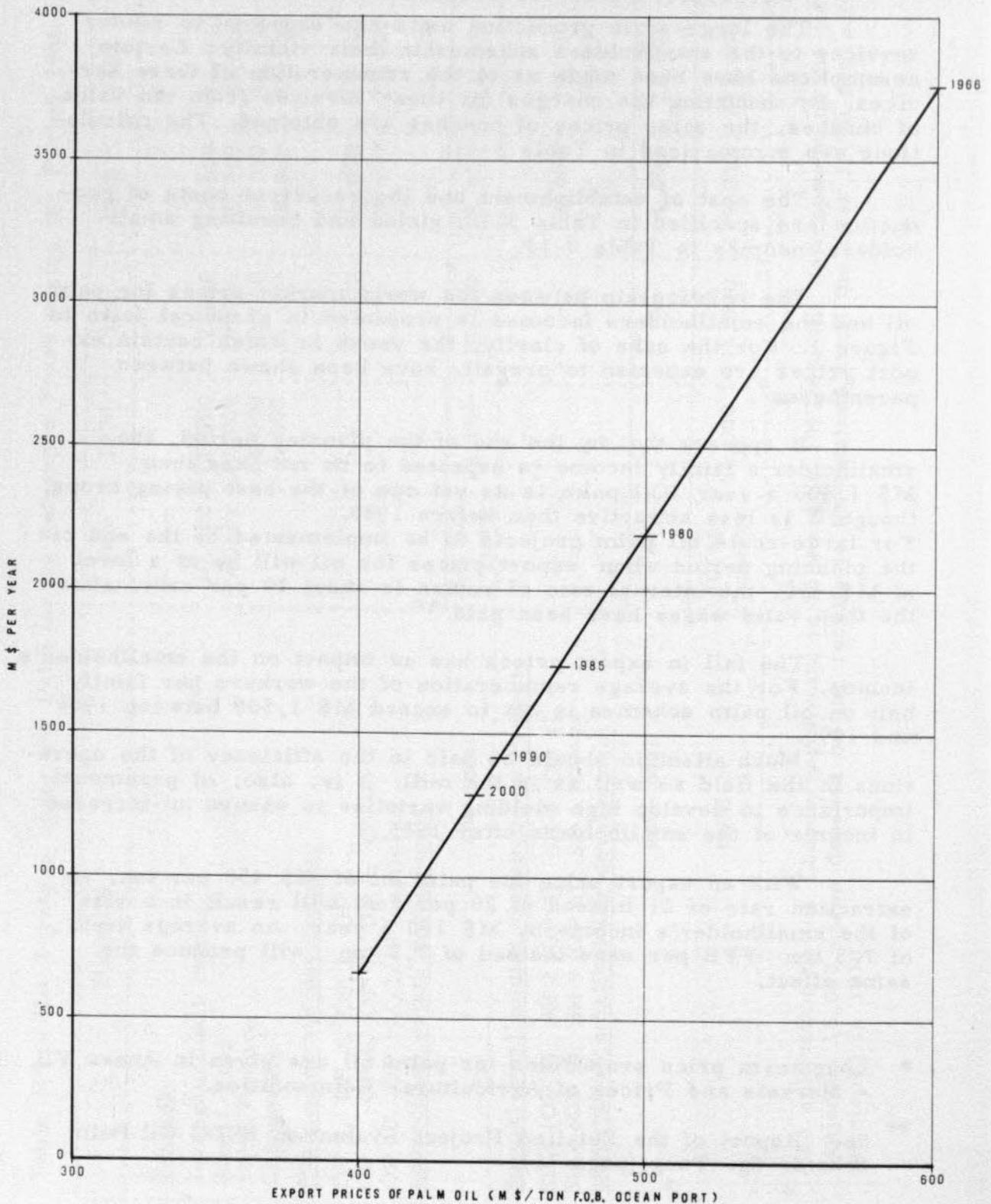
RELATIONSHIP BETWEEN THE WORLD MARKET PRICES FOR
PALM OIL AND THE SMALLHOLDERS INCOME

Table 3-10 - Price Structure of Palm Oil (M\$ per ton)

Year	1966	1980	1990	later
Palm oil price f.o.b. ocean port	600	500	450	400
Equivalent palm oil price including value of kernels	684	569	510	454
- cost of handling and transport between Trengganu harbour and ocean port including an allowance for the weight of kernels	44	44	44	44
- corresponding palm oil price f.o.b. Trengganu	640	525	466	410
- export duties 7.5 per cent of f.o.b. Trengganu value	48	39	35	31
- export value after payment of export duties	592	486	431	379
- storage and overloading Trengganu harbour	5	5	5	5
- transport from mill to Trengganu harbour	6	6	6	6
	11	11	11	11
Value ex-mill	581	475	420	368
<u>Processing charges</u>				
- cost of materials*	20	20	20	20
- gross value added, attributable to				
labour	15			
management	15			
depreciation	10			
interest	15			
contingencies	10%			
and profit	20%			
of total costs	<u>20</u>			
- total gross value added	75	75	75	75
- total processing costs	95	95	95	95
Value of 1 ton of oil in bunches	486	380	325	273
Equivalent value of 1 ton of bunches at factory gate, assuming 20 per cent oil extraction	97	76	65	55

* Data available in the Statistical Department indicate that the cost of materials amounts to M\$ 33 per ton of palm oil. However, because of an expected decrease in the utilization of fuel (nearly M\$ 7 per ton of oil) and of the bigger and therefore more efficiently operating oil mills in Trengganu and the resulting higher rates of extraction, a figure of M\$ 20 per ton has been applied.

Table 3-11 - Smallholder's Price of Fresh Fruit Bunches
(M\$ per ton)

Year	1966	1980	1990	later
Palm oil price f.o.b. ocean port	600	500	450	400
- corresponding value of one ton of oil in bunches with a 20 per cent oil content	486	380	325	273
- charges for services rendered to smallholders (purchasing of fertilizer, assistance in artificial pollination, advice on upkeep, etc.)	30	30	30	30
- internal transport of FFB (20 miles)	20	20	20	20
- contingencies 10 per cent	15	15	15	15
- profit 20 per cent				
- total costs	65	65	65	65
balance for smallholder	421	315	260	208
value of one ton of bunches (20 per cent oil extraction)	84	63	52	42

Table 3-12 - Special Smallholding Development Projects;
 Cost of Establishment and Recurrent Cost of
 Production of Oil Palm

Costs	M\$ per acre
<u>Cost of establishment (including labour)</u>	
- clearing and drainage	200
- internal road system	180
- platforming, terracing	100
- fertilizer	100
- cover crops, planting material	150
- planting, plant protection	60
- castration, pollination	35
- maintenance, etc.	115
- 10 per cent interest during non-productive period	260
total	1,200
<u>Recurrent cost of production (excluding labour and advice from large production unit)</u>	
- maintenance	7.-
- foliar analysis	0.15
- fertilizer	95.-
- plant protection	2.50
- pollination	2.-
- harvesting	2.50
total	109.15

Table 3-13 - Smallholder's Income from Oil Palm Cultivation

Year	1966	1980	1990	later
Palm oil price f.o.b. ocean port (M\$ per ton)	600	500	450	400
- corresponding value of bunches with 20 per cent oil extraction (M\$ per ton)	84	63	52	42
- average production (FFB in tons per acre a year)	7	7	7	7
- smallholder's gross income (M\$ per acre)	588	441	364	294
- recurrent production cost, excluding labour* (M\$ per acre)	110	110	110	110
- cost of establishment, including labour and interest during non-productive period* (M\$ per acre)	120	120	120	120
total costs (M\$ per acre)	230	230	230	230
- return to smallholders labour (M\$ per acre)	358	211	134	64
- total return** to smallholders labour (M\$)	3,760	2,215	1,410	670

* see Report Detailed Project Evaluation SEDC Oil Palm Scheme Sg. Tong (pages 3 and 65).

** Assuming 12 acres per smallholding with 10.5 productive acres; labour income from non-productive area not accounted for (see under cost of establishment).

By using the costs and yields mentioned in the Tables 3-12 and 3-13 in the calculations the smallholder's income has been kept on a conservative level. This is illustrated by the following. The costs have been derived from the report on the Detailed Project Evaluation of the SEDC Oil Palm Scheme 'Sungei Tong'. The B/C ratio of this project at a rate of interest of 10 per cent is 1.3.

The export prices for palm oil range between M\$ 570 per ton in 1970 and M\$ 450 in 1991.

As Sungei Tong belongs to the group of projects with a fair profitability and the smallholders are thought capable obtaining a result similar to that of the Sungei Tong Scheme, it is expected that the smallholder's income will at any rate not be lower than M\$ 1,400 by 1990. Moreover, the average yield used in the calculations has been 7.0 tons of FFB per acre as against 7.5 ton for Sungei Tong.

3.3.5 Rubber and Coco-nut Projects

3.3.5.1 General

As with oil palm the timing of the implementation of rubber and coco-nut projects has been based on the results of benefit/cost ratio calculations. The projects are located in areas which are less suited to the cultivation of oil palm because of either their remoteness or slopes up to 20 degrees or soils of a low water-retaining capacity, but yet suitable for rubber (sedentary soils) or coco-nut (beach ridge soils).

The Tables 3-14 and 3-15 show the timing of the implementation of the projects and the relevant acreages under rubber and coco-nut respectively in the reference years during the period 1966-1990.

Apart from the proposed estate projects and Special Smallholding Development Projects, the following developments are foreseen in the rubber cultivation.

- The establishment of smallholdings in the dispersed areas after 1975. The total area to be developed will amount to 15,000 acres by 1990.
- A reduction in the present rubber area of estates from 16,500 to 15,000 by 1990 as a result of the low market prices for rubber. Part of the owners will neither be in a position to make any profit with the then poorly producing old rubber clones nor succeed in converting old rubber plantings in new ones with newly selected, highly producing clonal material.
- A reduction in the present areas of Fringe Alienation Schemes, Controlled Alienation Schemes and Block New-planting Schemes. These schemes are not very promising since the development of the young trees has been very poor and no good yields can be expected.

Table 3-14 - Net Acreages under Rubber for the Reference Years during the Period 1966-1990

	1966	1970	1975	1980	1985	1990
<u>Production units</u>						
<u>Unspecified</u>						
smallholdings						
- established plantings of unselected material	115,000	115,000	115,000	115,000	115,000	115,000
- future plantings of first class material	-	-	-	5,000	10,000	15,000
estates						
- established plantings of unselected material	16,500	16,000	15,000	15,000	15,000	15,000
- future plantings of first class material	-	-	-	-	-	-
sub-total	131,500	131,000	130,000	135,000	140,000	145,000
<u>Planned</u>						
smallholdings						
- Fringe Alienation)	21,300	query	query	query	query	query
- Controlled Alienation)						
- Block Newplanting)	7,200	10,000	15,000	20,000	20,000	20,000
- FLDA						
- Special Smallholding Development Schemes : RU 4(SH), RU 5(SH), RU 6(SH), RU 7 (SH)	-	-	-	-	-	5,000
- estates : RU 1, RU 2, RU 3, RU 8 and other areas	-	-	-	-	10,000	20,000
sub-total	28,500	10,000	15,000	20,000	30,000	45,000
total	160,000	141,000	145,000	155,000	170,000	190,000

Table 3-15 - Net Acreages under Coco-nut for the Reference Years during the Period 1966-1990

Production units	1966	1970	1975	1980	1985	1990
<u>Unspecified</u>						
- smallholdings	17,500	17,500	17,500	17,500	17,500	17,500
- estates	1,500	1,500	1,500	1,500	1,500	1,500
sub-total	19,000	19,000	19,000	19,000	19,000	19,000
<u>Planned</u>						
on beach ridges						
- Special Smallholding Development Schemes	-	-	-	1,500	4,500	7,500
- estates	-	-	2,000	4,000	6,000	8,000
inland areas						
- smallholdings	-	-	-	-	-	query
- estates	-	-	-	-	-	query
sub-total	-	-	2,000	5,500	10,500	15,500
total	19,000	19,000	21,000	24,500	29,500	34,500

- A continuous extension of FLDA Settlement Schemes from 7,200 acres in 1966 to 20,000 acres in 1990 by extending the ongoing schemes as much as possible.

3.3.5.2 Benefit/Cost Ratios

Rubber

As to the yields, rubber is fairly tolerant to differences in soils, climate and relief, and the projects are situated in areas which are more or less identical as far as these factors are concerned. Consequently also the costs involved in the cultivation of rubber will be more or less the same in these areas.

In calculating the B/C ratios of the identified rubber projects (see Table 3-14) it has, therefore, been assumed that there are no variations in benefits, and thus in yields, and in costs between the individual projects.

Only for rubber that might be planted on soils of a better quality - and which, therefore, are also suited to oil palm - have the yields been taken at a higher level. The costs relating to the latter projects are assumed to be equal to those involved in the identified ones.

The data on which the benefit and cost calculations for rubber projects have been based are given below.

- Establishment costs, including clearing :

year 1	M\$ 540 per acre
year 1½ - 6½	" 140 per acre a year
- Recurrent costs

year 7 - 32	" 100 per acre a year
-------------	-----------------------
- Agricultural labour costs have been included in the establishment costs and excluded from the recurrent costs.
- Project supervision costs have been included in both the establishment and the recurrent costs.
- The yields of dry rubber in lb per acre (future plantings):

. year as from planting	7	10	15	20	25	30
. plantings before 1985 on land also suitable for oil palm	650	1600	1800	1700	1600	1400
. plantings before 1985 on land only suited to rubber	600	1400	1500	1400	1300	1100
. plantings after 1985	yields 10-20 per cent higher than the afore-mentioned ones.					
- Average net sales price : M\$ 0.375 per lb.
- Cost of latex processing : M\$ 0.025 per lb.
- Net sales revenue : M\$ 0.350 per lb.

The benefits, costs and return to labour for rubber projects are given in Table 3-16 below.

Table 3-16 - Benefits, Costs and Return to Labour (M\$ per acre)

Present values (at a 10 per cent interest rate) as per starting year of project	Future plantings			
	before 1985		after 1985	
	a	b	a	b
- net sales revenue	2,730	2,275	3,170	2,615
- recurrent costs	520	520	520	520
- benefits	2,210	1,755	2,650	2,095
- costs of establishment	1,180	1,180	1,180	1,180
- return to labour	1,030	575	1,470	915
annual equivalent amount of return to labour	200	112	285	185
B/C ratio	1.87	1.49	2.25	1.78

a = on land also suitable for oil palm cultivation
b = on land only suitable for rubber

One labourer is able to manage approximately 6 acres of rubber and, with the aid of his family members, approximately 10 acres. From these 10 acres about 2 acres will be covered by non-productive and 8 acres by productive trees.

The return to labour per family will thus be in the order of M\$ 2,000 a year on lands also suitable for oil palm if high-yielding clones are available early in the planning period. Oil palm, however, offers a return of M\$ 2,500 to 3,000 in the beginning of the planning period*. Consequently the best lands have been allocated to oil palm instead of to rubber in the beginning of the planning period.

By 1985 a decision will have to be taken whether either oil palm or rubber should be grown on the lands that are suitable for the growing of both crops. If the assumption that the rubber prices after 1975 will remain constant proves to be correct these lands offer a return to family labour of M\$ 2,500 to 3,000 when rubber is grown. It should be noted that a family will be fully occupied with a plot of 10 acres and will have no opportunity of earning something from other activities.

* see Sub-section 3.3.4.2.

If, on the other hand, such lands were used for oil palm the return to family labour will be in the order of M\$ 2,100 to 2,500 to which additional earnings from activities other than oil palm cultivation are to be added.

It may be concluded from the foregoing that by 1985 rubber and oil palm will be competitive crops as far as good-quality land is concerned.

The decision as to whether a piece of land will be planted with rubber or with oil palm depends on the development of the yields and the prices.

Although in the development plan more attention is given to the extension of the rubber area than to that under oil palm after 1985, it is clear that this preference is not decisive and subject to revision if so required.

Coco-nut

The general considerations underlying the benefit-cost calculations of rubber projects are also applicable to the coco-nut projects. The basic data for the benefit and cost calculations as stated hereunder, therefore, need no explanation.

- Establishment costs (including clearing on beach ridges) :
 - . Year 1 M\$ 140 per acre
 - . Years 1.5/6.5 M\$ 55 per acre a year.
- Recurrent costs period 7-40 years : M\$ 50 per acre a year.
- Agricultural labour costs have been included in the establishment costs and excluded from the recurrent costs.
- Project supervision costs have been included in both the establishment and the recurrent costs.
- Yields

. years	7	10	15	20	25	30	etc.
. number of nuts per acre	1,000	2,750	4,500	4,000	3,500	3,000	
- Average net sales price per nut M\$ 0.05 (small nuts from local tall varieties).

The benefits, costs and return to labour for coco-nut projects are given in Table 3-17.

Table 3-17 - Benefits, Costs and Return to Labour

Present values at a 10 per cent interest rate as per starting year of project		
- net sales revenues) M\$ per acre	860
- recurrent costs		283
- benefits		577
- costs of establishment		362
Return to labour (M\$ per acre)		215
Annual equivalent amount of return to labour (M\$ per acre)		42
B/C ratio		1.6

The returns to labour per acre are low. A farmer's family specializing on coco-nuts, however, can handle 15 to 20 acres. Their income is therefore estimated to be of the order of M\$ 600 to M\$ 850.

The calculations have been based on plantings on beach ridges under strict project supervision. Yields on inland soils are better, but the costs of clearing may be higher there.

3.3.6 Miscellaneous Crops

3.3.6.1 General

The greater part of these crops are grown in the close proximity of the homesteads of the rural population, the dusun areas. Fruit trees constitute the most important crop but annual and semi-perennial crops are also grown, albeit to a much smaller extent. The latter are also grown outside the dusun. Of the total area under miscellaneous crops approximately 80-85 per cent was covered by dusun crops in 1966.

It is assumed that the acreage of dusun land to be allocated to the individual smallholders in the future will be in the order of 0.5 acre. This acreage has been purposely made smaller than that of the average dusun at present to promote a more intensified use of the dusun land.

The acreage of dusun land to be allocated to others than smallholders, e.g. to labourers on estates, has been fixed at 0.1 - 0.2 acre per family.

It is expected that in 1990 approximately 75 per cent of the total area under miscellaneous crops will be constituted by dusun land. The total acreage of planted dusun land will increase from 25,000 acres in 1966 to approximately 40,000 acres in 1990.

Maize and soy beans grown on rainfed sawahs in the off season have been excluded from the miscellaneous crops. It is expected that an increasing interest will be shown in the cultivation of these crops (see Table 3-22). The phasing of the development of areas under miscellaneous crops is given in Table 3-18.

3.3.6.2 Benefits and Costs for Annual Crops

Benefits and costs for various annual crops are given in Table 3-19. The estimated benefits are only rough averages since the yields, and thus the benefits, will vary from region to region as a consequence of the differences in climate and soils as well as of the differences in the timing of the developments. If in certain areas the development starts after 1966, the initial yields are likely to increase as a result of the introduction of high-yielding varieties whereas the time required to attain the ultimate yield levels will be shorter since the farmers will gradually familiarize themselves with the modern cultivation techniques. For the sake of comparison sawah padi has been included in Table 3-19.

To determine which of the various annual crops will be the most profitable to grow, the returns to labour per acre for these crops have been expressed in annual equivalent amounts for the period 1966/1990, using an interest rate of 10 per cent. This has also been done for the crops to be grown on heavy clay soils on which more agricultural research is required before they can be recommended for cultivation on a sizeable scale. It has been assumed that before 1975 the production of these crops (soy beans, cassava and groundnuts) will be negligible.

The return to labour per acre expressed in annual equivalent amounts for the annual crops are summarized in Table 3-20.

Table 3-20 - Return to Labour for Various Annual Crops

Crop	Annual equivalent amount (in M\$ per acre)
<u>on higher-lying terraces</u>	
- dryland padi (lowland)	85
- rainfed maize after dryland padi	100
- rainfed soy beans after dryland padi	80
- cassava*	85
- groundnuts after dryland padi or cassava	185
<u>on heavy clays</u>	
- sawah padi, main season	150
- sawah padi, off season	190
- soy beans after sawah padi	50
- maize after sawah padi	30

* yielding once every two years

Table 3-18 - Net Acreages under Miscellaneous Crops for the Reference Years during the Period
1966 - 1990

Type of Crop	1966	1970	1975	1980	1985	1990
<u>Annual and semi-perennial crops</u>						
- maize	1,500	2,000	2,000	2,000	2,000	2,000
- soy beans	query	query	query	500	500	1,000
- cassava	1,000	1,000	1,500	1,500	1,500	2,000
- sweet potatoes	1,000	1,000	1,000	1,000	1,500	1,500
- pineapple	2,500	2,750	3,000	3,250	3,500	4,000
- tobacco	750	1,000	1,250	1,500	1,750	2,000
- other crops	1,250	1,500	1,750	2,000	2,250	2,500
sub-total	8,000	9,250	10,500	11,750	13,000	15,000
<u>Tree crops</u>						
- cocoa	1,100	1,250	1,500	2,000	3,000	4,000
- banana	5,500	5,750	6,000	6,500	7,000	7,500
- durian	4,000	4,250	4,500	4,750	5,000	5,250
- rambutan	1,500	1,500	1,750	1,750	2,000	2,000
- citrus	1,000	1,500	2,000	2,500	3,000	4,000
- cashewnut	1,000	1,250	1,250	1,500	1,500	1,500
- arecanut	1,500	1,500	1,500	1,500	1,500	1,500
- nipah	5,200	5,500	6,000	6,500	7,000	7,500
- other crops						
sub-total	22,300	24,000	26,000	28,500	31,500	34,750
total	30,300	33,250	36,500	40,250	44,500	49,750

Table 3-19 - Benefits and Costs for Various Annual Crops

Type of crop	Units	1966	1975	1980	1985	1990
<u>Dry padi on higher-lying terraces</u>						
yields	gantang/acre	180	225	250	300	350
producer's price	M\$/gantang	0.50	0.55	0.55	0.60	0.60
G.P.V.	M\$/acre	90	124	138	180	210
farm costs	M\$/acre	20	44	53	70	80
N.P.V.*	M\$/acre	70	80	85	110	130
<u>Maize in rotation with dry padi on higher-lying terraces</u>						
yields	lb/acre	1,300	1,700	2,200	2,900	3,300
producer's price	M\$/lb	0.08	0.08	0.08	0.08	0.08
G.P.V.	M\$/acre	104	136	176	232	264
farm costs	M\$/acre	24	51	76	97	114
N.P.V.	M\$/acre	80	85	100	135	150
<u>Soy beans in rotation with dry padi on higher-lying terraces</u>						
yields	lb/acre	-	650	850	1,300	1,700
producer's price	M\$/lb	-	0.165	0.165	0.165	0.165
G.P.V.	M\$/acre	-	107	141	214	282
farm costs	M\$/acre	-	32	56	64	102
N.P.V.	M\$/acre	-	75	85	150	180
<u>Cassava on higher-lying terraces</u>						
yields fresh roots	tons/acre	-	7	10	14	16
producer's price	M\$/ton	-	33.3	33.3	33.3	33.3
G.P.V.	M\$/acre	-	233	333	467	533
farm costs	M\$/acre	-	93	123	152	183
N.P.V. every two years	M\$/acre	-	140	210	315	350
N.P.V. per year	M\$/acre	-	70	105	157	175
<u>Groundnuts on higher-lying terraces</u>						
yields - unshelled	lb/acre	-	1,600	1,800	2,200	2,500
producer's price	M\$/lb	-	0.19	0.19	0.19	0.19
G.P.V.	M\$/acre	-	304	342	418	475
farm costs	M\$/acre	-	54	77	103	125
N.P.V.	M\$/acre	-	250	265	315	350
<u>Sawah padi - main season</u>						
yields	gantang/acre	250	325	450	550	625
producer's price	M\$/gantang	0.50	0.55	0.55	0.60	0.60
G.P.V.	M\$/acre	125	179	248	330	375
farm costs	M\$/acre	28	40	62	91	122
N.P.V.	M\$/acre	97	139	186	239	253
<u>Sawah padi - off season</u>						
yields	gantang/acre	300	450	575	700	800
producer's price	M\$/gantang	0.50	0.55	0.55	0.60	0.60
G.P.V.	M\$/acre	150	248	316	420	480
farm costs	M\$/acre	35	56	71	105	130
N.P.V.	M\$/acre	115	192	245	315	350
<u>Soy beans in rotation with sawah padi on heavy clays</u>						
yields	lb/acre	-	500	700	900	1,200
producer's price	M\$/lb	-	0.165	0.165	0.165	0.165
G.P.V.	M\$/acre	-	83	116	149	198
farm costs	M\$/acre	-	38	52	69	85
N.P.V.	M\$/acre	-	45	64	80	113
<u>Maize in rotation with sawah padi on heavy clays</u>						
yields	lb/acre	-	1,400	1,650	2,000	2,200
producer's price	M\$/lb	-	0.08	0.08	0.08	0.08
G.P.V.	M\$/acre	-	112	132	160	176
farm costs	M\$/acre	-	77	90	106	114
N.P.V.	M\$/acre	-	35	42	54	62

* G.P.V. = Gross Production Value (costs exclude agricultural labour).

N.P.V. = Net Production Value.

The return to labour for crops grown on the higher-lying terraces will be between M\$ 135 and M\$ 145 per acre if smallholders gradually introduce the double cropping system of dryland padi and another crop, the latter only in part of the area (e.g. padi 100 per cent, other crop 70 per cent). This is well below the return of M\$ 250 which can be obtained if such land were used for large-scale oil palm production units.

Groundnuts are comparatively attractive, though the acreage which a farmer's family can handle, is limited because the crop is very labour-intensive. Especially in the harvesting period there is a peak demand for labour.

For the sake of completeness, also the return to labour per acre of sawah padi and of soy beans and maize as second crops after sawah padi have been mentioned. Yields and costs have been very much generalized and cannot be used for the priority ranking of projects without considerable adjustments. The mere purpose of presenting these figures is to show that it is most profitable to grow sawah padi instead of other annual crops on land that is intrinsically suited to the cultivation of these crops.

It should be borne in mind that from the return to labour the costs of land preparation (clearing, roads and drainage, etc.) have as yet to be deducted. These costs will be higher for the large-scale production units than for the smallholdings since clearing of the latter will be done by the smallholders themselves without the use of heavy equipment. The presence of stumps and slash adversely affecting the yields in the beginning has been accounted for in the yield projections.

3.4 Total Agricultural Area Planned for Development

The net acreages of land that will have been developed for agricultural production in the reference years during the period 1966-1990 are given in Table 3-21.

This table shows that the planned development will result in an increase in the total acreage of agricultural land of roughly 300,000 acres over the period 1966-1990. The expected intensified land use as a result of double cropping with padi has not been accounted for. Neither have the areas which apart from those specified may be developed in the period 1986-1990.

The system of double cropping will lead to an increase in the padi producing acreage of approximately 100 per cent by 1990. In 1966 the acreage cropped with padi (irrigated sawah padi, rain-fed sawah padi, dryland padi) amounted to some 70,000 acres of which roughly 55,000 acres were under sawah padi. In 1990 this acreage will have been extended geographically to about 100,000 acres of which roughly 85,000 acres under sawah padi. This means an increase of approximately 45 per cent. However, with the system of double cropping only part of the acreage cultivated

Table 3-21 - Net Acreages of Cultivable Land for the Reference Years during the Period 1966-1990

Crop	1966	1970	1975	1980	1985	1990
<u>Sawah padi</u>						
- irrigation projects *	9,500	16,700	29,400	39,300	48,100	48,100
- drainage (rainfed) projects *	6,800	6,800	6,800	9,000	14,800	17,700
- unspecified projects **	41,100	38,100	30,000	25,000	20,000	20,000
<u>Dryland padi</u>						
- lowland	10,000	10,000	12,500	12,500	15,000	15,000
- upland	5,000	5,000	4,000	4,000	3,000	3,000
<u>Oil palm</u>	10,500	54,000	115,000	175,000	235,000	247,000
<u>Rubber</u>	160,000	141,000	145,000	155,000	170,000	190,000
<u>Coco-nut</u>	19,000	19,000	21,000	24,500	29,500	34,500
<u>Other crops</u>	30,300	33,250	36,500	40,250	44,500	49,750
total	292,200	323,850	400,200	484,550	579,900	625,050
area occupied by smallholdings ***	239,200	251,650	265,200	291,550	338,400	371,550

* Net area leaving aside the intensity of cropping.

** Reduction from roughly 40,000 acres to 20,000 acres owing to conversion into project areas.

*** Excluding Fringe Alienation, Controlled Alienation and Block Newplanting Schemes (period 1970-1990).

in the main season will be used for padi growing in the off season resulting in a total acreage of padi producing land of some 140,000 acres a year in 1990. This means an increase of 100 per cent as compared to 1966 (see Table 3-22).

3.5 Employment

The phasing of the land development programmes has been adapted to the availability of male labourers. It is assumed that the number of male labourers available in 1966 amounted to 37,500, 90 per cent of whom were smallholders.

In 1990 this number will have increased to more than 70,000, of which approximately two-thirds will work on smallholdings. The distribution of the male labour force over the different agricultural production units and over time is given in Table 3-23. The total net acreages of smallholdings (Fringe Alienation Schemes, Controlled Alienation Schemes and Block Newplanting Schemes excluded) in the reference years mentioned in Table 3-21 will gradually increase from 239,200 acres (1966) to 371,500 acres (1990). Thus the average acreage tended per male labourer (= average acreage of a smallholding) will rise from 7.0 (1966) to 7.6 acres (1990).

This increase, especially after 1980, is mainly the result of allocating larger areas to smallholders in the Special Smallholding Development Projects. The acreages to be allocated to the smallholders of such Projects amount to 12, 8-10, 15-20 and 10 acres for oil palm, rubber, coco-nut and cocoa smallholdings respectively.

Apart from the slight increase in the average geographical acreage there will also be some growth in the crop producing acreage per smallholding as a result of a rise in cropping intensity. The average acreage of the smallholdings may increase from 7.1 in 1966 to ultimately 8.7 acres by 1990, not taking into account a more intensified cropping of the dusun area and the possible intercropping of young tree crop plantings.

3.6 Animal Husbandry

3.6.1 Introduction

The natural grazing assets of the State are rather limited and any sizeable development of the large ruminant population, therefore, will have to be based on the cultivation of fodder crops.

The climatological conditions and the presence of tick-borne diseases do not favour the introduction of highly productive temperate breeds of cattle. Even the upgrading of the local cattle by using exotic blood (e.g. Red Shindi) should be executed with great care.

Table 3-22 - Net Acreages of Padi Producing Land* for the Reference Years for the Period 1966-1990

Type of padi cultivation	1966	1970	1975	1980	1985	1990
<u>Sawah padi</u>						
<u>irrigated</u> (double cropping)						
main season	8,000	15,100	27,000	35,850	43,450	44,400
off season	2,500	5,700	19,500	28,050	33,850	37,250
<u>rained</u>						
drainage projects, main season	5,900	5,900	5,900	8,100	10,500	16,800
unspecified projects, main season	41,100	38,100	30,000	25,000	20,000	20,000
maize , off season	-	-	500	1,000	2,000	3,000
soy beans **, off season	-	-	1,000	2,000	3,000	4,000
<u>Dryland padi</u>						
lowland	10,000	10,000	12,500	12,500	15,000	15,000
upland	5,000	5,000	4,000	4,000	3,000	3,000
total	72,500	79,800	100,400	116,500	130,800	143,450

* The intensity of cropping has been taken into account.

** To be grown in planned and unspecified projects after the main season padi.

Table 3-23 - Male Labour Force in Agriculture (in numbers)

Classification of agricultural holdings	Reference years					
	1966	1970	1975	1980	1985	1990
<u>Estates</u>						
- oil palm *	1,000	4,500	9,500	14,000	17,500	18,000
- rubber	2,400	2,200	2,000	2,000	2,750	3,500
- coco-nut	P.m.	P.m.	150	250	350	450
- cocoa	100	100	150	150	200	200
sub-total	3,500	6,800	11,800	16,400	20,800	22,150
<u>Smallholdings</u>						
	34,000	36,200	37,200	41,100	45,700	48,850
total	37,500	43,000	49,000	57,500	66,500	71,000

* Including FLDA-Schemes.

The current market price of M\$ 1.60 per kattie boneless beef is marginal for commercial beef production on cultivated fodders with its inherent high production costs.

Milk production from cultivated fodder crops could be profitable but only on a very small scale, since the demand for fresh milk is very small.

The mechanized cultivation of padi fields is only practised on a small scale at present. However, there will be a change-over from animal traction to tractors. The grazing resources constituted by off season padi fields will decline as a result of double cropping. This together with the increased mechanization will result in a reduction of the number of work animals.

The availability of food grains and fish proteins could support a large-scale production of pork but further development will depend on the increase in the Chinese population.

3.6.2 Proposals for Development

Although the scope for development of animal production remains limited in view of the constraints mentioned above, there are a number of possibilities which merit attention. These are :

- commercial broiler and egg production
- commercial beef production
- small-scale backyard pig production.

3.6.2.1 Broiler Production

An increase in the output of chicken meat can be achieved by the establishment of broiler farms.

Based on the assumption that the annual meat production of some 30,000 broilers can be sold in the urban areas of Trengganu, the profitability of the set up of 10 broiler farms, supervised by one manager, has been studied. With an interest rate of 10 per cent on capital to be invested and using 1967-prices, costs and benefits have been computed for a broiler farm feeding a batch of 1,000 one-day old chicken to broilers in 4 months and producing 3 batches annually.

The following summary of costs and benefits can be given:

- Capital costs expressed in annual equivalent amounts at a 10 per cent rate of discount	M\$ 250
- Annual recurrent costs (management, labour, purchase of chicken, feeding of chicken, drugs, interest on working capital, miscellaneous costs)	M\$ 11,750
- Benefits (950 broilers per batch with live weight of 3.5 kattie per head at a producers' price of M\$ 1.25 per kattie live weight; some manure production)	M\$ 12,700

As appears from the above summary the annual profit will be in the order of M\$ 700 per farm only, so the profitability is marginal. The sensitivity to changes e.g. in live weight or in price per kattie live weight is great.

In view of the fact that the investment costs (M\$ 2,000 per farm) are low and almost no financial risk is involved it seems, however, justified to make a start with the establishment of 10 farms.

3.6.2.2 Egg Production

In commercial egg production one-day old chicken will be used and raised over a period of 16 months. The egg production (from 4-16 months) will be in the order of 235 eggs (laying percentage 65). A production unit of three batches of 1,000 chicken will then yield a total of 600,000 eggs annually. For such a unit a manager and three labourers will be required.

In the following a summary is given of the costs involved in and the benefits to be obtained from the installation and management of a unit of the type as indicated above:

- capital costs expressed in annual equivalent amounts at a 10 per cent rate of discount	M\$ 1,500
- annual recurrent costs (management, labour, purchase of chicken, feeding of chicken, drugs, miscellaneous costs)	M\$ 59,000
- benefits (600,000 eggs at M\$ 0.10 per egg; (salable hens; some manure)	M\$ 69,000

The annual net profit will be in the order of M\$ 8,500 and so the enterprise is a profitable one. The sensitivity of the profitability to changes in the price of eggs is, however, large.

To avoid marketing problems a start should be made with only one unit. Should this one unit prove to be successful and marketing outlets be secured, the establishment of another unit might be considered. Since one manager should be able to handle up to three units, the profitability will become even greater.

A third way to promote poultry production is the improvement of the standard of chicken farming in the kampong. If more attention is given to housing and feeding of the chicken and to control of diseases, an increase in the farmers' income can be achieved.

A flock of 30 laying hens may produce about 1,200 eggs a year (1,350 minus a loss of roughly 10 per cent). For replacement of the hens every two years, a reservation of 60 hatching eggs a year (producing 20 pullets and 20 cockerels) will suffice to cover losses (20 eggs, 5 pullets and 2 cockerels) and ensure the annual requirement of 15 pullets.

The costs and benefits may be summarized as follows :

- costs (housing, drugs and equipment, feeding, replacement)	M\$ 160
- benefits (1,140 eggs at M\$ 0.10; selling of 18 cockerels and 15 hens)	M\$ 180

The cost of feedstuff such as padi, bran, maize and fish meal is an important item and has been estimated at M\$ 140. This amount can easily be lowered by using edible household refuse.

3.6.2.3 Beef Production

In view of an expected rise in the demand for meat the establishment of farms for fattening of buffaloes and cattle might be of importance. Yearling male buffaloes and cattle, to be purchased from the local farmers, should be stable-fattened on fodder crops during a period of one year. The increase in weight is expected to be 400 lb for male buffaloes and 325 lb for cattle. It is assumed that 800 buffaloes or 1,000 cattle can be fattened on a farm of 440 acres of fodder crops and that such a farm can be run by one manager and 20 labourers.

Land of good quality should be selected. It should be completely cleared from trees and shrubs, fenced and planted with fodder crops. Each year 25 per cent of the land will have to be replanted in order to keep the area productive. The production of green fodder should be 30 ton per acre a year to meet a consumption of 12 ton per cattle bull or 15 ton per male buffalo.

A summary of the costs of and the benefits from the fattening of 800 buffaloes is given below, assuming that the rate of interest on capital to be invested is 10 per cent:

- capital costs expressed in annual equivalent amounts at a 10 per cent rate of discount (clearing, fencing, land preparation, seeding or planting, feedlots, sheds, office, 4 tractors, landrover, additional equipment)	M\$ 29,000
- annual recurrent costs (manager, labourers, drivers, purchase of buffaloes, veterinary case, fertilizers, fuel land spares, tractors, etc., contingencies, interest on working capital)	M\$ 225,000
- benefits (760 buffaloes at M\$ 320, some manure)	M\$ 257,000

It is clear that buffalo fattening is of marginal profitability.

The outcome for cattle fattening is even worse (loss of M\$ 20,000). This marginal profitability is the result of the present low meat prices. The break-even price for buffaloes and cattle (benefits minus costs equalling zero at a 10 per cent interest rate on the capital invested) lies at respectively M\$ 316 and M\$ 233.

The conclusion therefore is that a start with the implementation of one or two fattening farms should be only made if

the sales price is well above the break-even price.

As the animals will have to be bought from local farmers, the number of fattening farms will depend on the availability of yearlings. The annual production of male buffalo calves in the State is estimated at 2,300 and of male cattle calves at 4,300 head.

In view of the limited availability of buffaloes fattening should not be started on more than two farms, one in Besut with e.g. 600 buffaloes and 250 cattle and a similar farm near Kuala Trengganu.

3.6.2.4 Small-scale Pig Production

To determine whether small-scale pig farming is economically feasible an analysis has been made of a unit of 10 breeding sows and one stud boar. The following assumptions have been made:

- The initial purchase of breeding stock consists of 10 gilts and 1 boar.
- The breeding sows farrow twice a year (for the first time when 1 year old) producing 16 piglets of which 14 will be weaned.
- For replacement of the breeding stock 1 out of 4 pigs has to be reserved for replacement of the sows and 1 out of 40 for replacement of the boar.
- The lifespan of the breeding stock is 4 years.
- Feeds are locally purchased.
- Replacement of stud boars, with a view to avoid inbreeding, is arranged in co-operation with neighbouring farmers.

A summary of costs and benefits is given below:

- capital costs expressed in annual equivalent amounts at a 10 per cent rate of discount (shed, purchase of breeding stock)	M\$ 400
- annual recurrent costs (labour, feeding expenses, miscellaneous costs, interest on working capital)	M\$ 12,710
- benefits (137 fatteners at M\$ 120, discarded sows and boars)	M\$ 16,500

As with the previous analysis the interest rate on capital to be invested has been fixed at 10 per cent. The annual net profit will be in the order of M\$ 3,000 - M\$ 3,500, so the enterprise is highly profitable and should be stimulated in locations suitable for the purpose.

3.6.3 Recommendations for Further Action

To improve the livestock production a number of recommendations for further action are given below :

- stimulation of commercial egg and broiler production
- support of the development of small-scale backyard pig farming
- research of fodder production (fodder grasses like Elephant-,

Guatemala-, Signal-, Pangola-, Para-, Sudan and Echinochloa grass; legumes like Stylosanthes, Pueraria and Centrosema) on different types of soil by establishing trial fields. Emphasis should be laid on the research on the fodder production on shallow and medium deep peat soils.

- introduction of artificial insemination, combined with the castration of scrub bulls, in areas with a dense cattle or buffalo population
- control of the export for slaughter of good quality male and female stock so as to preserve valuable breeding material within the State
- improvement of the present slaughter house facilities enabling the processing of animal by-products.

In general, the efficiency of the livestock production by the small-scale farmer can be greatly improved. The Veterinary Department is already putting great efforts in the development of this sector.

3.6.4 Contribution to the Economy

It is expected that per small-scale farmer the income derived from animal husbandry will more or less double during the next 25 years. Taking into account the increase in the number of small-scale farmers, the total contribution of livestock to the economy will be roughly three times as high as at present.

In Table 3-24 the GVA for the various reference years has been given.

Table 3-24 - Gross Value Added in Livestock Production
(in M\$ million)

	1966	1970	1975	1980	1985	1990
Gross Production Value	2.2	2.8	3.3	4.4	5.5	7.0
Costs of materials and services	0.2	0.3	0.3	0.4	0.5	0.5
Gross Value Added	2.0	2.5	3.0	4.0	5.0	6.5

3.6.5 Veterinary Services

To maintain the present level of services which is satisfactory, an increase of the veterinary staff with 2-3 experts on fodder production and poultry is recommended.

It is further assumed that, taking into account the new organizational set-up as brought forward in Section 4 of Annex IX (Demography, Social and Administrative Services) 8-10 Veterinary Assistants (graduates from a two-year course) will be required. It has been estimated that the present budget of M\$ 440,000 will increase to M\$ 730,000 (of which M\$ 480,000 to be provided by the State and M\$ 250,000 by the Federation) in 1990.

4 VOLUMES AND VALUES OF PRODUCTION

4.1 Volumes of Production

The volumes of production of the crops can be readily determined by multiplying the projected acreages intended for the growing of the different crops with the projected acre-yields for these crops.

The acreages intended for the cultivation of the major crops have been specified in the Sub-sections 3-3 (Tables 3-9, 3-14, 3-15, 3-20) and 3-4 (Table 3-24) for the various reference years.

The projections for acre-yields are dealt with in this Section. It is more difficult to determine the future acre-yields than the acreages since the yields depend on a number of interacting factors and thus they may differ widely from place to place.

4.1.1 Padi

Table 2-2 shows the projected average yields of the different types of padi for the various reference years. In the yield projections for sawah padi possible reductions as a result of bad drainage conditions and of crop failures resulting from the flooding of the padi land have been accounted for.

The yield projections have been adapted to the geographical situation of the projects they refer to, both in the case of irrigation projects and drainage projects. The acre-yields projected show an increasing trend but this trend is less conspicuous for projects in the South of Trengganu than for those in the North. For, the suitability of the land for the cultivation of sawah padi decreases from North to South whilst the interest in, the knowledge of and the experience with the growing of padi on sawahs decreases in this direction as well. These facts, in turn, will cause the irrigation and drainage projects in the South to be implemented later and the acre-yields to be temporarily lower than in the North where the running-in period of the project is over (see also Sub-section 3.3.3).

By multiplying the relevant yields per acre with the areas intended for padi cultivation, the volumes of production are calculated and are arranged per type of cultivation and per reference year in Table 4-1.

According to the projections made, the average production of dry padi per caput per annum will increase from less than 50 gantang in 1966 to more than 100 gantang in 1985 and to about 110 gantang in 1990.

To satisfy the demand for rice in Trengganu in the period 1985-1990 a quantity of 100 gantangs of dry padi per caput will be sufficient even when the higher standard of living is taken into account as well as the losses to occur in storage and food preparation.

Table 4-1 - Padi Production for the Reference Years in the Period 1966 - 1990

Type of padi cultivation		Production of dry padi in gantang x 1,000							
		1966	1970	1975	1980	1985	1990		
sawah	irrigated								
	irrigation projects	5,300	6,380	10,100	16,255	22,575	26,350		
	main season								
	off season	750	1,890	9,945	16,670	23,170	28,620		
rainfed	drainage projects	1,475	1,620	1,770	3,240	4,725	8,220		
	main season								
	other projects	6,975	8,250	9,000	8,750	8,000	9,000		
dryland	lowland	1,800	2,000	2,815	3,125	4,500	5,250		
	main season								
	upland	800	875	800	900	750	825		
total		17,100	21,015	34,430	48,940	63,720	78,265		

4.1.2 Oil Palm

In contrast to the calculations of the volumes of production of padi those made for oil palm have been based on one specific acre-yield per reference year. A sliding scale of production averages according to differing regional circumstances has not been made use of for the following reasons:

- It is not quite possible to predict to which extent the acre-yields will be influenced by such items as managerial skill, financing and kind of production unit (private enterprise, FLDA-Schemes, SEDC-Schemes, etc.).
- It is not unlikely that in the future several estates will be established at the same time irrespective of the differing outcomes of their benefit/cost ratios. Moreover, if situated within a relatively small area the various estates to be developed might be merged, to bring about economics of scale. In view of this there is no necessity to determine specific acre-yields for each project to arrive at a total production volume.

The production volumes of oil palm calculated for the different reference years have been based on an average peak-yield of 8.8 tons of F.F.B. per acre.

In determining the corresponding volumes of production of palm oil the oil content has been assumed to be 20 per cent of the bunch weight. The productions of fresh fruit bunches (F.F.B.), palm oil and palm kernels for the different reference years in the period 1966-1990 are given in Table 4-2.

Table 4-2 - Oil Palm Production for the Reference Years in the Period 1966-1990 (in tons*)

Produce	1966	1970	1975	1980	1985**	1990**
fruit bunches	-	58,250	430,150	951,450	1,414,500	1,787,800
palm oil	-	9,580	76,515	181,050	273,660	348,725
palm kernels	-	2,335	17,225	38,010	56,510	71,625

* 1 ton = 1,016 kg.

** as from 1980 the oil content is assumed to increase to 22 per cent of the bunch weight.

In Table 2-7 information on the production of oil palm with increasing age is given.

4.1.3 Production Volumes of Rubber

To determine the production volumes of rubber the acre-yield projections have to be differentiated according to the age of the plantings since the production capacity of the rubber trees varies with their age. Moreover, the type of production unit (estate,

smallholding, etc.) has to be taken into account since the tending of the plantings at any age will greatly determine the yields to be obtained in future years.

It, therefore, stands to reason that the acre-yield projections for identically aged plantings established in the past and still to be established should differ.

For already established plantings the acre-yields are thought to increase only very modestly. Nearly 50 per cent of these plantings are constituted by trees which are not yet in production (Fringe Alienation Schemes, Controlled Alienation Schemes and Block Newplanting Schemes excluded), whilst possible replantings of the producing trees will result in a temporary drop of the acre-yields since a number of years will elapse before these replantings come into production.

In projecting the acre-yields for new rubber plantings the differences in production between 'independent' smallholdings and those which are controlled by the management of the estates (Special Smallholding Development Projects) have been accounted for. The acre-yields to be obtained in the year of peak production (15th year after planting) from independent rubber smallholdings which will be established after 1970 are thought to average 1,100 lbs of dry rubber per acre. An average acre-yield of 1,500 lb is expected from Special Smallholding Development Projects (management-controlled) laid out on soils which are exclusively suited to rubber. On soils that are also suitable for the growing of oil palm, rubber productions of 1,800 lb per acre should be feasible (see also Table 2-9). Peak acre-yields to be obtained from plantings established after 1980 are expected to be 10-20 per cent higher owing to the progress made in breeding.

No data were available to allow the determination of the acreages occupied by replantings of unselected clonal material and by plantings of selected material established on new land in the recent past. To arrive at the total volumes of production to be obtained from replanted and newly planted rubber the acreages of the types of plantings mentioned are included in the total acreages of new plantings to be established. The acre-yields projected for the latter plantings have been adjusted to account for the intrinsically lower yields to be obtained from plantings of unselected material.

By multiplying the acreages occupied by the different types of production units with the relevant acre-yields projected the total volumes of production for the various reference years have been calculated (see Table 4-3).

4.1.4 Coco-nut

For coco-nut plantings, too, a distinction had to be made between producing plantations and those to be established in the future. In determining the future acre-yields for the plantings in production, the conditions prevalent in the past have been taken into account.

Table 4-3 - Rubber Production for the Reference Years in the Period 1966-1990

Type of production unit	Production of dry rubber in lb x 1,000					
	1966	1970	1975	1980	1985	1990
<u>Smallholdings</u>						
- established plantings of unselected material	17,500	14,000	10,500	3,500	-	-
- replantings of selected material	3,850	9,750	17,500	26,250	40,000	54,000
- established and future plantings on new land	2,800	10,000	20,250	20,250	25,000	30,250
sub-total	24,150	33,750	48,250	50,000	65,000	84,250
<u>FLDA-Schemes</u>	800	2,700	8,000	14,300	21,600	28,600
<u>Special Smallholding Development Projects</u>	-	-	-	-	-	-
<u>Estates</u>						
- established plantings of unselected material	4,850	3,500	2,500	1,250	-	-
- replantings of selected material	3,000	5,500	9,000	11,700	16,100	18,750
- established and future plantings on new land	-	-	-	-	-	3,000
sub-total	7,850	9,000	11,500	12,950	16,100	21,750
total	32,800	45,450	67,750	77,250	102,700	134,600

Somewhat higher acre-yields than obtained at present have been projected for coco-nut smallholdings to be replanted. The highest yields have been projected for plantings on future estates and Special Smallholding Development Projects.

In Table 2-11 the projected acre-yields for the various types of production units are given per reference year.

The age-class distribution of the established coco-nut plantings and the acreages occupied per age-class are not exactly known. Therefore, the acre-yields of the established plantings have been projected similarly for all reference years.

For the present smallholdings replanting at a rate of 50 acres a year between 1971 and 1990 has been projected.

Because of the poor condition of the estate plantings about two-thirds of the acreage are considered ready for gradual replanting after 1970. The remaining one-third has as yet to come into production.

The volumes of production for coco-nut are given in Table 4-4.

4. 1.5 Miscellaneous Crops

For cocoa, maize and soy beans the projected acre-yields have been mentioned in the Tables 2-3, 2-4 and 2-13. Based on the relevant figures the volumes of production for the various reference years are as follows (Table 4-5).

Table 4-5 - Production Volumes of Cocoa, Maize and Soy Beans for the Reference Years in the Period 1966-1990 (in lb x 1,000)

Crop	1966	1970	1975	1980	1985	1990
cocoa	550	625	900	1,200	1,800	2,400
maize	1,950	3,000	4,100	6,050	9,800	13,200
soy beans	-	-	500	1,625	3,350	6,500

The production volumes of other crops under the heading miscellaneous have been approximated as well as possible by taking the acre-yields of fruit and vegetable experiment stations as a basis.

In view of the different ages of the fruit plantings and because part of the production of fruits and vegetables will not be sold or consumed these acre-yields have been reduced.

The figures thus obtained have been compared with the relevant farm survey data collected in 1967. As a result the combined production of fruits and vegetables has been arbitrarily fixed on 100-125 lb per caput per year for 1966. This equals an acre-yield of approximately 0.5-1.0 ton.

Table 4-4 - Coco-nut Production for the Reference Years in the Period 1966-1990

Type of production unit	Production of nuts					
	1966	1970	1975	1980	1985	1990
Smallholdings						
- established plantings of unselected material	21,600,000	22,275,000	23,287,500	22,950,000	22,612,500	22,275,000
- replantings of selected material	-	-	-	168,750	540,000	1,023,750
Estates						
- established plantings of unselected material	-	600,000	675,000	750,000	750,000	750,000
- replantings of selected material	-	-	-	450,000	1,800,000	3,000,000
Special Smallholding Development Projects						
- smallholdings	-	-	-	-	1,350,000	5,400,000
- estates	-	-	-	1,800,000	7,200,000	15,600,000
total of nuts	21,600,000	22,875,000	23,962,500	26,118,750	34,252,500	48,048,750

4.2 Value of Production

4.2.1 Prices of Agricultural Products

In order to compute the gross value of crop production for 1966 and other reference years a projection of the prices of the agricultural products has been made. A summary is given in Table 4-6.

The prices of padi are ex-farm gate. Those for padi grown on irrigation and drainage projects are expected to increase at a higher rate than those of dry land padi. The comparatively large surplus production from the project areas will in all likelihood be milled in model plants and the rice produced by such mills will obtain a premium on the market because of its better appearance compared to rice from less well-equipped mills.

For padi grown outside the project areas the increase in price will be in general lower. For the places of production are more scattered and more isolated, the marketable surpluses are small and consequently the model mills will not be able to operate efficiently. In these areas poorly equipped mills will continue to operate and the low-quality rice produced will be mostly used for own consumption by the farmer and his family or for sale in the near vicinity.

The prices of palm oil and kernels are ex-factory and include export duties. To arrive at the ex-factory price one has to deduct from the f.o.b. prices ocean port (Singapore):

M\$ 18 per ton for handling and bulking in Singapore;
 M\$ 13 for shipment from Trengganu to Singapore;
 M\$ 4 for handling and bulking in Trengganu and
 M\$ 5 for transport from the plantation to the bulking station at the coast, or

M\$ 40 per ton in total

The shipping charges to Port Swettenham are about M\$ 3.50 higher. It has been assumed, however, that the net value added in shipping to and in handling and storage of the oil in Port Swettenham would more than compensate for the loss in savings and that therefore shipping to Port Swettenham will be more attractive from a macro-economic point of view.

Export duties are 7.5 per cent of the f.o.b. value Trengganu harbour.

The producers prices for good-quality dry rubber are estimated to fall approximately 25 per cent between 1966 and 1975 as a result of a further weakening of the world market position of natural rubber. The differences between the prices obtained by the individual smallholders and those fetched by the development schemes and estates are assumed to decrease as a result of improvements in processing and handling of the latex by the first-mentioned.

The amount of scrap to be produced by smallholders is assumed to decrease considerably. Apportioned to each pound of dry rubber sold the scrap will contribute only one cent to the price

to be obtained per pound in the period 1966-1975 as against five cents in the past. For the development schemes and the estates this contribution will be in the order of 0.5 and 2.5 cents per pound of dry rubber respectively.

4.2.2 Gross Value Added

To determine the contribution of the agricultural sector to the economy of the State its value of production should be expressed in terms of Gross Value Added (GVA).

The GVA is the sum total of wages and salaries, gross profits (including depreciation of fixed assets), interest on own capital, and all other forms of income that accrue from productive activities in any one year. According to the rules of national accounting, a distinction should be made between the productive activities in the agricultural sector proper (crop establishment, cultivation, harvesting) and those in the agro-industrial sector (processing of latex, extraction of palm oil). Therefore, the total costs of processing have been deducted in those cases where the ex-farm prices include processing costs, i.e. for oil palm and rubber.

For completeness sake the GVA in processing of latex and oil palm products have been presented separately.

Though the farm price of padi does not include an allowance for the cost of milling and therefore nothing had to be deducted from the gross value of production in the agricultural sector, the GVA of padi milling has been included in order to show the influence of crop production on the State's industrial sector.

For a running production the GVA is often approximated by deducting from the annual gross value of production the recurrent costs of the materials used and of the services rendered by parties outside the sector (e.g. insurance and construction). When this method is used some difficulties may arise as in the case of perennial crops, for which the period of crop establishment covers several years. The expenditure incurred in some year of crop establishment does not produce a gross production value until after a few years. In other words, during the years without production, recurrent expenditure is made which produces capital goods. This investment (or capital formation) can be in turn broken down in the recurrent costs of materials and services and in a GVA; the latter, however, without profits since these can be only realized once the plantation comes into production.

Where possible and significant, the figures for the agricultural sector have been broken down in gross production values and the GVA of the running production on the one hand and in the gross capital formation and the GVA during the establishment* period on the other. This has been done for the crops oil palm and rubber. For coco-nut and 'other crops', the capital formation on an annual basis is insignificant and has therefore been neglected.

* either initial or replanting.

Table 4-6 - Prices of Agricultural Products (in M\$)

Product	1966	1970	1975	1980	1985	1990
<u>Padi</u> (per gantang)						
<u>sawah cultivation</u>						
irrigation projects	0.50	0.55	0.60	0.65	0.65	0.65
drainage projects	0.50	0.55	0.60	0.65	0.65	0.65
rained, main season	0.50	0.55	0.55	0.60	0.60	0.65
'alor'-cultivated, off season	0.50	0.55	0.55	0.55	0.60	0.60
<u>dry land cultivation</u>						
lowland	0.50	0.55	0.55	0.55	0.60	0.60
upland	0.50	0.55	0.55	0.55	0.60	0.60
<u>Palm oil</u> * (per ton ex-factory)	-	520	480	455	430	415
<u>Palm kernels</u> (per ton ex-factory)	-	315	290	275	260	250
<u>Dry rubber</u> ** (p.lb)						
smallholdings	0.475	0.40	0.35	0.35	0.35	0.35
Special Small-holding Development Projects	0.525	0.375	0.375	0.375	0.375	0.375
estates	0.525	0.45	0.375	0.375	0.375	0.375
<u>Coco-nut</u> (per nut)						
<u>big nuts</u>						
smallholdings	0.09	0.08	0.075	0.075	0.07	0.07
<u>small nuts</u>						
Special Small-holding Development Projects	0.07	0.06	0.055	0.055	0.05	0.05
estates	0.07	0.06	0.055	0.055	0.05	0.05
shelled maize (per picul)	12.00	11.00	11.00	11.00	11.00	11.00
soy beans (per picul)	22.00	22.00	22.00	22.00	22.00	22.00
fresh cassava roots (p.picul)	2.00	2.00	2.00	2.00	2.00	2.00

* including export duties on oil and kernels.

** including cost of latex processing and 4.5 cents replanting cess and 1.5 cents export duties per lb.

Though capital formation in irrigation and drainage projects in fact fall under the agricultural sector, according to the system of national accounting the GVA-part of it must be allocated to the construction sector instead of to the agricultural sector. To a certain extent the same applies to the construction activities with regard to houses, roads, drainage, etc. in the sub-sectors oil palm and rubber in so far as the work is done by construction labour.

However, since an important part of these activities is done by the agricultural labour force itself and hence is difficult to separate, all the relevant GVA's have been considered to belong to the agricultural sector proper.

An exception has been made for the establishment costs of palm oil factories as these costs can be regarded as capital formation in the industrial sector; its GVA component, therefore, is to be allocated to the construction sector.

For padi, oil palm, rubber and coco-nut separate calculations have been made for each type of development unit. Other crops have been dealt with as one group. The results of the calculations of the GVA of crop and livestock production and of agricultural processing are given in the Tables 4-7 and 4-8.

The estimated contribution of crop and livestock production - processing and marketing excluded - to the economy of the State will increase from roughly M\$ 32 million in 1966 to roughly M\$ 173 million by 1990 which means an average annual growth of 6.7 per cent. This growth is not constant; for the period 1967-1970 it has been calculated to be 8 per cent, for 1971-1975 nearly 10 per cent, for 1976-1980 8 per cent, for 1981-1985 5 per cent and for 1986-1990 3 per cent.

The growth rate might, however, turn out to be higher in the last-mentioned period, since under the planned development the land resources will not have been utilized to their fullest extent.

The GVA per male labourer will increase from about M\$ 840 in 1966 to M\$ 2,450 by 1990. The trend is as follows: for 1966, M\$ 840; for 1970, M\$ 1,100; for 1975, M\$ 1,500; for 1980, M\$ 2,000; for 1985, M\$ 2,300 and for 1990, M\$ 2,450.

In the amounts mentioned in the Tables 4-7 and 4-8 the contribution of female and non-adult labour has been accounted for.

It is to be expected that this contribution will decrease over time, because the standard of living will rise whilst there will be less need for female labour on the oil palm plantations.

Table 4-7 - Gross Value Added in Crop and Livestock Production
(M\$ million)

Type of production		1966	1970	1975	1980	1985	1990
padi	1	8.6	11.6	20.0	31.0	40.8	50.1
	2	1.9	2.7	4.8	8.1	11.8	16.5
	3	6.7	8.9	15.2	22.9	29.0	33.6
coco-nut	1	1.9	1.8	1.8	1.9	2.2	2.8
	2	-	-	0.2	0.4	0.7	0.8
	3	1.9	1.8	1.6	1.5	1.5	2.0
oil palm	1	0.0	4.4	31.1	68.4	96.1	116.3
	4	4.0	16.4	18.4	18.4	18.4	1.7
	3	4.0	20.8	49.5	86.8	114.5	118.0
rubber	2	1.9	7.7	17.2	25.1	32.5	32.2
	3	2.1	13.1	32.3	61.7	82.0	85.8
	1	13.0	14.7	17.7	20.2	26.6	34.9
other crops	4	6.2	4.4	3.8	5.9	6.2	7.1
	2	19.2	19.1	21.5	26.1	32.8	42.0
	3	2.8	2.5	3.3	4.9	6.5	8.4
livestock	3	16.4	16.6	18.2	21.2	26.3	33.6
	1	3.0	3.5	4.8	7.0	10.0	14.0
	2	0.5	0.5	0.8	1.2	2.0	3.0
grand total	3	2.5	3.0	4.0	5.8	8.0	11.0
	3	2.0	2.5	3.0	4.0	5.0	6.5
	31.6	45.9	74.3	117.1	151.8	172.5	

- 1 = Gross Production Value
2 = Cost of materials and services
3 = Gross Value Added
4 = Capital formation

Table 4-8 - Gross Value Added in Processing Oil Palm, Rubber and Padi (M\$ million)

Type of processing		1966	1970	1975	1980	1985	1990
oil palm	1	-	1.3	10.7	24.3	36.2	45.6
	2	-	0.2	1.5	3.6	5.5	7.0
	3	-	1.1	9.2	20.7	30.7	38.6
rubber	1	1.1	1.4	2.4	2.9	4.2	5.5
	2	0.4	0.6	1.0	1.3	2.1	2.8
	3	0.7	0.8	1.4	1.6	2.1	2.7
padi milling	3	0.8	1.0	1.7	2.4	3.2	3.9

- 1 = Gross Production Value
 2 = Costs of materials and services
 3 = Gross Value Added

5 AGRICULTURAL RESEARCH

5.1 Introduction

To promote the development and the diversification of Malaysia's agricultural production sound and progressive research and extension are of paramount importance. So far, intensive research has been carried out on rubber, oilpalm and sawah padi and, to a smaller extent, on pine-apples.

The results obtained have substantially contributed to the realization of higher yields. Unfortunately the research on crops other than those mentioned has been practically neglected as a result of lack of interest, of shortage of staff and of problems in financing and organization. For these crops the results achieved so far are poor.

The research on rubber is conducted by the Rubber Research Institute in Kuala Lumpur and that on pine-apples by the Pine-apple Industry Board in Johore. The research on all other crops is the responsibility of the Department of Agriculture. As the research on oilpalm was not given much attention by this Department lately, the research work on this crop was undertaken by the estate agencies themselves.

In view of the current strong expansion of the cultivation of oilpalm and its bright prospects the Department of Agriculture decided to revive its interest in the research on this crop recently.

To concentrate the activities in the field of agricultural research by both government and private agencies in one autonomous organization, the establishment of a Research and Development Institute (MARDI) was given consideration by the Malaysian Government. This organization should be also given the responsibility to familiarize the small-holders and the estates with the results obtained in research by an effective extension.

5.2 Agricultural Research Programmes

The improvement and expansion of agriculture in the State of Trengganu will greatly depend on the activities of the extension services of the Rubber Replanting Board, the Rubber Research Institute and the State Agricultural Department. These bodies should pass information obtained from the experimental station where the research on the crop concerned is carried out to the small-holders and the estates. The research on the major crops grown in Trengganu such as rubber, padi, oilpalm and coconut is practically entirely conducted at experimental stations outside the State. Thus, for information on padi Trengganu has to rely on the P. E. S. 'Lundang' in Kelantan, for information on rubber on the Rubber Research Institute in Kuala Lumpur, for information on oilpalm on the estate-sponsored research on the West Coast and on the F. E. S. 'Serdang' and for information on coconut on the F. E. S.

'Sungei Baging' in Pahang.

In Trengganu itself the F.E.S. 'Jerangau' has been established for the research on cocoa and oilpalm. Understaffing, transfer of staff and the lack of a long-term programme are as many reasons why the results achieved so far are scarce.

Apart from the Federal Experimental Station there are two agricultural experiment stations in Trengganu, one at Ajil and one at Ajer Puteh, both for the purpose of demonstration and propagation.

Near Kuala Trengganu there is a small sub-station of the P.E.S. 'Lundang' where variety trials and fertilizer trials with sawah padi are replicated.

Trengganu's agricultural development potential will be determined by oilpalm, rubber and padi. The improvement of these crops will largely contribute to the ultimate agricultural production in the State. Research on these crops, therefore, is of paramount importance.

With the available information from the Rubber Research Institute on planting material and cultivation practices, it must be possible to raise the rubber yields substantially, provided a good extension service is available.

No additional experiments in this field are required in Trengganu.

The research on oilpalm is also well-advanced particularly owing to the recent activities in the private sector. As the Department of Agriculture is showing a revived interest in this crop, research will be further continued and even extended. Only subjects that specifically relate to the East Coast should be studied in Trengganu.

So far all oil palm experiments have been conducted on the West Coast. In Trengganu with its notably different soil and climatic conditions additional trials on fertilizer and assisted pollination will be required.

Special attention should be also given to erosion control in the hilly areas of Trengganu where slopes up to 20 degrees frequently occur in terrains which have been selected for the cultivation of oilpalm. To determine the effects of platforming and terracing on both the yields to be obtained from and the costs involved in oilpalm cultivation, this item should be included in the research programme.

All experiments to be carried out might be taken care of by the proposed new experimental station at Kuala Brang in close co-operation with the F.L.D.A. and the S.E.D.C. which should make their plantations available for trials when so requested.

The material and information necessary to improve the padi production on the East Coast should be released by the P.E.S. 'Lundang' in Kelantan. This station works in close co-operation with Malaysia's main Padi Experimental Station in Kedah (West Coast) which has the advantage that newly made discoveries of general importance can be easily passed on to the East Coast. As there are notable differences in both soils and climate between the East Coast and the West Coast a well-functioning experimental station on the East Coast is, however, imperative.

In view of the current and expected developments in agriculture such as the implementation of large irrigation and drainage schemes for the cultivation of padi, the services of the P. E. S. 'Lundang' will be increasingly required. To meet these future requirements the station should be staffed adequately.

As the conditions in Trengganu do not virtually differ from those in Kelantan it is not thought necessary to establish another padi research station in Trengganu. It will be certainly more advantageous to distribute the small number of available research officers over as few stations as possible.

Although most information on cultivation practices and inputs will come from the stations in Kelantan and Kedah it is nevertheless strongly recommended to carry out a large number of variety - fertilizer trials on different types of soil within Trengganu.

Less important than rubber, oilpalm and padi, but the only crop with reasonable prospects on the beach ridges is coconut. Good planting material of tall varieties is available from estates on the West Coast. Little is known as regards the results of fertilizer applications to palms grown on the marine sands. Therefore it is essential to accelerate the research programme at the F. E. S. 'Sungei Baging' in Pahang. This station has been established to improve the coconut production on the beach ridges along the East Coast. Recently one factorial fertilizer experiment has been started, but this is far from adequate.

Other items on which the research should be focussed are the cultivation of fodder grasses and legumes underneath coconut palms, especially of *Stylosanthes*, *Pueraria* and *Centrosema* and the necessity of slashing fodder crops during the dry season to avoid a possible competition for moisture.

If this proves to be necessary the production of the fodder crop certainly will fall behind at the moment that the demand for it will be greatest. It should also be determined whether *Stylosanthes*, as assumed at present, is the most suitable fodder crop to be underplanted. The cover crops *Pueraria* and *Centrosema* should be tested on their ability to concurrently increase the organic matter content of the beach-ridge soils.

A selection programme should be drawn up for dwarf varieties since these come into production three or four years earlier than the tall varieties. The present dwarf material is occasionally planted by the farmers, but because of its unreliable production it is not popular. Selected dwarf varieties should attain the same production as the tall varieties. Apart from the advantage of early bearing, they are much easier to harvest. A disadvantage is the larger amount of labour required for the copra preparation, as the nuts are considerably smaller.

Cocoa is not likely to be of great importance in the future. It is only advisable to go in for this crop after the dieback problem is solved. Information on cultivation practices can be obtained from the Jerangau Estate and from Sabah.

The research on fruits and vegetables for the whole of Malaysia should be concentrated at two stations, one in the highlands and one in the lowland area. The results of the latter station should be made available to Trengganu. An exception must be made for the research on cashew. Although the East Coast climate is not ideal due to rainfall during the flowering period of the crop, cashew growing may be possible on the beach-ridges. Substantially higher yields must be obtained than at present to make cashew growing as paying proposition. The introduction and testing of material from other countries will show whether higher yields can be indeed obtained. This may be done at the F.E.S. 'Sungei Baging' in Pahang.

In Trengganu itself research on dryland food crops may be undertaken. Although the area intended for dryland crops in the regional development plan, is rather limited, it should be borne in mind that food crops might replace the oilpalm plantings projected on the higher alluvial terraces. Trengganu is one of the few states where dryland padi (taboran) is grown. Based on the latest results obtained in rice breedings and in weed control the growing of taboran padi offers good prospects. Other dryland crops may be grown in the off season in rotation with taboran padi.

Dryland crops may be also intercropped in rubber replantings, as long as the slopes of the soils intended for this crop do not exceed two degrees. The activities of the Rubber Research Institute in this regard should be closely followed.

Dryland crops which might be considered for intercropping are dryland padi, cassava, soy beans, maize, groundnuts. As to maize, groundnuts and cassava reasonably good planting material is available in Malaysia. The current soy bean varieties are not successful, but good seed is likely to be obtainable from the East Coast of Sumatra. Variety-fertilizer-spacing trials should be undertaken to obtain data as to how the yields of the above-mentioned crops can be improved.

Suitable land for dryland padi amounts to at least 30,000 acres in Trengganu and a similar area is available in Kelantan. Good yields may be obtained after the introduction, and selection of promising material available on the Philippines, in Madagascar and in Congo. Sowing techniques, fertilizer and herbicides are the inputs from which the more spectacular yield increases are to be expected. Experiments on these items should be given priority.

When the land pressure in Trengganu further increases it may be considered to bring peat soils into cultivation. Before starting to implement projects in these areas, a sound research programme should be carried out to determine whether economic crop production is possible on these soils. A close co-operation with the F.E.S. Jalan Kebon, - the experimental station on peat soils on the West Coast - is essential. Potential crops are sawah padi, grasses and fodder crops. The production costs will certainly be high. Investigations should be undertaken as to the costs involved in land clearing, drainage and the application of fertilizers of which most likely

very high quantities will be required. Subsidence as a result of drainage and the possible formation of cat clays should be given special attention.

The high organic matter content of peat soils may prove to be a limiting factor for double cropping of padi, because of the release of harmful substances under anaerobic conditions.

Research on all these items is necessary to assess the feasibility of developing peat soils.

5.3 Research Stations and their Staffing

The research in the State of Trengganu should be organized as follows. One agricultural research station should be established near Kuala Brang in the neighbourhood of the proposed agricultural college or school.

The station should undertake the research on dryland food crops. Moreover, an oil palm and a rice specialist who will be responsible for the oil palm experiments and padi trials in the various parts of Trengganu should be attached to the station.

The staff of the station should consist of one director (soil fertility specialist), assisted by one dryland crop specialist and the above-mentioned oil palm and rice research officers.

For the experiments on dryland crops two research assistants and four field assistants are required apart from the specialist. Five research assistants and 10 field assistants should be placed under the research officers in charge of the oil palm and padi experiments.

If research on peat soils is necessary in the future, a second research station should be established. Its staff should consist of a director (agronomist), an irrigation/drainage specialist, a soil scientist and a mechanization specialist. Each of these officers should have one research assistant and some field assistants.

The costs involved in the research on dryland crops, sawah padi, oil palm and coco-nut are estimated at :

investment	M\$ 500,000
salaries, etc. (staff)*	M\$ 200,000
running costs	M\$ 200,000

The costs for the research station on peat soils will amount to M\$ 500,000 for investment, M\$ 125,000 for salaries and M\$ 125,000 for running costs.

* Director	M\$ 12,000
Research officer	" 10,000
Research assistant	" 7,000
Field assistant	" 4,800

