THE GOVERNMENTS OF MALAYSIA AND THE STATE OF JOHOR

SHORT-TERM ROTATION CROPS

WORKING PAPER

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SHORT-TERM ROTATION CROPS

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SHORT-TERM ROTATION CROPS

1. INTRODUCTION

In compliance with the terms of reference the Consultants have examined a wide range of possible diversification crops. These have included a short-term crops, in which some interest has already been shown in West Malaysia, both for intercropping in immature rubber and oil palms, and as pure crops. Most of the work on these crops has been carried out in the monsoon climate zones of the country rather than in the southern equatorial zone, and it became clear early in the course of this review that the difficulties of successfully cultivating these crops in the climate of south-east Johore would be formidable. Further, it was also clear that the areas of land in the Project Area of suitable slope for production of short-term crops would be limited in extent and scattered, and that the place of these crops in the context of the development of the Project Area did not warrant the expenditure of much time on further analysis.

However the early market analysis showed that there is a large and growing demand for these short term crops for stock feed, particularly grains and legumes for pigs and poultry. This analysis, which is given in Section 2 of this paper, warranted first evaluations of a number of possible enterprises. These early evaluations are given in Appendices B and C. On the assumptions made, which subsequent appraisal suggests may have been optimistic it appeared that the profitability of production was closely related to the size of the operation. Holdings of less than 60 acres were clearly not attractive; however holdings of 1000 acres, using a good range of machinery showed rates of return between 17 and 31 per cent.

The assured market and the large scale production prospects were considered promising enough for more thorough appraisals of the agronomic and conservation problems involved. These are set out in section 3 and Appendix A respectively. It is abundantly clear that the problems are formidable. The conservation requirements limit the production areas to the flatter land; the agronomic requirements for success in the equatorial zone are still largely unknown; the problem of mechanisation, particularly in connection with harvesting of cereal and legume grains and groundnuts, are immense.

Thus, though the potential profits are high, the attendant risks of failure are high. At present commercial production can not be recommended. However it is considered that an experimental programme should be laid down by MARDI at their research station to be established in Johor Tengah.

Emphasis must be placed on testing various lay-outs for soil conservation and control of run-off. Crop variety trials, time of planting, crop spacing and all aspects of fertiliser application (rate, method and timing) need to be investigated. Weed, insect and disease control methods must be evaluated, and the problems of mechanisation sorted out before commercial production is undertaken. It is considered that a minimum of five years work will be necessary before valid conclusions can be drawn on many of these aspects.

2. MARKET

Most of the cereal and legume grains, oilseeds and starchy root crops have more than one market outlet. They produce food for direct human consumption and also, either in the same form and/or as by-products, food for conversion through animals into meat and livestock products. These two outlets are examined in the following sections.

2.1 The Market for Direct Human Consumption

The present positions and future potentials of the following crops will be considered:-

Cereal grains	-	rice, maize, sorghum
Legume grains	-	cowpeas
Oilseeds	-	groundnuts, soya beans
Root crops	-	tapioca, sweet potatoe
Fibre crops	-	kenaf

2.1.1 Cereal grains.

Rice : rice forms the major staple food in the Malaysian diet. The country has however traditionally been an importer of this commodity. Actual imports fluctuate from year to year, but in the past decade have averaged about

350,000 tons per year (about 40 per cent of total rice consumption) and have cost about $140 million per year. Official policy is now to increase rice production to the point of self-sufficiency by 1975 or earlier. There are two major schemes, at Muda, in Kedah and Perlis, and at Kemubu, in Kelantan, and many smaller ones in other states; all are designed to increase rice production sharply by double cropping. The Muda and Kemubu schemes are expected to be fully operative by 1975. Efforts are also being made to develop, improved, higher yielding varieties.

Consumption of rice per head in West Malaysia is around 220 lbs per annum. It appears to have fallen slowly in the past decade. Using a three year moving average, consumption has been as follows:-

Years	Average per Capita consumption (pounds)
1958/60	255.584
1959/61	255.584
1960/62	253.12
1961/63	254.016
1962/64	250.432
1963/65	248.416
1964/66	229.152
1965/67	219.968

It is expected that this trend will continue. Using assumptions of 3 per cent growth in population, 2.5 per cent growth in per capita incomes and income elasticities ranging from -0.2 to 0.0 the projected per capita and total consumption for rice (assuming constant prices) were estimated (Table 1).

The figures indicate that total rice consumption will increase by about 75 per cent in the period to 1990 (assuming an income elasticity of -0.1), while per capita consumption falls slightly to .0909 tons (203 lbs) per annum. In the Nathan Transport Study it was assumed that total consumption would be 1,040,980 tons in 1975 and remain at that level through 1985. This implies an income elasticity of demand of about -1.2 and appears to be highly unrealistic.

TABLE 1 PROJECTION OF RICE CONSUMPTION TO 1990

Per Capita (tons)

Inc. Elast.	-0.2	-0.1	0.0
1967	0.0985	0.0985	0.0985
1970	0.0969	0.0977	0.0985
1975	0.0942	0.0963	0.0985
1980	0.0910	0.0947	0.0985
1985	0.0874	0.0929	0.0985
1990	0.0834	0.0909	0.0985

Total (thousand tons)

Inc. Elast.	-0.2	-0.1	0.0
1967	865.5196	865.5196	865.5196
1970	935.5852	942.1303	949.4415
1975	1048.6000	1072.5017	1096.4035
1980	1174.9553	1222.9995	1271.0441
1985	1308.4316	1390.9464	1473.4616
1990	1447.0040	1577.5102	1708.1870

Production projections were also made in the Nathan Study for the period of 1985 (Table 2).

TABLE 2 PRODUCTION ESTIMATES 1966-1985

Year	Land Area Planted			Production	
	Single crop	Double crop	Total	Padi	Rice
	......('000 acres).......			....(000 tons)....	
1966	651.3	104.4	860.2	853.0	568.098
1970	630.0	175.0	980.0	1,129.2	752.472
1975	341.7	460.0	1,261.7	1,646.5	1,096.569
1980	248.8	580.0	1,408.8	2,113.2	1,407.391
1985	234.3	613.2	1,460.7	2,410.2	1,605.193

Source: Malaysian General Transport Survey

These production and consumption estimates thus predict that self sufficiency in rice should be attained by 1975. The production estimates are based upon increased use of double cropping, principally resulting from the Muda and Kemubu schemes. They also assume an increase in yield of padi per crop from 1.15 tons per acre in 1970 to 1.65 tons in 1985. The major increase in production occurs before 1975 as the two irrigation schemes come into operation, the main factor beyond that time being increasing yield.

At present the Government guarantees a minimum price of $16 per pikul of padi. The Trengganu Report provided the following data on milling costs:-

Value of padi at farm		$16 per pikul
Transport to mill		65 cents
Cost of milling		$ 1.97
		$18.62
Value of second grade rice		$ 2.31
Cost of first grade rice		$16.31 for 0.6 pikul
	=	$27.18 per pikul
Assuming transport & port charges	=	$ 1.82 per pikul
F.O.B. Cost	=	$29.00 per pikul
	=	$488.00 per ton

The average price of rice imported into West Malaysia since 1962 has been:

Year	Price $ per ton
1962	427
1963	413
1964	384
1965	384
1966	438
1967	533
1968	566

Thus at prices prevailing prior to 1967 the guaranteed price to domestic producers was above the domestic price. In its Commodity Review for 1969 F.A.O. expected prices to be lower this year. It further states that "the medium term prospects for trade and prices will primarily be influenced by future developments in production. The high-yielding varieties, which are likely to cause considerable changes in the pattern of supply and demand, have so far had greater impact in importing than in exporting countries. Rice output has been encouraged also in several developed countries. Although a temporary return of scarcities owing to crop failure cannot be ruled out, the developments in progress are already leading to lower imports, higher export availabilities and even surplus stocks. In such circumstances, adjustment of national production policies and programmes to the changing supply and demand pattern will be increasingly necessary".

Thus prices may be expected to fall back to earlier levels in the near future. A major factor in causing fluctuations in world prices is the small proportion of total production which enters world trade, 6.5 million tons out of total output of 284 million tons i.e. only just over 2 per cent. Thus import demand and export supplies tend to be residuals in many cases.

The F.A.O. in the note quoted earlier suggest that the primary influence in future trends will be production. However changes may take place in consumption, particularly substitution of bread for rice. This appears to have been occurring in Malaysia and may be an important reason for the apparent sharp fall in rice consumption in the past four years. Table 3 shows the growth in wheat imports since 1965.

TABLE 3 WHEAT IMPORTS TO MALAYSIA 1966-1968

Year	Wheat Imports (tons)	Value $
1966	173,754	38,566,637
1967	272,592	62,454,972
1968	354,640	76,823,712

World wheat prices have fallen this year and stocks particularly in North America are at high levels. There is some prospect of countries such as Malaysia obtaining wheat at prices below those paid by millers in North America and West Europe. At present bread prices in Malaysia are lower than in U.K. or U.S. (and presumably Europe as a whole).

A relative fall in wheat prices might increase the growth of bread consumption in South East Asia and reduce the rate of growth of demand for rice.

Thus future price of rice appears more likely to be in the region of $400 per ton than the guaranteed equivalent of $490. In these circumstances exports by Malaysia will be subsidized unless the guaranteed price is reduced. Given the above projections stimulation of additional rice production in areas such as Johor, outside traditional producing centres appears inadvisable. Any such proposals should be evaluated in terms of a 'shadow' price based on the import price level. For this purpose $400 per ton of milled rice appears to be the best estimate.

This price is equivalent to $23.77 per pikul and would be approximately equivalent to $13.75 per pikul of padi at the farm.

Maize and sorghum : The Department of Agriculture estimated that in 1967 the equivalent of some 12,600 acres of maize as a sole crop were grown in Malaysia; production would have been around 10,000 tons; production of sorghum was also very small. Annual imports of maize grew rapidly from about 80,000 tons (1962-1964 average) to 150,000 tons in 1968. No data have been found to indicate the usage of either the local production or the imports, but most of the maize and sorghum from both sources is likely to have been fed to livestock, and the future demand will be determined almost entirely by the needs of animals. The market for these crops is therefore discussed in detail in section 2.3.2.

2.1.2 Legume grains

Cowpeas:

Legume grains are a major vegetable protein source and are a fairly important part of the diet particularly among the Indian members of the population. Inputs of dried legume grains amount to some $7 million per year. There are a wide variety of these vegetables, each with its own particular texture and flavour. It is possible that cowpeas might substitute for some part of the imported types, perhaps 10-20 percent of the 13,000 tons at present imported. Assuming yields of ½ ton per acre this means a national acreage of 2,500 to 5,000.

2.1.3 Oilseeds

Groundnuts: Only small quantities of groundnuts are produced in Malaysia at present. The equivalent of about 5000 acres of sole crop are grown anually, mostly in the states of Kelantan and Perak. Some 6000 tons of shelled nuts and 5000 tons of unshelled nuts have been imported annually in recent years.

Groundnuts are used for a variety of purposes. The whole nuts form a confectionery type of food and are used for the manufacture of peanut-butter. The nuts can be crushed to extract oil - 40 per cent by weight. This oil is of a type referred to as a "soft oil" and can be used for cooking; the residual mea of a valuable animal feed.

The quantity of groundnuts used for human consumption in West Malaysia is difficult to estimate. The 1957/58 Household Budget Survey indicated that per capita consumption of groundnuts was 0.75 kati/year among Chinese and 0.4 kati/year among Malays. At this level in 1967 total consumption would have been about 6 million lbs. Oil appeared to be used only by Chinese, at a rate of 3 kati/head/year. This would amount to approximately 14 million lbs. in 1967.

Studies have indicated the income elasticity of demand for vegetable oils and fats to be about 0.6. Assuming this value for both groundnuts and oil, Table 4 shows the projected growth of consumption on a per capita and total basis.

TABLE 4 PROJECTION CONSUMPTION OF GROUNDNUTS AND GROUNDNUT OIL

Per capita (lb)	Groundnuts	Groundnut oil
1967	0.6828	1.5933
1970	0.7141	1.6664
1975	0.7722	1.8020
1980	0.8379	1.9551
1985	0.9121	2.1283
1990	0.9961	2.3243
Total (mil. lbs)	**Groundnuts**	**Groundnut oil**
1970	6.8332	16.0625
1975	8.5953	20.0581
1980	10.8123	25.2285
1985	13.6441	31.8372
1990	17.2744	40.3080

It was noted above that about 14 million lbs. of groundnut oil were probably consumed in West Malaysia in 1967. In that year about 4.5 million lbs. of oil were imported. Thus approximately 9.5 million lbs, came from domestic crushing. Assuming a 40 per cent extraction rate this is equivalent to 23.75 million lbs. of shelled nuts. Thus the approximate situation in 1967 seems to have been as follows:-

Direct consumption	2,700 tons
Crushed for oil & meal	10,600 tons
	13,300 tons shelled nuts
Total use	20,000 tons unshelled nuts

This ties up approximately with supplies:-

Imports	15,000 unshelled equivalent
Domestic prod.	5,000 tons (one ton/acre)
	20,000 tons

In addition to 4½ thousand tons of oil the groundnuts crushed in 1967 are estimated to have provided approximately 6½ thousand tons of residue for animal feed.

Price projections for groundnuts are particularly tricky. At the present time the small local crop is almost entirely sold for confectionery. Prices quoted vary considerably but appear to average around 20 cents/lb. of fresh nuts. This is equivalent to about $75 per pikul of dry shelled nuts.

However if production is greatly expanded the crop will have to be sold for crushing for groundnut oil and animal feed. Groundnut oil is at present imported for $70 - $75 per pikul. However on the world market it normally fetches a price about 5 per cent above coconut oil. The long run price in Malaysia is likely therefore to be in the region of $55 per pikul. The value of groundnut meal for animal feed is about $18 per pikul.

Groundnuts normally yield about 40 per cent oil and 60% meal when crushed. Thus one pikul of shelled nuts will produce about:-

0.4 pikuls oil @ $55	=	$22
0.6 pikuls meal @ $18	=	$11
		$33

Coconut oil mills in W. Malaysia spend on copra about 87 per cent of the sale value of the products from it. Although the ratio of the more valuable oil to the less valuable residue is less in groundnuts than in copra, the milling procedure for the two is essentially the same and the relationship between the price of the raw material and the sale value of the end products is likely to be similar. Thus the price paid for groundnuts by mills might be approximately $28.50 per pikul, giving an expected farm price(bagged) of $27.50 per pikul of shelled nuts.

This estimated price is only about 37½ per cent of the price quoted above for confectionary nuts.

Soya beans: since 1945 the soya bean has become the major source of protein in animal feeds in developed countries. The demand for it as a food for direct human consumption is much less important, and therefore the market prospects for this crop are discussed in detail in section 2.3.1.

2.1.4 Root Crops

Tapioca : the demand for human consumption is in two forms, (a) as a vegetable (b) as starch. The markets for these are discussed in detail in Appendix C. Briefly it seems that the domestic demand for tapioca is likely to remain at about its present level, which is estimated to be between 10,000 and 20,000 tons of fresh roots per annum.

The domestic demand for tapioca starch is projected to rise from 24,000 tons in 1970 to nearly 40,000 tons in 1990. This would mean a production of 200,000 tons of fresh roots in 1990. The farm gate price of roots to supply this outlet could be about $2.50 per pikul.

Exports of starch in 1968 amounted to some 18,000 tons. To expand the exports of this product it will be necessary to sell at a price competitive with corn starch. At present this price would allow the farm gate price of fresh tapioca roots to be about $2.80 per pikul. However this price is very vulnerable to changes in the available supply and price of corn starch, and is likely to fluctuate.

Sweet potatoes: this crop is at present grown as a fresh vegetable for human consumption. Dried sweet potatoes has nearly twice the crude protein, fat and mineral contents of tapioca chips and is much less fibrous. There should be a steady increase in consumption but the market is a small one. The crop has poor storage qualities and is not an easy one for large scale individual production. A major demand would be likely to develop only if it, like tapioca could be processed for animal feed or as a source of pure starch.

2.1.5 Fibre Crops

Kenaf :- These two products have been widely used for the production of sacking both for manufacture of bags and for other products such as baking for carpets and other floor coverings. In common with other fibres, such as Manila hemp and sisal, they have been under increasing pressure in developed countries from synthetic substitutes eg. plastic and paper sacks and the use of the bulk handling methods for grains etc. In developing countries expansion of output of agricultural commodities and less sophistication in handling techniques have resulted in rising demands. In aggregate demand is likely to continue to rise at about 3-4 per cent per year. Since many of the developing countries will attempt to produce to meet domestic requirements, export demands will grow at a much slower rate, if at all.

Malaysia traditionally appears to have been a net exporter of sackings - mainly used, presumably re-export of sacking materials used to carry imported materials such as grains. In addition to these supplies about 1,000 tons of new sacking appears to be imported per annum. A new joint venture has recently been established to manufacture jute products in Penang and in 1969, 1,300 tons of raw jute was imported. Local production, if competitive could perhaps replace these imported supplies.

2.2 The Market for Livestock Feeds

To estimate the potential market for livestock feeds in West Malaysia and Singapore it is necessary to

(a) Make projections of the growth of demand for the major livestock products.

(b) Assess the numbers of stock required to meet that demand.

(c) Estimate the feed requirements of these various categories of livestock.

The major livestock products in this context are poultry meat, eggs and pork. The likelihood of cattle and goats, whether kept for milk or beef, reaching productivity standards before 1990 that would require significant quantities of concentrated foods in small.

2.2.1 The future demand for livestock products.

The factors determining future demand for eggs, poultry meat, pork, beef and mutton have been discussed in the working papers on poultry, pigs, beef production and goats respectively. The projected consumptions are reproduced in Table 5.

TABLE 5 PROJECTED CONSUMPTION OF MEATS (MIL. LBS) AND EGGS (MIL)

Year	Beef	Pork	Mutton	Poultry	Eggs
1967	35	107	7.8	114	984
1970	42	124	9.3	135	1162
1975	54	159	12.3	176	1519
1980	71	204	16.3	231	1992
1985	93	263	21.5	303	2613
1990	123	339	28.4	398	3427

The income elasticities of demand assumed in the compilation of the above table are: beef 1.0, pork 0.8, mutton 1.1, poultry and eggs 1.0 .

The future consumption of milk has been ignored in these calculations. The total requirements for all cattle will be small (section 2.2) and the proportion officially classified as milking cattle is less than a quarter of the national herd. Further, only about six per cent of the milking cattle are likely to be fed any concentrates, and even if these "commercial" dairy cattle increase at ten per cent per annum their concentrate feed requirements will still be a negligible proportion of the demand in 1990.

2.2.2 Future numbers of livestock

Poultry: no reliable estimates of the national poultry population or of its productivity have been found. A survey of "commercial poultry-farms" was carried out by the Veterinary Department in 1966. Its value was substantially reduced by the fact that no guidance was given to enumerators (local staff of the Veterinary Department). However from this information and the Veterinary Department estimates of consumption it is possible to piece together some picture of poultry in Malaysia.

The survey indicated that there were almost 1.5 million laying birds on commercial farms and daily egg production was 54.1 percent of this (equivalent to 197.5 eggs/annum).

Total egg consumption in 1967	= 984,144,000
Commercial Production = 1,477,699 x 197.5	= 321,082,762
Non-commercial production	= 663,061,238

Two thirds of production is thus from "kampong hens" and small flocks. If the average hen produces 50 eggs per year then there are just over 13 million of them in the country. (the NEDECO report suggested 25 per annum but this does not seem much better than the average pigeon).

Commercial laying flock	=	1,477,699
Non-commercial " "	=	13,261,224
Total laying flock	=	14,738,923

The overall average egg production per bird is then 66.8 eggs/annum. Commercial flocks have been expanding rapidly and are expected to continue to do so, gradually replacing kampong scrubs. As this process continues average egg production will rise. It may be reasonable to assume that by 1990 average production per bird will be close to present commercial levels. A 4½ percent per annum rate of improvement would lead to an average production per bird of 183.8 eggs in 1990. Assuming this rate of improvement, Table 6 shows the number of laying birds needed to meet projected demands to 1990. It is clear that if improvement does take place at this rate then the total number of laying birds required will only increase by 20 percent. There appears to be no reason why such improvement should not occur; in fact the above assumptions may be pessimistic.

Assuming that the average chicken at slaughter weighs 3 lbs, then the present estimated consumption of poultry meat implies that approximately 38 million chickens are slaughtered per year. Taking the median estimate of the increase in consumption to 1990 Table 6 shows the number of birds required to be slaughtered per annum to meet this demand, assuming a dead weight of 3 lbs per bird throughout.

TABLE 6 PROJECTED ANNUAL REQUIREMENTS OF LAYERS AND TABLE BIRDS

Year	Annual production per layer	Number of layers required (mil)	Number of Table birds to be slaughtered (mil)
1967	66.8	14.739	38.077
1970	76.2	15.257	45.626
1975	95.0	15.989	60.879
1980	118.3	16.841	81.311
1985	147.5	17.714	108.350
1990	183.8	18.648	144.097

These numbers may appear large but seem perfectly attainable. Ritz Farms at Senai - Johor are at present producing 20,000 chicks per week or 1 million per year. 200 enterprises of this type will cope with foreseeable demands and there is no reason to suppose that they will not come into operation. In short the poultry industry will become semi-industrial.

Pigs: according tothe Veterinary Department the average dead weight of slaughtered pigs in W. Malaysia is 110 lbs. As there is no preference for bacon or large pork joints here it seems reasonable to assume that this will continue to be the preferred slaughter weight. Taking the median consumption projections, the number of pigs required to be slaughtered per annum to 1990 are as follows (Table 7):

TABLE 7 PROJECTED ANNUAL REQUIREMENTS OF SLAUGHTERED AND BREEDING SOWS

Year	Total slaughter	Pigs reared/sow	Total Breedings/Sow
1967	970,000	11.5	83,900
1970	1,127,000	11.8	95,500
1975	1,445,000	12.1	119,400
1980	1,855,000	12.4	149,600
1985	2,391,000	12.7	188,300
1990	3,082,000	13.0	237,100

As shown at present approximately eleven and a half pigs are reared per sow per year. This is quite a reasonable level of production. It is assumed that improvement will occur to approximately 13 pigs reared per sow in 1990. The breeding sow herd therefore needed is shown in Table 7. This indicates that in the thirteen years to 1980 the herd should almost double to 154,000. Since there has been a doubling from 42 to 84,000 between 1954 and 1967 this rate of growth appears to be well within the capacity of the industry.

Mutton: present supplies of mutton come from 2 sources, local goat and imported sheep (live or carcass). In 1967 some 113,427 goats were slaughtered which at an average dead weight of 20 lb supplied approximately 29 percent of the mutton consumed.

There are at present approximately 308,000 goats in West Malaysia. Numbers have increased slowly from 268,000 in 1958. The animals are generally not of high quality. Crosses with Jamnapuri (Indian) and Indonesian goats have produced larger animals which weigh about 60 lb at one year (30 lb dead weight).

Over the past seven years the retail price of local goat has averaged $2.70 per kati compared with $1.81 per kati for Australian mutton, indicating a degree of preference for goat meat. Table 8 shows the quantity of goats meat demanded to 1990 assuming that the proportion of goat meat in total mutton consumption rises to 50 percent by 1990. The table also indicates the number of animals required to meet this demand assuming a rise in carcass weight to 30 lb over the same period.

TABLE 8 PROJECTED ANNUAL REQUIREMENTS OF GOATS FOR SLAUGHTER AND FOR BREEDING

Year	Mutton demand (mil.lbs)	Percent Goat	Goat demanded (mil. lbs)	Average carcass weight(lbs)	No. of goats required
1970	9.2440	30	2.7732	20	138,660
1975	12,0786	35	4.2275	22.5	187,888
1980	15,8402	40	6.3361	25	253,444
1985	20.7765	45	9.3494	27.5	339,978
1990	27.2529	50	13.6265	30	454,216

This rate of growth of consumption would require a four-fold increase in number of slaughterings even allowing for the increase in slaughter weight. However, goats will produce their first offspring at about one year, local breeds give 30 percent or more twins, and they can be bred more than once per year. Thus if production of goat meat is profitable in Malaysia it should be possible to build up numbers as required.

<u>Cattle (including buffaloes)</u>: while the outlook for pigs and poultry looks promising under present conditions, that for cattle is extremely clouded. The trends in numbers of animals in W. Malaysia since 1952 is indicated in Table 9.

TABLE 9 NUMBERS OF BUFFALOES AND OXEN W. MALAYSIA, 1952 - 1967

Year	Buffaloes			Oxen		
	Malayan Swamp		Indian Murrah	Agricultural &	Milking	
	Over 3 years	Under 3 years	Total	Draught. Total	Total	Females over 3 yrs
1952	136,899	95,665	4,147	206,964	57,810	24,472
1955	136,798	101,332	4,462	202,990	76,008	33,817
1958	139,228	110,057	5,411	211,574	79,279	34,606
1961	147,390	121,912	6,226	216,516	89,366	33,591
1964	153,012	127,427	3,483	224,618	81,141	32,620
1967	124,507	110,699	2,642	220,078	65,608	29,091

Numbers of both buffaloes and oxen increased slowly in the early years of the period but have been decreasing in recent years. At present 90 percent of requirements of dairy products and almost 10 percent of beef are imported. Given the increase in consumption projected for these products imports will increase very rapidly unless the decline in numbers is reversed. However with the increasing acreage of double cropped rice there will be a need for greater mechanisation and the demand for draught buffaloes is more likely to fall, reducing still further the potential supply of meat from that quarter.

Increased supplies of locally produced beef therefore will require an organised breeding programme to increase the size and quality of the national herd. Conditions for grassland farming are considered to be excellent in the Project Area, and a scheme for the establishment of cattle multiplication units has been prepared (Dairy farming Feasibility Report). Although primarily aimed at capturing the lucrative fresh milk market in Singapore and Johor, this commercial dairy herd will turn out half-bred Friesian steers for acceptable beef and cull grade Friesian cows and heifers, which if crossed with tropical beef bulls, should produce quality beef. Several expatriate private beef producing interests have recently been investigating the possibilities of investing in the development of a beef industry in West Malaysia. The part which such interests might be encouraged to play is discussed in detail in the Working Paper on beef.

Owing to the relatively low reproductive rate and long gestation of cattle compared with pigs, the numbers of "commercial" dairy and beef stock that can be raised by 1990 will not make a significant impact on the demand for concentrated animal feeds. For purposes of calculation the commercial herd has been assumed to grow as follows:-

Year	Cows	Stock 0-1yr.	Stock 1-2yr.	Stock 2-3yr.
1975	6,400	5,200	4,700	1,300
1980	10,600	8,500	7,700	2,100
1985	17,100	13,600	12,500	3,400
1990	27,600	22,100	20,100	5,500

2.2.3 Future livestock feed requirements

The above projections of livestock numbers are extremely tentative as also must be the estimates of future animal feed requirements. These should be viewed as an indication of the general scale of probable demand rather than as estimates of actual future demands.

The following projections have been derived from estimates of the numbers of livestock in commercial herds and flocks, that is for those animals whose feed requirements are all or partly purchased. The amount of dry matter consumed by these animals has been estimated, and then the amounts consumed in the form of carbohydrate feeds and vegetable protein rich feeds determined.

Poultry: it has been assumed that the following proportions of the total flock are in "commercial" flocks.

Year	Layer (percent)	Table Birds (percent)
1970	30	40
1975	40	55
1980	60	70
1985	80	85
1990	100	100

Assuming that feed intake is made up of 60 percent carbohydrate rich feeds, 20 percent vegetable protein feeds, 20 percent other, the following amounts of feed would be required:

Year	Total Dry Matter (Thousand tons)	Carbohydrate Feed (Thousand tons)	Protein Feed (Thousand tons)
1970	285	172	57
1975	442	265	88
1980	719	432	144
1985	1,074	645	215
1990	1,536	922	307

Pigs: it has been assumed that the entire herd is already fed on 'purchased' feeds. 70 percent of dry matter requirement is assumed to be derived from carbohydrate feeds, 17½ percent from vegetable protein feeds and 12½ percent from other sources. The quantities required are estimated to grow as follows:

Year	Total Dry Matter (Thousand tons)	Carbohydrate Feed (Thousand tons)	Protein Feed (Thousand tons)
1970	284	199	50
1975	361	253	63
1980	460	322	82
1985	589	412	103
1990	753	527	132

Goats: at present most local goats are not fed any supplementary feed at all, existing on what they can find around kampongs. Being ruminants they will primarily be fed on bulky forages and therefore the demand for concentrate feeds will be low. In this exercise it has been assumed that both carbohydrate and protein feeds will make up 2½ percent of feed of breeding animals in the near future, rising to 5 percent by 1990, and that for fattening animals the relevant proportions are 3½ to 10 per cent. Using these values feed requirements are:

Year	Total Dry Matter (Tons)	Carbohydrate Feed (Tons)	Protein Feed (Tons)
1975	35,128	1,029	1,029
1980	47,385	1,829	1,829
1985	63,566	3,498	3,498
1990	84,924	6,072	6,072

Cattle as with goats the major part of cattle feed will come from bulky forages. The proportions for concentrate feed are assumed to be 7½ per cent for both carbohydrates and proteins. Requirements will be,

Year	Total Dry Matter (Tons)	Carbohydrate Feed (Tons)	Protein Feed (Tons)
1975	30,340	2,275	2,275
1980	50,115	3,759	3,759
1985	80,640	6,048	6,048
1990	129,975	9,748	9,748

<u>Total requirements</u>: in summary these are as follows:

Year	Total Dry Matter Thous(Tons)	Carbohydrate Feeds Thous(Tons)	Protein Feeds Thous(Tons)
1970	569	371	107
1975	868	521	154
1980	1,276	760	232
1985	1,808	1,067	328
1990	2,504	1,465	455

These projections indicate a large potential demand for animal feeds by 1990, about four times as much as at present or a compound growth of about 7.2 per cent per annum. This results from the growth of output of livestock products and from the projected "commercialization" of the poultry industry. Talks with feed millers have indicated a general belief that the market for their products will grow at seven to eight per cent per year, which is closely in line with the above estimates. The estimated feed needs will be considered with reference to present and prospective sources of supply.

2.3 The Sources of Supply of Animal Feedstuffs

2.3.1 Protein Feeds

Oilcakes and meals, the residues obtained upon crushing oil rich fruits such as palm kernels, groundnuts, soyabeans and copra, (dried coconut), are relatively rich in protein and form an important part of most animal feeds. Proprietary animal feeds are prepared from a mixture of foodstuffs according to the requirements of the type of livestock or their stage of growth and the relative prices of alternative feeds at the time of mixing. Individual oilcakes vary considerably in composition (Table 10). Coconut meal and palm kernel meal are relatively low in protein and high in carbohydrates (N-free extract) compared with groundnut and soyabean meals. All these oilcakes have however lower protein contents than fish meal which has, on average, almost 54 percent disgestible protein. Clearly such feeds, together with carbohydrate rich feeds such as maize and other grains, tapioca and fodders can be mixed in a large number of combinations to obtain given proportions of protein, fat, fibre and carbohydrate in the feed. Assuming the objective is to produce a satisfactory feed as cheaply as possible the particular combination chosen will depend upon the relative prices of the alternative feeds. Therefore it is not possible to predict with precision the demand for any particular oilcakes at some time in the future. In the following paragraphs the apparent usage of various oilcakes in West Malaysia in the most recent years is indicated.

The following tables show estimates of production and/or imports of various oilcakes for the years 1966-68:

TABLE 11 COPRA CAKE PRODUCTION AND IMPORTS

Year	Production (tons)	Imports	
		Quality (tons)	Price/ton ($)
1966	53,476	10,862	212.41
1967	57,877	17,331	187.90
1968	62,532	15,427	154.37

Source - Statistics Department.

TABLE 10. AVERAGE COMPOSITION OF OILCAKE, FISHMEAL AND GROUNDNUTS

Feed	Total Dry Matter	Total Dig. Nutrients	Dig. Protein	Average Total Composition				
				Protein	Fat	Fibre	N-free Extract	Mineral Matter
Coconut oilmeal	93.0	77.1	18.0	21.2	6.7	11.2	47.4	6.5
Palm Kernel Oilmeal	91.4	76.5	15.4	19.2	6.7	11.9	49.7	3.9
Peanut oilmeal 41% Protein	92.3	73.3	36.6	41.1	6.6	15.0	24.8	4.8
Soyabean oilmeal	91.0	77.9	37.0	44.0	4.9	5.9	30.0	6.2
Fish meal	92.0	70.8	53.6	60.9	6.9	0.9	5.0	18.3
Peanut kernels	94.6	137.9	27.7	30.4	47.7	2.5	11.7	2.3
Cowpea	89.0	75.9	19.2	23.4	1.3	3.9	56.8	3.6

TABLE 12 PALM KERNEL AND GROUNDNUT CAKE PRODUCTION

Year	Palm Kernel Meal (tons)	Groundnut Meal (tons)
1966	11,000	6,500
1967	13,750	6,500
1968	14,714	6,500

TABLE 13. IMPORTS OF "OTHER OIL CAKES"

Year	Quantity (tons)	Price per ton ($)
1966	15,006	310.19
1967	14,849	311.17
1968	21,029	318.61

Source - Statistics Department

Import statistics indicate that the major suppliers of these other oilcakes are mainland China, Burma, Thailand and India. Supplies from China are probably mainly soyabean, from the others groundnut or sesame seed.

Considerable quantities of soyabeans and sesame are imported in seed form. Assuming that all the sesame and half the soyabeans are crushed for oil, the following quantities of meals would have been available:-

Year	Sesame seedmeal (tons)	Soyabean meal (tons)
1966	1,375	6,425
1967	1,608	6,964
1968	1,525	7,439

Summing these various supplies of oilcakes, the following estimates of total available supply to West Malaysia are obtained:-

Year	Total Oilcake Supplies(Tons)
1966	104,644
1967	118,859
1968	129,166

This represents a growth rate of 11 per cent per annum, somewhat above the projected growth. The estimate for 1968, 129,000 tons is also above the 107,000 tons estimated for 1970. This discrepancy is probably accounted for by the fact that the largest component of Malaysian protein feeds is coconut oil cake and palm kernel cake, both relatively low in protein (about 20 percent) and high in carbohydrate. The earlier estimates were based upon a higher protein content feed. Thus more coconut oil cake would have to be fed to provide the required quantity of protein. This would also substitute for some carbohydrate feeds.

<u>Palm Kernel meal</u> : the most rapidly expanding potential local source of protein feed is palm kernel. It has been estimated that by 1974 some half a million acres of oil palm will be in production and that this would rise to 1.5 million acres by 1990. Such an increase would yield about 200,000 tons of palm kernels in 1974 and 600,000 tons in 1990 sufficient to produce 110,000 tons and 330,000 tons of palm kernel cake respectively. However because of the relatively fibrous nature of this oilcake, (Table 10), it cannot be used as the sole source of protein especially for poultry; about one-third of total protein requirements would perhaps be met from this source at a price of about $13 per pikul. This would still leave the following approximate quantities (tons) to be filled by other vegetable protein foods.

1970	1975	1980	1985	1990
72,000	104,000	156,000	220,000	307,000

Three crops that could fill this gap are soyabeans, groundnuts and cowpeas.

<u>Soya beans</u> : Since World War II this crop has become the major source of protein in animal feed rations in developed countries. Its value is based upon the high protein content of the meal which is obtained after the oil present in the seed has been extracted. At the present time soyabean meal is not widely used in Malaysia; it is estimated that some 7½ thousand tons are used for livestock feed purposes annually, amounting to about 6 per cent of the total oil cake supplies.

The major world producer and exporter of soyabeans is the United States, and the major markets are in Japan and West Europe. These markets are expected to continue to expand, but at a slightly slower rate than hitherto. U.S. farm policy has maintained the price of soyabeans at US$2.50 per bushel ($280 per ton). It is expected that supplies will be available at that price for the forseeable future. Assuming $50 per ton transport costs to Malaysia, this means a c.i.f. price of $330 per ton, slightly below prices paid in the past. Given the expected world market situation this would appear to be a reasonable price level for future imports. The equivalent mill and farm gate prices for locally produced beans would then be,

Price at mill	=	$340 per ton		
Farm Price	=	$320 per ton	=	$19 per pikul

The equivalent meal prices would then be in the range $22 - $25 per pikul.

<u>Groundnuts</u>: in section 2.1.3 it was estimated that some 10,600 tons of shelled nuts were crushed in 1967, yielding some 4,500 tons of oil and 6500 tons of residual animal feed. Future requirements of oil were estimated to be (tons),

1970	1975	1980	1985	1990
7100	8950	11250	14200	18000

At a ratio of 6:4 meal to oil, the following quantities of meal would be available if the above oil was extracted locally.(tons)

1970	1975	1980	1985	1990
10650	13425	16875	21300	27000

The price of the meal to the user is expected to be $18 per pikul, that is $302.40 per ton. The projected farm gate price for locally produced groundnuts for crushing is $27.50 per pikul.

<u>Cowpeas</u> : Cowpeas are not yet used in Malaysia as a livestock feed. As indicated in Table 10 it has a composition somewhat similar to that of coconut or palm kernel oil meal, although with a somewhat lower fibre content. If available this crop could provide a useful addition to overall supplies of relatively high protein feeds. Its value would probably be in the region of $14 - $15 per pikul at feed mill.

2.3.2 Carbohydrate feeds

The same problems are faced in viewing requirements for carbohydrate feeds as for protein rich feeds. There are a large number of potential feed sources each of which has a different composition (Table 14). The actual quantities of each used will depend upon their characteristics and relative prices. The major present sources of carbohydrate feed in W. Malaysia are maize, rice bran and tapioca.

Maize : at present maize is a minor crop in Malaysian agriculture. The Department of Agriculture estimated that the equivalent of 12,637 acres of sole crop were grown in the country in 1967. This is unlikely to produce more than 10,000 tons of grain. Estimated acreage has remained at about this level for the past decade. Usage however has been rising and this is reflected in increased imports.

Year	Maize Unmilled	Maize for Animals	Maize Meal and flour	Total
1962/4 (av.)	64,185	na.	7,996	78,838
1965	40,138	24,760	4,764	69,622
1966	57,398	49,076	7,820	114,294
1967	60,964	50,305	6,686	117,955
1968	82,553	60,000	7,672	150,225

The crop has shown promise in field trials, and is worthy of attention as an import substitute.

Maize is the largest element in world feed (Coarse) grain production. Other feed grains are barley, oats, sorghum and rye. The world market situation for feed grains is however linked to that for wheat and, to a lesser extent, rice. Official comments on the outlook for these commodities are closely related to the outlook for food as a whole and have varied considerably from time to time; at present the market is in an extremely volatile phase. In 1967 F.A.O. projected wheat output in 1975 at 303 million tons, forecasts an increased deficit in developing countries, particularly in the Far East and expressed concern over the falling level of wheat stocks. It is now estimated that world production in both 1968 and 1969 was 333 million tons, with major increases occurring in

TABLE 14

AVERAGE COMPOSITION OF SOME CARBOHYDRATE FEEDS

Feed	Total Dry Matter	Total Digestible Nutrients	Digestible Protein	Average Total Composition				
				Protein	Fat	Fibre	N-free extract	Mineral Matter
Maize	88.5	83.4	7.5	9.8	4.3	1.9	71.0	1.5
Sorghum	89.6	79.9	8.4	10.8	2.8	2.3	71.7	2.0
Rice (brown)	87.8	81.0	7.0	9.1	2.0	1.1	74.5	1.1
Rice bran	90.8	67.4	8.4	12.4	13.6	11.6	39.9	13.3
Tapioca roots	32.6	25.7	0	1.1	0.3	1.4	28.8	1.0
Tapioca chips	94.4	75.0	0.1	2.8	0.5	5.0	84.1	2.0
Tapioca Waste (dried)	86.8	70.4	0	0.9	0.7	4.6	78.8	1.8
Sweet potato	31.8	35.6	0.2	1.6	0.4	1.9	26.7	1.2
Sweet potato (dried)	90.2	72.7	0.7	4.9	0.9	3.3	77.0	4.1

India and Pakistan, and Canada and Australia in particular are embarrassed by stock levels. It was noted in section 2.1.1 on rice that lower wheat prices could result in increased substitution of wheat for rice; lowering rice prices. Similar effects could occur in the feed grain market with wheat. Feed grains such as barley and maize are also substitutes for wheat in production. In the E.E.C. feed grain prices have been raised to encourage such substitution.

In 1968 the export price of U.S. maize fell to U.S. $44 per ton ($135). It has since risen to about U.S. $50 per ton. Given current production and consumption trends it appears likely to stay at this level since grain output is now so closely determined by government policies. Assuming maximum transport and delivery charges of $50 per ton to Malaysian ports the c.i.f. at port is approximately $220 per ton.

Import Price	=	$200 per ton
Handling & transport	=	$ 10
Price at mill	=	$210
Transport etc. Farm-mill	=	20
Producer Price	=	$190 per ton
	=	$11.30 per pikul

<u>Sorghum</u>: sorghums, like maize, are at present a very minor crop in Malaysia but have potential as an animal feed. The amount of the grain imported into the country is not known with accuracy, but the following amounts of "other grains," presumably main sorghum, were imported in 1966 and 1967.

Year	Tons	Price per ton ($)
1966	20,561	179
1967	16,941	182

Sorghum normally fetches a price between 5 and 10 per cent below that for maize. An import price of $200/- per ton has been projected for maize. Taking sorghum at a 7½ percent discount this means a price c.i.f. of $185/- per ton.

Import Price	=	$185/- per ton
Price at mill	=	$205/- per ton
Transport etc. farm-mill	=	$ 30/- per ton
Producer price	=	$175/- per ton
	=	$ 10.40 per pikul

Sorghum is readily substitutable for maize in livestock feeds. There is to be no reason why 25 percent of the total demand for maize estimated earlier could not be satisfied by the use of sorghum. This would mean a potential demand for up to 200,000 tons in 1980 or 400,000 tons in 1990 in West Malaysia alone.

Rice bran: the quantity of rice bran used in Malaysia is not known. However padi when milled normally yields about 10 per cent bran and imports have been running at over 20,000 tons per year. The amounts available for feed are probably just over 100,000 tons per year, (Table 15). This bran is somewhat lower than maize in feed value (Table 14) having higher fibre and lower carbohydrate contents, but is a useful animal feed especially for ruminants.

TABLE 15 RICE BRAN SUPPLIES

Year	Padi Production	Bran content	Imports	Available supply
1966	899,468	89,947	22,996	112,943
1967	872,425	87,242	20,987	108,229
1968	1,034,240	103,424	28,721	132,145

Assuming 10 per cent yield of bran from padi and the padi production estimates from the Nathan Report (Section 2.1.1), future supplies of local rice bran will be (tons):

1970	1975	1980	1985
113,000	165,000	211,000	241,000

Rice : it was suggested (section 2.1.1) that there could be a surplus of local rice over domestic requirements by the end of the decade. Rice in common with other grains can be used as an animal feed. Brown rice (husked but not milled) is roughly equivalent to maize in feeding value (Table 14).

Assuming the same value as maize i.e. $11.30 the value of padi for this purpose would be approximately $9.00 per pikul since 1 pikul of padi yields 0.8 pikuls of brown rice. Dehusking would cost at least 50 cents per pikul giving a producer price of $8.50 per pikul. Since this is well below expected price levels it is probable that surplus production would be exported rather than used for animal feed unless some pool price arrangement was introduced.

Broken rice from the mills may also be used as an animal feed. The amount available would be about one-third to one half of the quantities projected for bran.

Tapioca: it is estimated that about 70,000 tons (in terms of dry matter) of tapioca are at present used as animal feed (Appendix C). There is some resistance by millers to using more than 10 percent of tapioca in compound feeds, but there is no reason why it should not continue to supply 15 - 20 percent of the future carbohydrate feed supply. This would amount to 250,000 to 300,000 tons of dry roots by 1990. For chip production wet root prices have been estimated at $1.70 per pikul at the farm gate.

Sweet potatoes: this crop is in general use for direct human consumption. It is superior to tapioca in feeding value, and could be substituted for it if it can be shown to be suitable for pelleting. The price at the farm gate would be similar to that for tapioca.

Total carbohydrate feed supplies: Summing the three main main sources of supply, (maize, rice bran and tapioca), indicates a total availability of about 300,000 tons of carbohydrate feeds per annum in the 1966-68 period. This tallys fairly closely with the estimated requirement of 350,000 tons. Future needs are expected to rise rapidly to almost 1,500,000 tons by 1990. Potential Malaysian sources of these requirements are the three crops discussed above plus sorghum and starchy roots such as sweet potatoes.

3. PRODUCTION

3.1 Environment

3.1.1 Climate

The equatorial conditions prevailing over the project area make the climate most suitable for vegetative growth.

The continuous high humidity, heavy and well distributed rainfall and absence of long periods of drought, together with an average of 5.4 or more sunshine hours per day, combine to produce a near optimum environment for the rapid and luxuriant growth of vegetation including weeds, for the multiplication of many insect pests and for the maximum bacterial and fungal activity. Insofar as the crops under consideration in this paper are concerned, the climate is most suited to the production of the root crops and least suitable for the cereal and legume grains. The yields of these grains has been very erratic in field trials in the monsoon climate of Selangor State (Table 16). They may be even more variable in the equatorial region of south Johor, and they will certainly be more difficult to harvest safely.

TABLE 16 YIELDS FROM FIELD TRIALS IN WEST MALAYSIA (PER ACRE)

Crop		FES Serdang	RRI	FMS, Dept. of Agric.
Maize	(lb)	2000 - 5500	3000 - 3600	2000 - 4000
Sorghum	(lb)	3000 - 6000	4000	3500 - 4000
Upland padi	(lb)			
Soya beans	(lb)	1200	2000	
Cowpeas	(lb)	450 - 2200		
Groundnuts	(lb)	650 - 2200 (shelled dried)	3750 (un-shelled) 2000 shelled dried	2660 (un-shelled)
Tapioca	(tons)	15 (in 12 - 14 months)	12 (in 8 months)	15
Sweet potaotoes (tons)		4-12 (in 23 weeks)		

3.1.2 Topography

In the heavy rainfall conditions within the project area, great care must be taken to minimise erosion. Liability to erosion is increased by soil disturbance, and the risk of erosion is greatest on steep slopes. Since the crops under consideration demand frequent soil disturbance, their cultivation should preferably be confined to areas with an overall average slope of less than 4^{o}. The maximum slope should be 6^{o}. Precautions must be taken to conserve the land against erosion. The nature of the erosion problem and the recommended measures to prevent it are described in Appendix A.

3.1.3 Soils

The physical properties of the soils selected for short term crops are important. The soils must be friable and easy to work into a good seed-bed, must be stable under cultivation; well to imperfectly drained, capable of holding moisture, but never waterlogged. All the soils of the project area are highly leached, acid and of low or very low nutrient status, so that it will be necessary to lime regularly and apply fertilisers generously if good yields are to be sustained on any of them.

3.2 Agronomy

3.2.1 Farming calender

Study of the meteorological data reveals the following general pattern:-

January. 1st half. Usually wet. Starting from 2nd half of January, and through to March, there are likely (P 0.5) to be periods of 10 days without rain, and one year in four droughts may be of 20 days duration. Rainfall, when it comes, may be intense, especially in January and February.

April - May. Inter-monsoonal rains in these months are reliable, well distributed and not often intensive. This is a most favourable period for planting.

June, July, August. Any of these months may have a 15 day drought (P0.25). The usual pattern, however, is for frequent showers, and soil moisture stress is less likely than in February-March.

September-October. Similar to April-May. Favourable for planting.

November-December. Months of high, often intense rainfall. The soil is often saturated and uncultivable. The land should be covered in this period to avoid erosion.

The general conditions described above impose a number of constraints on farming practices and choice of crops. The following rules should be observed for winter cropping:

(a) The winter crop may best be planted in September - October, but the latest sowing date should be mid-October and crops making a quick and complete ground cover should be preferred to prevent erosion.

(b) Crops will best be grown on ridges to control run-off of rain water and avoid damage by water logging. The rows should run on grade between conventional graded channel terraces.

(c) Good harvesting conditions are unlikely to occur before the middle of January. Thus no crop should be sown which has a growing period of less than 90 days, and one requiring less than 100 days imposes a severe constraint on the planting period.

The crops for planting in the autumn and harvesting in late winter which fulfil the above conditions best are: late maturing (140 days) groundnuts, sweet potatoes, eddo, dasheen.

For spring planting (April-May) to harvest between June and September there is more choice. Early maturing groundnuts (110 days); soya beans; cowpeas; sorghum; sweet potatoes, kenaf are all possible crops. Maize appears less attractive, as it is less tolerant of the lengths of drought that could occur any time between June and August.

Tapioca may be planted at most times of the year; varieties have markedly different maturation periods, from as little as 6-7 months to as much as 15 months. Eddoes and dasheens (Chinese yams) are likewise accommodating, with growing lives of 6-7 or more months respectively.

3.2.2 Crop rotations

The simplest rotation is continual monocrop cultivation. Such a system is vulnerable to price falls, and the risk of building-up a specific disease, pest or weed complex to epidemic proportions is greatly increased. Since crops vary in their need for plant nutrients to meet all the requirements by the application of artificial fertilisers will be expensive, especially in the project area, where the soils are low in humus and rapidly lose soluble salts through leaching. The emphasis therefore, certainly in the early years, should be on crops likely to increase fertility, that is legumes to increase nitrogen and others which produce substantial organic residues for return to the soil directly or as dung after passing through livestock. It is therefore desirable to employ a rotation of crops with different requirements and subject to different diseases and pests. This will serve to protect the grower against large price falls of any one commodity.

There are many possible rotations that could be expected to work satisfactorily. The simplest could be alternating tapioca and groundnuts, to give two crops of each in three years Two examples below shown 5 and 6 crops respectively in three years.

Sweet potato/Eddo (yam)	Sweet potato/Eddo (yam)
Sorghum	Sorghum
Groundnuts	Groundnuts
Tapioca	Sorghum
Groundnuts/Soya beans/ cowpeas	Sweet potato/Eddo (yam)
	Groundnuts/Soya beans/Cowpeas

Figure 1 and 2 show these two rotations fitted into the farming calendar.

3.2.3 Farming machinery

Land preparation: the importance of carrying out the proper cultivations thoroughly and at the right time can not be over emphasised. The evidence from many of the developing tropical countries in which the Consultants have worked in recent years is that, in general, insufficient effort is made to obtain a satisfactory seed-bed for plant growth. Since this failure to cultivate adequately is usually associated with a failure to adopt many other essential inputs, such as pure seed of proven varieties, adequate quantities of fertiliser, proper control of weeds, pests and diseases, it is difficult to demonstrate beyond argument to the farmer that the quality of the seed-bed may influence yield and that any extra effort required to prepare the land will be rewarded by a larger harvest. Nevertheless experience elsewhere and observation in Malaysia suggests that losses of crop through incorrect and/or inadequate tillage are very real.

The land preparation operations must not only be aimed at obtaining a suitable medium for rapid crop growth; they must also be designed and carried out in such a way as to give maximum protection to the soil from the destructive erosion that may follow the frequent intense rainstorms. The recommended procedures are fully described in Appendix A.

Land preparation will require either animal or tractor drawn tillage implements. As there is no traditional use of animals in West Malaysia, except in padi cultivation, (and even in this sphere tractors are steadily superseding animals), it is considered that tractors will be needed. The most suitable type and size of tractor will depend on the method of land preparation employed. There are several possibilities and the best for the local conditions will only be found by trial. The main feature of the land after harvest is likely to be the very large quantity of residues that will be left. Since most of the soils are of low organic matter status, it is clearly desirable to incorporate these residues. This can be done very well with a rotovator, but the power requirement is very high, necessitating a tractor of the order of 90 h.p. Rotovation too may leave the soil in a very fine condition, liable to severe erosion in a heavy rainstorm.

A better method of handling the crop residues could be to macerate them with a rotary slasher, and partially incorporate them into the plough layer with disc tillers. Subsequently the land can be ridged, using ridging bodies of the "Lister" type.

The use of a chisel plough rather than discs could be beneficial in cracking possible soil pans and so improving water penetration, but chisel ploughs are usually most effective in dry conditions.

Planting and fertiliser application: grain bulls would need considerable modification to enable them to operate over ridged land. Four-row planters, properly adjusted, should be satisfactory provided that the ridges are stable. Side-dressing of fertilisers within the growing crop should be investigated.

Weed control: weed control is likely to be abundant and control a major problem. Herbicides are expensive and the use of band spraying techniques, which reduce the consumption of material, should be investigated. This leaves the interrows to be weeded by hand or machine, though this may be to a great extent done by the ridging bodies driving the course of re-ridging.

Harvesting: harvesting conditions, particularly for cereal and grain crops, will certainly be difficult in many years. There is no reliable long drought period. The most usual length of rainless period varies between five days (October and November) and 11 days (February). The best periods for grain harvesting would seem to be from, say, 20th January to 28th February, and between June and August. In most years rain would be likely to cause some interference with the operation. Problems are likely to arise through uneven ripening and excessive vegetative growth. To harvest large quantities in the sport suitable periods will require machinery, but the suitability of combine harvesters for sorghum and soya beans will need to be proved by extensive field trials over at least five years. Groundnuts are also likely to be troublesome through the risks moulding, sprouting and aflatoxin infection. Ordinary grain combines can not be used for groundnuts so either special machine will have to be imported (from U.S.A.) or else a part mechanised system of stooking and subsequent threshing used.

Artificial drying will have to be installed. The high grain moisture contents are likely to make "aeration" techniques impracticable, and continuous flow dryers, or batch dryers, will be required. These are not only costly to instal but relatively expensive to operate.

The artificial drying of groundnuts is a particularly slow and costly process, involving low temperatures and several stages with rest periods in between.

Harvesting of root crops by machine may be easier. Since their harvest period can be spread over a long period they can, anyhow, be dug by hand until suitable machinery is devised. Both sweet potatoes and tapioca could conceivably be lifted and windrowed by a chain elevator type of digger. However tuber damage could be high, which would be a serious drawback with sweet potatoes, which have poor storage characteristics.

3.2.4 Crop varieties

Trials have been undertaken at Federal Experiment Stations and/or at the Rubber Research Institute with all the crops mentioned in section 3.2.2. The results have been reported in various Departmental reports, in the Proceedings of the Malaysian Maize and Sorghum Coordination and Improvement Workshop, and at the Crop diversification Conference. However no reported data specific to S.E. Johor has been uncovered.

The most promising varieties are considered to be:-

(a) Sorghum. Wad Bashir; SB65; Dobbs; 655N-Burma; E9; E71; E75; E174; E178; E179; E546; 56-7. Varietal difference in sorghums are so many and so marked that opportunities exist for the plant weeder to develop varieties with specific characteristics.

(b) Soya beans Hardee; Bossier; Improved Pelican; Palmetto; Acadian; Sankou; NK3; S2 In contrast to sorghum there has been little reward to the plant breeder up to the present time. Varieties which ripen their pods at the same time are particularly important to find.

(c) Ground-nuts V-12; USA varieties.

(d) Sweet potatoes Serdang I; Large white;

(e) Cassava Black Twig; Jurai; Green Twig; Kakabu; Medan; Ubi Puteh.

(f) Cowpeas Estados unidos; IC394; IC409; Venezuela 12A.

3.2.5 Seed

<u>Sorghum</u>: optimum planting distance for yield has been found to be 24" x 2", requiring about 130,000 seeds per acre; say 15 lb seed. This seed should be selected from apparently disease free fields and seed should be treated. Both anthracrose leaf spot (<u>Colletotrichum graminicola</u>) and zonate leaf spot (<u>Gloeocercospora sorghi</u>), two destructive diseases, are seed-borne.

Soya beans: planting distance 24" x 4", 2 seeds per hole = 130,000 seeds say 60 lb per acre. Seed must be treated with *Rhizobium japonicum* bacterial culture.

Groundnuts:- best spacing 12" x 4" = 130,000 seeds, say 80 lb shelled nuts per acre.

Sweet potatoes: suggested planting distance 36" x 9". Using "slips", the requirement of "seed" potatoes would be about 5-6 cwt. Vine cuttings may be used instead of slips.

Cassava: by cuttings, 9" long, laid flat. But spacing varies with variety: Suggested are:

$5^1/_3$' x 3'	Black Twig, Jurai, Ubi Puteh	= 2725 plants.
4' x 3'	Green Twig	= 3630 plants
3' x 3'	Melaka	= 4840 plants
3' x 2'	Medan	= 7260 plants.

Using Jurai 3 stalks per plant gave the highest yield.

Cowpeas: planting distance 36" x 12" and 48" x 12" were used by FES Serdang. This seems far too wide. It is suggested that 24" x 6" would be better, say 45,000 seeds per acre, or 20 lb. Seed should be treated with *Rhizobium* culture.

3.2.6 Fertilisers.

The high acidity of most of the soils has already been stressed. Much more work needs to be done on plant/soil/nutrient relationships in West Malaysia, but it is virtually certain that uptake of some nutrients must be at least partly inhibited at the generally low pH levels prevailing. The quantities of lime to be applied and the frequency of application needs to be worked out, but, in a mixed cropping pattern, where crops have widely different demands for calcium and marked differences in tolerance to acidity, it may be best to apply lime in relatively large quantities to the most demanding crops rather than in smaller quantities to every crop in the rotation. It is therefore suggested that, pending some definite experimental evidence on the subject, a general dressing of 30 cwt per acre of lime should be given to the two legume crops in the three year rotations proposed. Since magnesium deficiency is widespread in Johor, a magnesium bearing limestone e.g. dolomite, is to be preferred if it is available, but if not, soluble magnesium can be added in the N.P.K. fertiliser mixture or compound used.

The needs for N.P.K. are discussed below for each crop:

Sorghum: more work is needed. Present recommendation by Serdang Experiment Station for general use is 100 lb N: 60 lb P_2O_5: 40 lb K_2O per acre. The nitrogen dressing may be split, one half applied to the seed-bed with the phosphate and potash, the balance top-dressed later.

Soya beans: not proven. RRI suggests 3-6 cwt dolomite and 12 lb N: 60 lb P_2O_5: 30-60 lb K_2O per acre. FES Serdang has used 30 lb N; 60 lb P_2O_5; 30 lb K_2O and 45 lb N: 40 lb P_2O_5: 90 lb K_2O. RRI has obtained higher yields than FES in reported trials. Since the plant, if inoculated with Rhizobium, nodulates satisfactorily, only small quantities of nitrogen should be required. The high demand for phosphate is agreed, and the potash requirement in S.E. Johor can be expected to be high. Pending the results of local trials, and assuming a dressing of dolomite has been applied as suggested above, the following mixture is suggested: 15lb N; 60 lb P_2O_5: 60 lb K_2O: all in the seed-bed.

Groundnuts: no fertilizer trials reported by FES, but a dressing of 30 lb N: 50 lb P_2O_5: 50 lb K_2O is used. RRI uses the same formula as for soya beans, stipulating that single superphosphate should be used for its sulphur. Again reported yields from RRI are higher than from FES. It is considered that the RRI formula is likely to be superior to that of FES, but trials are required. Pending these it is suggested that the same dressing be given as for soya beans, with the proviso that single superphosphate must be used.

Sweet potatoes: fertilisers have given erratic responses in the FES experiments. The latest thinking is that phosphate is less important than for other crops. Responses to nitrogen are evident in increased yields of both vines and tubers, while potash increased tuber yields. High nitrogen without potash may depress tuber yields. Trials are needed in Johor, until these concluded the following is recommended:-

45 lb N: 15 lb P_2O_5: 90 lb K_2O.

Cassava: early trials by FES showed yield responses to 40 lb N: 30 lb P_2O_5: 70 lb K_2O. Doubling the nitrogen application rate had no further effects. In later trials

50 lb N: 30 lb P_2O_5: 70 lb K_2O as a mixture was compared with
42 lb N: 21 lb P_2O_5: 77 lb K_2O: 10½ lb MgO in the form of 352 lb CCM 44
49 lb N: 49 lb P_2O_5: 49 lb K_2O in the form of 352 lb CCM 66

All three types were also applied at double the above rates. There were no differences in yield between the fertiliser types, but the double rate increased yield significantly, from just under 11 to just over 12 tons per acre. In a second trial with the NPK mixture at the same two rates, the effect of time of N & K application was tested, the treatments being (a) all N & K at planting, (b) half at planting, half top-dressed four months after. None of the treatment effects were significantly different. In a trial with dolomite, no effects were obtained from applications of 1, 2, 3, 4 and 5 cwt/acre.

Experience at RRI is different. There all fertilisers are given in two or three top-dressings. From this conflicting evidence, little can be said with certainty. It appears however that the phosphate requirement is low, the N & K requirements high and closely related, high N being justified only in combination with high K. As far as timing is concerned it might be reasonably expected that, in an environment where soluble salts are rapidly leached, little and often would be more effective than one large application. Equally, however, some fertiliser in the seed-bed should help to get the crop away quickly.

It is suggested that, pending evidence from trials in Johor, the following treatments might be tried:-

30 lb N: 30 lb P_2O_5: 30 lb K_2O at planting
30 lb N: 50 lb K_2O at 2 months old
40 lb N: 60 lb K_2O at 5 months old.

Cowpeas: in FES trials 15 lb N: 30 lb P_2O_5: 30 lb K_2O were given in the seed bed and 15 lb N was added 30 days later (at bud emergence) as a top-dressing. If the seed is inoculated with Rhizobium the top-dressing could be omitted. Dolomite would be applied to this crop.

3.2.7 Weed control

Sorghum: a weedkiller trial at FES in 1969 was unsuccessful. Atrazine 80W and a 2,4-D amine/MSMA mixture both seriously affected germination and growth of sorghum; atrazine has also a long residual effect, and can affect a subsequent legume crop such as soya beans or groundnuts. Ramrod was safe, but ineffective against the important weeds, and there was no yield difference between the Ramrod and control treatments. Lasso, 2-chloro-2, 6'-diethyl-N (Methoxymethyl) acetanilide, has been successfully used in groundnuts, maize, cassava and soya beans to control grass weeds. Sedges and broadleaved weeds, particularly legumes, are resistant. The chemical is applied as a pre-emergence killer at planting time, at the rate of 3-4 pints in 40-60 gallons of water per acre. Respraying may be required after 2 months. This chemical is available in Malaysia and should be tested in sorghum. Pending trials control must be by mechanical or hand weeding.

Soya beans: one pre-emergence spray at planting, with 3 pints per acre of Lasso should be sufficient.

Groundnuts: as for soya beans.

Sweet potatoes: no evidence on the use of herbicides has been found. The crop spreads quickly and smothers weeds effectively. One weeding by hand or machine may be needed early in the post-planting period.

Cassava: a pre-emergence spray at planting time of 3 pints of Lasso per acre has shown promise, suppressing susceptible weeds for 2 months. A second round may be required.

Cowpeas: no data on herbicides. Lasso might be expected to be successful.

3.2.8 Insect control

Sorghum: the principal insect pests are the corn borer, *Ostrinia salientalis* and the corn earworm *Chloridea obsoleta*.

Both attack maize as well as sorghum, but other crops are seldom, if ever, attacked. The corn borer spends two thirds of its life in or on the maize plant in the larval phase, and nearly all of the remaining third is spent pupating within the stem. There may be 12 overlapping generations in a year. Since the pest is specific in its tastes, the practice of crop rotation, avoiding the successive planting of susceptible crops, should be followed. If this is done it should not be necessary to burn the old stalks and trash, which it is desirable to use to maintain fertility. Two insect parasites, a chalcid and an ichneumonid, have been obtained from pupae, but no attempt has yet been made to achieve control of the pest by their mass release.

The most effective insecticides for chemical control have been BHC and dieldrin, the former being currently recommended. It is best used as a wettable powder at 0.1% active ingredient (.35 lb ai) in 35 gallons of water per acre. Four rounds are usually required, at 4, 6, 8 and 10 weeks after sowing.

Corn ear-worm larvae feed externally on the young and tender leaves; they pupate in the soil, about 1" below the surface. The larvae can be effectively destroyed by spraying with 0,1% a.i. of azodrin or dipterex.

Three species of rats are serious pests of maize and sorghum in the field. Two of them, Rattus rattus diardii and also Rattus exulans, are important pests of the grain in storage, as is the mouse, Mus musculus. Zinc phosphide, and anti-coagulants, such as warfarin, racumin and tomorin, are the best poisons to use.

Birds are most destructive of sorghum. Varieties have been developed in Africa which are resistant to bird damage. Artificial scarecrows, scareguns and strings of cans across fields, and shooting are seldom effective. The employment of the young and old as bird watchers and scarers is probably the least ineffective. Three species of munia, two doves, a finch and a sparrow have been recorded or reported to feed on the grain.

Soya beans: a number of caterpillars, beetles, bugs and grasshoppers, among them the pyralid caterpillar, Nacoleia diemenalis, and the chrysomelid beetle, Pagria signata are frequently found feeding on the foliage.

The worst pest, however, is the bean fly, Melanagromyza phaseoli, the maggots of which tunnel through the petiole into the stem of young plants, and finally pupate in the collar, which swells, cracks and rots. The tap root then dies. Control by 3 sprayings at 1, 2 and 3 weeks after sowing with 0.02% diazinon is effective. A similar routine using 0.05% dimethoate (a systemic) was also found to give good control.

The bean pod borer, the caterpillar of the noctuid moth, (Etiella zinckenella), may cause serious damage by boring into the pods and eating the seeds. High volume spraying with 0.1% carbaryl (sevin), at first signs of damage, repeated a fortnight later, gives good control.

Groundnuts: many of the pests attacking soya beans also attack groundnuts, including the pod-borer, which is difficult to control in the underground pods of this crop. Another serious pest is the gelechiid caterpillar, *Stomopteryx subsecivella*; this pest mines the leaf surface, webbing the leaflets together, which are then skeletonised. Low volume spraying with 0.4% trichlorphon at first sign of damage usually controls the pest; a second application after 14 days may be needed.

Sweet potatoes: the weevil (*Cylas formicarius*) can cause severe damage to tubers, and there are numerous foliage feeding insects. The latter can be controlled with DDT, sevin or Azodrin, if the attack is serious but weevils are more difficult to destroy. Treatment of the soil with dieldrin before planting has been successful in the past, but the use of this persistent hydrocarbon has now been banned in some countries and a ban is possible in Malaysia.

Cassava: this crop has so far proved to be free of serious pests.

Cowpeas: in trials at Serdang two serious insect pests were encountered, the bean fly, which is controlled in the same way as on soya beans, and a pod-borer, (*Maruca testulalis*), controlled with 1 lb sevin a.i. in 100 gallons of water.

3.2.9 Disease control

Sorghum: besides the two seed-borne foliar diseases mentioned previously (Section 3.2.5), sorghum is attacked by several leaf spot diseases as follows:-

Black tar spot *Phyllachora sorghi*
Helminthosporium sorghicola
Helminthosporium rostratum
Curvularia lunata

Tar spot is common, but its economic importance remains to be determined. The others are of little importance.

Soya beans: the most serious disease appears to be a leaf wilt caused by the bacterium *Xanthomonas phaseoli*. The variety Palmetto is said to show resistance. Various fungal diseases also cause collar rots and leaf spots of soya beans and other legumes. (See under cowpeas below).

Groundnuts: this crop is attacked by bacterial wilt and also by mosaic virus. The latter can be controlled by spraying the insect vector.

Sweet potatoes: no serious diseases reported.

Cassava: no serious diseases.

Cowpeas: observed diseases are:-

(a)	Damping off	*Pythium sp.*	Serious in wet weather.
(b)	Collar rot	*Rhizoctonia sp.*	Very serious in wet weather.
(c)	Leaf rust	*Uromyces vignae*	Not serious.
(d)	Leaf spot	*Cercospora sp.*	Not serious.
(e)	Wet root	*Choanephora sp.*	Serious in wet weather
(f)	Wilt	*Sclerotium rolfsii*	Not serious

(a), (b), (f) attack the collar; (c) & (d) the leaves and (e) flowers and pods. The use of copper based fungicides will control most of them. Brassicol 75 at 0.3% a.i. is recommended for treatment against collar rot.

3.3 Production Patterns.

The range of suitable short term crops makes mixed cropping very flexible. It is therefore usually possible to select several patterns that are not only technically and economically sound, but also reflect variations in farmers' personal tastes and interests. It is also relatively simple and inexpensive to change the farming plan. This flexibility is likely to make mixed farming more widely attractive than mono-cultural farming. However at the same time it demands of management an ability to make daily decisions of important consequence and to adapt or change policy and cultural practices promptly in response to frequent changes in external economic and environmental influences.

The possible variations may be broadly classified as follows: Without livestock.

(a) Arable crops only: all crops sold for cash, crop residues ploughed in.

(b) Arable crops and grass: all crops and grass sold; crop residues and grass incorporated in the soil.

With livestock

(a) Arable crops only: (i) crops sols, stock feed purchased; residues folded or fed to yarded stock; dung returns to land.

(ii) as above, but some stock feed grown.

(b) Arable crops and grass: (i) all crops and some grass sold; concentrates purchased; residues return to ground.

(ii) fully integrated, self-contained mixed farm. Grass and concentrates grown for stock; dung and residues returned to soil. Balance between stock numbers, ratio of cash crops to crops grown for stock open to variation at farmer's discretion.

It is important that the selected variations in South East Johor must among other requirements,

(a) Be designed to protect the soil from erosion

(b) Maintain or, better increase the inherent fertility of the soil.

Protection from erosion is discussed in detail in Appendix A. It entails a strict adherence to established conservation practices and a close observance of crop calendars to ensure that the rate of water movement over the ground is controlled and that the land is covered at the times of the year when very heavy rainfall is most likely.

Fertility in the climatic conditions prevailing in the project area will not be maintained by reliance on mineral fertilisers alone. If excessively wasteful leaching of soluble nutrients is to be avoided, it will be necessary to build up the humus content of the soils.

With these two objectives in mind the relative merits of the various mixed cropping systems are examined below.

3.3.1 Production without livestock

Cash crops from continuous arable land: this is the simplest system and therefore has some merit in the initial years where the mixed cropping is being introduced to smallholders without previous experience. Fertility maintenance depends entirely on the proper incorporation of crop residues as well as the application of fertilisers, or on the growing or a green manure crop.

Arable and grass farm, all production sold: this is less simple than the above, but remains uncomplicated by the presence of livestock. Its feasibility will depend on a good market for dried grass meal or pellets off the farm. The length of ley can be altered as experience dictates. The system should enable humus to be built up and surface soil structure to be improved, but ley farming in the equatorial regions poses problems, major ones being the difficulty and expense of establishing the sward for the grass break, and of eradicating it from the arable land.

3.3.2 Production with livestock

Cash crops from arable land. All sold. Livestock maintained on purchased food: this simply adds a livestock production enterprise to the farming pattern. The stock would be yarded and the dung returned to the land. The crop/stock integration would be confined to feeding of crop residues to stock folded on the crop, or to stock in yards, carting the residues to the yards and the dung back to the fields. The merits of this system are that it is the simplest form of mixed farming for introduction of the concept to smallholders, and that it yields some saleable production from the crop residues as well as material for fertility maintenance.

Arable crops only, but some grown for stock feed. Stock yarded: this is similar to the last variation except that there is some inter-dependence between crops and livestock.

Arable crops and permanent grass or alternate arable/grass leys: All arable crops and perhaps some grass sold. Concentrate feeds bought in: here some of the land is specifically set aside for providing grass for cattle, but all the arable land produces crops for cash sale. Most of the cattle manure will return to the grass, and the arable land will receive crop residues, unless it is possible to fold or herd the stock on them and so return dung in this manner. Fertility maintenance can be improved by alternating the arable and grass breaks, but as explained previously (3.3.1) there are practical difficulties to contend with.

Fully integrated, self-contained mixed farm. Grass and some (or all) concentrates grown for stock: in this system the livestock and arable enterprises are interdependent and fully integrated, with stock numbers and acreages of grass, arable crops for stock feed and for cash sale all carefully balanced. This balance is open to variation at the farmer's discretion. This system requires the highest degree of management skill, and gives the greatest opportunity for the maximum use of farm by-products and residues, thus reducing waste to a minimum. If the grass/arable sections are alternated in a ley system, maintenance of fertility can be ensured.

APPENDIX A

SOIL CONSERVATION IN JOHOR

1. THE NATURE OF THE PROBLEM

It is probable that the risk of soil erosion in S. East Johor may easily be underestimated. With soils of fair depth, drainage, and fertility, and with high temperatures and high rainfall throughout the year giving dense vegetative cover, the erosion hazard will be masked. With low population pressures there is little disturbance of the natural vegetation but the large scale introduction of annual cropping will bring major changes, and soil conservation measures should cater for the greatly increased rates of erosion and rates of surface run-off which will result from removal of the natural vegetation.

2. THE EROSIVE POWER OF THE RAINFALL

It is possible to calculate the potential power of rainfall to cause erosion from rainfall records. Using the information available a first approximation of this has been made assuming

(a) An annual rainfall of about 100 inches per year
(b) Fairly uniform distribution throughout most of the year, but monthly totals in November and December twice those of the driest month
(c) A high proportion of high intensity rain during November and December
(d) That severe "Sumatras" (live squalls) seldom reach the area.

Using an arbitrary scale to show relative values of annual erosivity the figures are something like

London	2-5
Iowa, U.S.A.	5-10
Southern Rhodesia	15-20
Louisiana, U.S.A.	20-25
Malaya	30-40

There are regions of the world with rainfall of greater potential erosivity, but not many, and not much greater.

3. SOIL ERODIBILITY

Erosivity values are concerned only with rainfall. Soils, vegetation and terrain also influence the amount of erosion which will actually occur. In south-east Johor the influence of soil type is probably the least important; observations made by the Consultants during the course of their field work suggest that, under any similar conditions of rainfall, terrain and vegetative cover, erosion is less severe on soils derived from granite than on those derived from shale.

The removal of the forest cover to develop the land for agriculture will increase the rates of surface run-off of water and of erosion. The few measurements made by the Consultants indicate that stream flows may be 12 percent higher in catchments under rubber and oil palms than in jungle catchments, and that the sediment load may be 50 percent greater.

Erosion is particularly rapid on the steep land of the Project Area, where it may exceed the rate of weathering, so that soil profiles may be shallow. In the undulating and rolling landscapes the terrain is mature, slopes are rounded and the rate of erosion is less. However, where a lowering of base level results in valley incision, the rate of erosion again increases. Thus geological erosion is most rapid in steep lands and valleys.

Although large landslides do occur in steep lands, and small ones are common along the backs of terraces and the sides of incised valleys, erosion in general takes the forms of gradual depletion of the soil surface and soil creep. It is often therefore unobserved. In view of the insidious danger it is essential to confine annual cropping, which may involve frequent disturbance of the soil surface by implements, to slopes within the range of those found in terrain classes 1 and 2, and to take special soil conservation measures, as suggested below.

4. SOIL CONSERVATION MEASURES

4.1 Terrain Class 2 (Average slopes 2^{o}-6^{o})

In view of the high rainfall, crops should be grown on graded ridges between a mainline defence of conventional graded channel terraces. Natural drainage lines should be kept open, and to cater for the high rates of run-off artificial waterways will probably also be required to take the discharge from the channel terraces. These waterways should have a wide, shallow, parabolic section and be grass-lined with a vigorous close-growing runner grass, eg. Cynodon spp. The waterways and channel terraces should cater for rates of run-off of the order of 2 cusecs per acre for soils of good and medium drainage, and 3 cusecs for poorly drained soils.

The channel terraces should discharge directly into the waterways running straight down the slope. They should have a cross-sectional area of about 10 square feet for a gradient of 1/250. The length should be strictly controlled to a maximum of 300 yards. For the spacing down the slope between channel terraces the following intervals are suggested:

Slope degrees	Interval between terraces Heavy Soils feet	Medium Soils feet	Light Soils feet
2	95	115	135
3	80	90	105
4	70	80	95
5	65	75	85
6	65	70	75

For the layout of the smaller ridges between the channel terraces the "String Method" is recommended (North Carolina State College, 1948). This ensures that the ridges are on the same or a steeper gradient as the channel terraces so there is no ponding or waterlogging. The basic rule is that, when the channel terraces are converging, the ridges follow the top one, and when diverging, they follow the lower one.

4.2 Terrain Class 1 (Slopes 0^{o}-2^{o})

On these gentler slopes the same system of channel terraces and waterways will certainly work, but, in the flattest parts, it may well be worth trying the simpler system called bedding (USA) or ridge and furrow (Rhodesia). The process is simply to plough inwards narrow strips of land varying in width from 30-48 feet and to leave an open furrow between these ridges. The chosen width of the strip should be a multiple of six feet in order to facilitate planting of row crops. By repeating annually the inward ploughing on the same strips a series of stabilised undulations is obtained.

It is essential that the ridges should be graded sufficiently to provide a constant fall, and where the land is very flat ploughing of the ridges should be preceded by an accurate contour survey. The method has worked well on grades as low as 1:400, provided that the ridges are high enough; they should if possible be 15-18 inches above the level of the furrow bottom, but never less than 12 inches. The length of furrow should normally be not more than 400 yards. All natural waterways should be used to take the discharge from the furrows, and additional artificial waterways must be provided if necessary. Adequate storm drains to divert water round the fields must also be provided.

5. CONSTRUCTION AND MAINTENANCE

For the channel terraces, and ridge and furrow layouts a once-only job with heavy machinery will be most efficient, but subsequent maintenance, and the raising of the crop ridges can be done with light equipment. The crop ridges can be put up by walking tractors in light and medium soils.

6. CULTIVATION

The use of rotary slashers to macerate crop residues and facilitate their return to the soil is recommended. For primary cultivation chisel ploughs are to be preferred to rotavators. The latter produce an excellent tilth and incorporate the crop residues very well but examples can be quoted of a complete 9 inch layer of rotavated soil being washed away in a single storm of say three inches of rain, to which is not an uncommon occurrence in the Project Area. An adequate but less erodible tilth should be obtainable with ploughs and discs.

Minimum cultivation is well worth trying, for the provision of a good surface mulch may be the best way of reducing run-off and erosion. If the consequent increased penetration of rain leads to waterlogging an alternative variation would be "trash-farming", that is the incorporation of large amounts of organic residues by tillage into the plough layer. This practice does not prevent subsequent ridging. The method has been very effective in Africa, where it was found that, even when the mulch was incorporated by disc tillers and so only partly buried, it was just as effective in reducing erosion as when left entirely on the surface.

APPENDIX B

SOME PRELIMINARY MIXED CROP ENTERPRISE EVALUATIONS

1. INTRODUCTION

In the body of this paper the market potential and the production problems of a number of short term crops have been discussed. Except for tapioca these crops are generally unlikely to be grown on a monocultural basis, but will be fitted together into a rotational pattern as discussed in section 3. There are too many practicable combinations for all to be considered, but in this appendix three possible large scale (1000 acres) schemes using different rotations have been evaluated.

In addition to the 1000 acre units three smaller sizes of 60, 24 and 15 acres respectively have been considered, and their costs and returns discussed. A number of costs and yield assumptions are common and these will be given before the different enterprises are discussed.

(a) Land clearance: clean clearance including burning, stumping, sub-soiling, root removal is costed at \$350 per acre for the net acreage.

(b) Farm roads: a flat rate of \$17 per net acre has been taken for the large units, \$20 per net acre for smaller holdings. The increase is taken because it is assumed that a greater length of access roads would be required. Maintenance has been assumed as 2½ percent per annum.

(c) Housing: the following costs have been taken:-

(1) Labourers, mandores, tractor drivers	- \$2,000
(2) Mechanics, clerks, field assistants	- \$5,000
(3) Manager	-\$20,000

Maintenance charged at 1½ percent per annum.

(d) Wages:

unskilled casual labour	\$3.50 per day
Regular labour	\$100-120 per month
Tractor drivers	\$160 " "
Clerk/stopkeeper	\$160 " "
Mandores	\$160 " "
Mechanics	\$240 " "
Field assistant-conductor	\$300-400 " "
Assistant manager	\$700-900 " "
Manager	\$1,500 " "

In addition provident fund contributions are paid for employed persons at the rate of 5 percent of wages paid.

(e) Premium and rent: the premium has been taken as $50 per gross acre. It is assumed that the gross acreage is 110 percent of the net acreage, i.e. about 10 percent of the total area is unused. Land rent is taken at the rate of $3 per gross acre, that at present applied to land for padi and vegetables.

(f) Machinery: machinery costs have been estimated in two stages. Having determined the number and type of machines required the annual work hours were estimated. From data from the University of Malaya, and from other sources, the variable cost per hour of use, i.e. fuel, spares, maintenance, was estimated. The annual operating cost was thus determined. Capital costs were included at the time of initial purchase or replacement, the latter determined by expected machine life and annual usage rates. Costs for some of the items specified are estimates since the relevant machines do not exist at present, but most of them should be well within the capacity of local workshops to produce.

(g) Fertilizers: (i) lime: all the crops considered here grow best under less acid conditions than will naturally be obtained here. A soil pH range of 5.5-6.0 will be preferred. The amounts of lime necessary to maintain this level under the type of cropping we are considering not known. It has been assumed that one ton per acre per year will be adequate. This would probably be added, to the soil at about 3 tons per acre every third year. This therefore assumes that lime will be available from a site near the project area. If it is not a higher price level will have to be charged.

(ii) other fertilizers: these have been based upon recommendations made in section 3 of this paper and are as follows:-

Maize, sorghum: 100 lb N, 60 lbs P_2O_5, 40 lb K_2O. Half of the nitrogen to be applied to the seedbed and the remainder as a topdressing.

The fertilisers used and their cost are

3½ cwt Nitro 26	$47.60
1½ cwt superphosphate	$20.10
75 lb muriate of potash	$ 7.00
	$74.70

Soya beans, groundnuts: the recommended application is 15 lb N, 60 lb $P_2 O_5$, 60 lb $K_2 O$ as follows:-

60 lb Nitro - 26	$ 9.17
150 lb Super phosphate	$20.00
100 lb Muriate of Potash	$11.00
	$40.17

Sweet potatoes: the recommended application is 45 lb N, 15 lb $P_2 O_5$, 90 lb $K_2 O$ as follows:

175 lb Nitro - 26	$21.16
375 lb Super phosphate	$ 6.02
150 lb Muriate of Potash	$13.90
	$41.08

Tapioca: recommendations are as follows:

(a) 30 lb N, 30 lb P_2O_5: 30 lb K_2O at Planting

(b) 30 lb N, 50 lb K_2O at 2 months

(c) 40 lb N, 60 lb K_2O at 5 months

The respective fertiliser requirements and costs are:

(a)	120 lb No - 66	$27.1
(b)	115 lb Nitro - 26	$14.42
	83 lb Muriate of Potash	$ 7.78
(c)	155 lb Nitro - 26	$19.23
	100 lb Muriate of Potash	$ 9.34
		$77.87

These fertiliser rates are assumed to be applied on large units in years 1 and 2; thereafter rates are assumed to rise at 2 percent per year.

Smallholders obtaining high yields start at 10 percent lower levels rising at 2½ percent per year. Average smallholders begin at 20 percent lower levels but rise at 3 percent per year.

(h) Prices: the following farmgate prices have been assumed as being constant over the 20 years planning period

Sorghum	=	$10.40 per pikul	
Maize	=	$11.30 " "	
Soya beans	=	$19.00 " "	
Groundnuts	=	$26.67 " "	(= 20 cts/lb) shelled nuts
Sweet Potatoes	=	$25.00 per ton	
Tapioca	=	$25.00 " "	

(i) Yields: except for tapioca three sets of yield assumptions have been made, one for large units and two for smallholders, one of the latter being for average smallholders and the other for the best (the top 5-10 percent). For tapioca only one set of assumptions has been used for smallholders.

Sorghum

Year	Large Unit	Yield per Acre (Pikuls) Smallholders High Yield	Average Yields
1	20	16	13
2	20	16	13
3	22	17.5	13.5
4	23.5	19	14
5	25.5	20.5	14.5
6	28	22	16
7	30	25	19
8	31.5	27.5	22.5
9	33	29.5	25
10	34	31	27
11	35	32	28.5
12	36	33	29.5
13	36.5	34	30.25
14	37	35	31
15	37.5	35.5	31.5
16	38	36	32
17	38.5	36.5	32.5
18	39	37	33
19	39.5	37.5	33.5
20	40	38	34

Maize

Year	Large Unit	Yield per Acre (Pikuls) Smallholders High Yield	Average Yields
1	15.0	12.0	9.75
2	15.0	12.0	9.75
3	16.65	13.125	10.125
4	17.25	13.875	10.50
5	18.90	15.0	10.875
6	20.80	16.5	12.0
7	22.50	18.75	13.25
8	23.625	20.625	16.875
9	24.75	22.125	18.75
10	25.5	23.25	20.25
11	26.25	24.0	21.0
12	27.0	24.75	22.0
13	27.375	25.5	22.5
14	27.75	26.125	23.25
15	28.125	26.625	23.625
16	28.50	27.0	24.0
17	28.875	27.375	24.375
18	29.25	27.75	24.75
19	29.625	28.125	25.125
20	30.0	28.5	25.5

Soyabeans

Year	Large Unit	Yield per Acre (Pikuls) Smallholders High Yield	Average Yields
1	12.0	10.8	9.9
2	12.0	10.8	9.9
3	12.6	11.25	10.05
4	13.05	11.7	10.20
5	13.65	12.0	10.35
6	14.4	12.6	10.8
7	15	13.5	11.7
8	15.45	14.25	12.75
9	15.9	14.85	13.5
10	16.2	15.3	14.1
11	16.5	15.6	14.5
12	16.8	15.9	14.85
13	16.95	16.2	15.05
14	17.1	16.4	15.3
15	17.25	16.65	15.45
16	17.4	16.8	15.75
17	17.55	16.95	15.9
18	17.7	17.1	16.05
19	17.85	17.25	16.20
20	18.0	17.4	16.35

Groundnuts

Year	Large Unit	Yield per Acre (Pounds) Smallholders High Yields	Average Yields
1	1400	1150	980
2	1400	1150	980
3	1520	1250	1010
4	1580	1325	1040
5	1730	1400	1070
6	1880	1520	1160
7	2000	1700	1340
8	2090	1850	1550
9	2180	1970	1700
10	2240	2060	1820
11	2300	2120	1880
12	2350	2180	1940
13	2390	2220	2000
14	2420	2280	2060
15	2450	2330	2090
16	2480	2360	2150
17	2510	2390	2180
18	2540	2420	2200
19	2570	2450	2220
20	2600	2480	2240

Sweet Potatoes

Year	Large Unit	Yield per Acre (tons) Smallholders	
		High Yields	Average Yields
1	6.0	4.8	3.9
2	6.0	4.8	3.9
3	6.6	5.25	4.05
4	7.05	5.7	4.2
5	7.65	6.0	4.35
6	8.3	6.6	4.8
7	9.0	7.5	5.7
8	9.5	8.25	6.75
9	9.9	8.85	7.5
10	10.2	9.3	8.1
11	10.5	9.6	8.55
12	10.8	9.9	8.85
13	10.95	10.2	9.10
14	11.1	10.5	9.3
15	11.25	10.65	9.45
16	11.4	10.8	9.6
17	11.55	10.95	9.75
18	11.7	11.1	9.9
19	11.85	11.25	10.05
20	12.0	11.4	10.2

1.1 Fifteen Acre Holding

This holding is based upon the use of a 9 hp two wheeled power tiller used for cultivations, planting and some interrow cultivation.

1.1.2 Cropping pattern

10 acres sorghum
10 acres groundnuts
5 acres tapioca

1.1.3 Cropping schedule

Sorghum planted April, harvested July.
Groundnuts planted October, harvested February
Tapioca 2 acres planted April, harvested Jan-March
3 acres planted September, harvested June-August

The rotation is then either,
Sorghum, Groundnuts, Sorghum, Groundnuts, Tapioca
or Groundnuts, Sorghum, Groundnuts, Sorghum, Tapioca.
Both extend over 3 years.

1.1.4 Machinery

The total investment in machinery amounts to $4870, broken down as follows:-

Two wheel power tiller + cultivator	$3500
Ridger	$ 120
Planter	$ 500
Groundnut lifter	$ 250
Trailer	$ 500

As far as is known neither the planting attachment nor groundnut lifter are at present available in Malaysia but they could, it is thought, be made here fairly simply. Annual usage of this machinery is assumed to be:

Tractor	600 hrs at $2.00/hr	=	$1200
Ridger	75 hrs at 0.15/hr	=	$ 11
Planter	45 hrs at 0.40/hr	=	$ 18
Groundnut lifter	20 hrs at 0.40/hr	=	$ 20
Trailer	250 hrs at 0.20/hr	=	$ 50
			$1289

Two rotovations are assumed to prepare the seed bed, the first taking 4 hours per acre, the second three. The planter, used for sorghum and groundnuts, would be a simple attachment on the back of the machine which would dribble seed down into the centre of a low ridge made by two small offset discs. The rotary cultivator would continue to operate, perhaps with one or two outside bladers removed. Basal fertiliser dressings would be applied by hand after planting. Planting would require about 2.2 hours per acre and ridging 3 hours.

It is assumed that the sorghum crop would be combined direct by contract, and a charge of $30 per acre has been included for this. In addition drying will certainly be necessary and 40 cents per pikul has been charged. The groundnut crop cannot be combined direct (see section 3). It has been assumed that lifting and turning (the latter by hand) would take 12 hours per acre. This has to be done in February in order to maximise the chance of a good dry spell.

For tapioca, ridging would be carried out before planting. Planting including sett cutting, is assumed to take 21 hours per acre, and harvesting 120 hours per acre, carried out by hand. Haulage of wet roots to a local collection centre would be by means of the two-wheel tractor and its trailer. This type of unit can usually take up to about ½ ton loads.

Monthly labour requirements are:-

Month	Labour required (hours)
January	128
February	125
March	200
April	123
May	63
June	153
July	120
August	120
September	177
October	62
November	71
December	-

In computing net present values and internal rates of return a monthly income of $150 per month has been charged to the smallholder. The net cash flow for both average yield and high yield assumptions are given in Tables B1 and B2. Under both yield projections the net cash flow (undiscounted) is negative, i.e. the operator would never be able to repay his capital in the 20 years period, even if no interest were charged.

Except in March and perhaps September this holding would not require the full-time labour of one man. Some time would be available for an additional activity to provide extra return, e.g. some goats, fishpond, etc. However the greater the number of enterprises to be managed, the greater the management problem, and the individuals working such holdings are likely to be particularly short of management experience.

A larger sized holding, 24 acres, was therefore investigated in order to try and better utilize available time.

1.2 Twenty-Four Acre Holding

The organization of this holding is basically similar to that of the 15 acre example above. However, in the cropping pattern groundnuts are replaced by soyabeans, which is now:-

Sorghums	16 ac.
Soyabeans	16 ac.
Tapioca	8 ac.

This has been done for two reasons. During groundnut harvest the required hand turning of the crop must be done within a few days. One family could probably handle 10 acres, but the 16 acres required here would be too great a task especially as labour is likely to be short at this time of year as it is the most intense harvesting period. Secondly, in order to handle more tapioca the amount harvested in the January-March period would have to be increased and this is not possible if a large acreage of groundnuts have to be handled as well. The soyabeans however, can be combined direct and a charge of $30 per acre has been made. This releases family labour for tapioca harvest.

The machinery requirement is in fact reduced by $250 as a groundnut lifter is not now required. However, the power tiller has to be replaced after 5 years because

...

TABLE B1. 15 ACRE HOLDING (AVERAGE YIELDS) COSTS, SALES AND NET CASH FLOW ($)

Year	Land Clearance	Housing	Roads	Buildings	Machinery Capital	Machinery Operating	Seed	Lime	Ferti-liser	Sprays	Premium & Rent	Other	Own Salary	Combine Hire	Total Costs	Total Sales	N.C.F.
1	7,500	2,000	300	600	4,890	1,289	440	450	1,207	300	825	150	1,800	600	22,351	3,162	-19,189
2	-	30	7	9	-	1,289	440	450	1,207	300	49	150	1,800	600	6,351	4,412	- 1,919
3	-	30	7	9	-	1,289	440	450	1,243	300	49	150	1,800	600	6,367	4,643	- 1,724
4	-	30	7	9	-	1,289	440	450	1,280	300	49	150	1,800	600	6,404	4,876	- 1,528
5	-	30	7	9	-	1,289	440	450	1,318	300	49	150	1,800	600	6,442	5,108	- 1,334
6	-	30	7	9	-	1,289	440	450	1,358	300	49	150	1,800	600	6,482	5,429	- 1,053
7	-	30	7	9	3,720	1,289	440	450	1,399	300	49	150	1,800	600	10,243	6,133	- 4,110
8	-	30	7	9	-	1,289	440	450	1,441	300	49	150	1,800	600	6,565	6,882	317
9	-	30	7	9	-	1,289	440	450	1,484	300	49	150	1,800	600	6,608	7,480	872
10	-	30	7	9	-	1,289	440	450	1,528	300	49	150	1,800	600	6,652	7,908	1,256
11	-	30	7	9	1,250	1,289	440	450	1,574	300	49	150	1,800	600	7,948	8,234	286
12	-	30	7	9	-	1,289	440	450	1,621	300	49	150	1,800	600	6,745	8,447	1,702
13	-	30	7	9	3,720	1,289	440	450	1,670	300	49	150	1,800	600	10,464	8,700	- 1,764
14	-	30	7	9	-	1,289	440	450	1,720	300	49	150	1,800	600	6,844	8,735	1,891
15	-	30	7	9	-	1,289	440	450	1,772	300	49	150	1,800	600	6,896	8,995	2,099
16	-	30	7	9	-	1,289	440	450	1,825	300	49	150	1,800	600	6,949	9,222	2,273
17	-	30	7	9	-	1,289	440	450	1,880	300	49	150	1,800	600	7,004	9,329	2,325
18	-	30	7	9	-	1,289	440	450	1,936	300	49	150	1,800	600	7,060	9,417	2,357
19	-	30	7	9	3,720	1,289	440	450	1,994	300	49	150	1,800	600	10,838	9,567	- 1,271
20	-	30	7	9	-	1,289	440	450	2,054	300	49	150	1,800	600	7,178	9,656	2,478
															162,371	146,335	-16,036
N.P.V. at 15%	7,500	2,186	344	656	7,803	9,279	3,169	3,239	10,023	2,159	1,128	1,079	12,956	4,320	65,841		
% of Total Cost	11.39	3.32	0.52	1.00	11.85	14.09	4.81	4.92	15.22	3.28	1.72	1.64	19.68	6.56	100		

TABLE B2. 15 ACRE HOLDING. (HIGH YIELDS). COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Buildings	Machinery Capital	Machinery Operating	Seed	Lime	Ferti-liser	Sprays	Premium & Rents	Other	Own Salary	Combine Hire	Total Costs	Total Sales	N.C.F.	D.C.F. @ 15%
1	7,500	2,000	300	600	4,890	1,289	440	450	1,368	300	825	150	1,800	600	22,512	3,785	- 18,727	- 16,477
2	-	30	7	9	-	1,289	440	450	1,368	300	49	150	1,800	600	6,492	5,035	- 1,457	- 1,267
3	-	30	7	9	-	1,289	440	450	1,402	300	49	150	1,800	600	6,526	5,499	- 1,027	- 777
4	-	30	7	9	-	1,289	440	450	1,437	300	49	150	1,800	600	6,561	5,918	- 643	- 423
5	-	30	7	9	-	1,289	440	450	1,473	300	49	150	1,800	600	6,597	6,334	- 263	- 150
6	-	30	7	9	-	1,289	440	450	1,510	300	49	150	1,800	600	6,634	6,713	79	39
7	-	30	7	9	3,720	1,289	440	450	1,548	300	49	150	1,800	600	10,392	7,417	- 2,975	- 1,286
8	-	30	7	9	-	1,289	440	450	1,587	300	49	150	1,800	600	6,711	7,951	1,240	466
9	-	30	7	9	-	1,289	440	450	1,627	300	49	150	1,800	600	6,751	8,443	1,692	553
10	-	30	7	9	-	1,289	440	450	1,668	300	49	150	1,800	600	6,792	8,764	1,972	561
11	-	30	7	9	1,250	1,289	440	450	1,710	300	49	150	1,800	600	8,084	9,040	956	236
12	-	30	7	9	-	1,289	440	450	1,752	300	49	150	1,800	600	6,876	9,254	2,378	511
13	-	30	7	9	3,720	1,289	440	450	1,796	300	49	150	1,800	600	10,640	9,493	- 1,147	- 214
14	-	30	7	9	-	1,289	440	450	1,841	300	49	150	1,800	600	6,965	9,707	2,742	446
15	-	30	7	9	-	1,289	440	450	1,887	300	49	150	1,800	600	7,011	9,851	2,840	401
16	-	30	7	9	-	1,289	440	450	1,934	300	49	150	1,800	600	7,058	10,021	2,963	364
17	-	30	7	9	-	1,289	440	450	1,982	300	49	150	1,800	600	7,106	10,127	3,021	323
18	-	30	7	9	-	1,289	440	450	2,032	300	49	150	1,800	600	7,156	10,235	3,079	286
19	-	30	7	9	3,720	1,289	440	450	2,083	300	49	150	1,800	600	10,927	10,404	- 523	- 42
20	-	30	7	9	-	1,289	440	450	2,135	300	49	150	1,800	600	7,259	10,512	3,253	229
															165,050	164,503	- 547	- 16,221
N.P.V at 15%	7,500	2,186	343	656	7,803	9,278	3,167	3,239	11,087	2,159	1,128	1,079	12,956	4,319	66,905			
% of Total Cost.	11.21	3.27	0.51	0.98	11.66	13.87	4.74	4.84	16.57	3.23	1.69	1.61	19.36	6.46	100			

of the increased annual use rate. Recurrent costs are:-

Tractor	860 hours at	$2.00 =	$1720
Ridger	111 hours at	0.15 =	17
Planter	70 hours at	0.40 =	28
Trailer	400 hours at	0.20 =	80
			$1845

The same methods would be used as in the 15 acre example. Monthly labour requirements are:-

Month	Labour Required (hours)
January	120
February	180
March	193
April	193
May	197
June	206
July	204
August	212
September	208
October	163
November	53
December	17

Allowing an extra 10 percent for general chores and contingencies the average requirement in the February-October period is 210 hours per month. Assuming 20 days available per month on average this would mean 20, 10½ hour days, thus requiring about 1¼ man-units for operation.

Tapioca operations are phased as follows:-

Month	Planting (acres)	Harvesting (acre)
January	-	1.0
February	-	1.5
March	-	0.5
April	3	-
May	-	0.8
June	-	1.5
July	-	1.7
August	-	1.0
September	5	-
October	-	-
November	-	-
December	-	-

TABLE B3. 24 ACRE HOLDING (AVERAGE YIELDS). COSTS, SALES AND CASH FLOW ($)

Year	Land Clearance	Housing	Roads	Buildings	Machinery Capital	Machinery Operating	Seed	Lime	Fertiliser	Sprays	Premium & Rent	Other Costs	Own Salary	Combine Hire	Total Costs	Total Sales	N.C.F.	D.C.F. @ 15%
1	12,000	2,000	480	600	4,620	1,845	256	720	1,932	384	1,320	120	1,800	960	29,037	5,010	-24,027	-20,427
2	-	30	12	9	-	1,845	256	720	1,932	384	79	120	1,800	960	8,147	7,010	- 1,137	- 898
3	-	30	12	9	-	1,845	256	720	1,990	384	79	120	1,800	960	8,205	7,335	- 870	- 658
4	-	30	12	9	-	1,845	256	720	2,050	384	79	120	1,800	960	8,265	7,659	- 606	- 398
5	-	30	12	9	-	1,845	256	720	2,111	384	79	120	1,800	960	8,326	7,984	- 342	- 196
6	-	30	12	9	3,500	1,845	256	720	2,174	384	79	120	1,800	960	11,889	8,357	- 3,532	- 1,756
7	-	30	12	9	120	1,845	256	720	2,239	384	79	120	1,800	960	8,574	9,203	629	272
8	-	30	12	9	-	1,845	256	720	2,306	384	79	120	1,800	960	8,521	10,074	1,553	584
9	-	30	12	9	-	1,845	256	720	2,375	384	79	120	1,800	960	8,590	10,796	2,206	721
10	-	30	12	9	-	1,845	256	720	2,446	384	79	120	1,800	960	8,661	11,294	2,633	749
11	-	30	12	9	4,500	1,845	256	720	2,519	384	79	120	1,800	960	13,234	11,752	- 1,482	- 366
12	-	30	12	9	-	1,845	256	720	2,595	384	79	120	1,800	960	8,810	12,016	3,206	689
13	-	30	12	9	120	1,845	256	720	2,673	384	79	120	1,800	960	9,008	12,295	3,287	614
14	-	30	12	9	-	1,845	256	720	2,753	384	79	120	1,800	960	8,968	12,489	3,521	572
15	-	30	12	9	-	1,845	256	720	2,836	384	79	120	1,800	960	9,051	12,613	3,562	503
16	-	30	12	9	3,500	1,845	256	720	2,921	384	79	120	1,800	960	12,636	12,882	246	30
17	-	30	12	9	-	1,845	256	720	3,009	384	79	120	1,800	960	9,224	13,006	3,782	404
18	-	30	12	9	-	1,845	256	720	3,099	384	79	120	1,800	960	9,314	13,131	3,817	355
19	-	30	12	9	120	1,845	256	720	3,192	384	79	120	1,800	960	9,527	13,555	3,828	309
20	-	30	12	9	-	1,845	256	720	3,288	384	79	120	1,800	960	9,503	13,480	3,977	280
															207,490	211,741	4,251	-18,708
N.P.V. at 15%	12,000	2,186	554	656	7,986	13,281	1,843	5,183	16,046	2,764	1,810	864	12,957	6,910	85,040	5% =	-11,565	
% of Total Cost.	14.10	2.57	0.65	0.77	9.39	15.62	2.17	6.09	18.87	3.25	2.13	1.02	15.24	8.13	100		IRR =	1.35%

TABLE B4. 24 ACRE HOLDING (HIGH YIELDS). COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Buildings	Machinery		Seed	Lime	Ferti-liser	Sprays	Premium & Rent	Other Costs	Own Salary	Combine Hire	Total Costs	Total Sales	N.C.F.	D.C.F. @ 15%
					Capital	Operating												
1	12,000	2,000	480	600	4,620	1,845	256	720	2,173	384	1,320	120	1,800	960	29,278	5,757	-23,521	-23,521
2	-	30	12	9	-	1,845	256	720	2,173	384	79	120	1,800	960	8,388	7,757	- 631	- 549
3	-	30	12	9	-	1,845	256	720	2,227	384	79	120	1,800	960	8,442	8,330	- 112	- 85
4	-	30	12	9	-	1,845	256	720	2,283	384	79	120	1,800	960	8,498	8,903	405	266
5	-	30	12	9	-	1,845	256	720	2,340	384	79	120	1,800	960	8,555	9,432	877	502
6	-	30	12	9	3,500	1,845	256	720	2,399	384	79	120	1,800	960	12,114	9,850	- 2,264	- 1,125
7	-	30	12	9	120	1,845	256	720	2,459	384	79	120	1,800	960	8,794	10,696	1,902	822
8	-	30	12	9	-	1,845	256	720	2,520	384	79	120	1,800	960	8,735	11,317	2,582	971
9	-	30	12	9	-	1,845	256	720	2,583	384	79	120	1,800	960	8,798	11,916	3,118	1,019
10	-	30	12	9	-	1,845	256	720	2,648	384	79	120	1,800	960	8,863	12,289	3,426	974
11	-	30	12	9	4,500	1,845	256	720	2,714	384	79	120	1,800	960	13,429	12,637	- 792	- 196
12	-	30	12	9	-	1,845	256	720	2,782	384	79	120	1,800	960	8,997	12,886	3,889	836
13	-	30	12	9	120	1,845	256	720	2,851	384	79	120	1,800	960	9,186	13,235	4,049	756
14	-	30	12	9	-	1,845	256	720	2,922	384	79	120	1,800	960	9,137	13,454	4,317	701
15	-	30	12	9	-	1,845	256	720	2,995	384	79	120	1,800	960	9,210	13,608	4,398	621
16	-	30	12	9	3,500	1,845	256	720	3,070	384	79	120	1,800	960	12,785	13,832	1,047	129
17	-	30	12	9	-	1,845	256	720	3,147	384	79	120	1,800	960	9,362	13,957	4,595	491
18	-	30	12	9	-	1,845	256	720	3,226	384	79	120	1,800	960	9,441	14,081	4,640	431
19	-	30	12	9	120	1,845	256	720	3,307	384	79	120	1,800	960	9,642	14,306	4,664	377
20	-	30	12	9	-	1,845	256	720	3,390	384	79	120	1,800	960	9,605	14,430	4,825	339
															211,259	232,673	21,414	-12,641
N.P.V. at 15%	12,000	2,186	554	655	7,986	13,281	1,843	5,183	17,604	2,764	1,810	865	12,956	6,910	86,597		5% = - 322	
% of Total Cost.	13.86	2.52	0.64	0.76	9.22	15.34	2.13	5.99	20.33	3.19	2.09	1.00	14.95	7.98	100		I.R.R. = 4.95%	

The cash flows on both high and average yield assumptions are given in Tables B3 and B4. Under average yields the internal rate of return is 1 percent (allowing a $150 per month income to the operator), under high yields this rises to 5 percent.

1.3 Sixty Acre Holding

The 60 acre holding was taken to investigate the possibilities of holdings large enough to require a small four-wheeled tractor (in the 20-25 h.p. range) but small enough to be worked by one or two men.

The basic cropping pattern is similar to that for the 15 acre holding reviewed earlier:-

Sorghum	40 acres,	plant March-April, harvest June-July.
Groundnuts	40 acres,	plant September-October, harvest February.
Tapioca	20 acres.	

Tapioca phasing is as follows:-

Month	Plant (acres)	Harvest (acres)
January	-	2.5
February	-	2.7
March	-	2.5
April	5	1.3
May	4	1.3
June	-	3
July	-	3
August	5	1.3
September	6	1.3
October	-	-
November	-	-
December	-	-

Because of the use of a four-wheeled tractor with three-point linkage and hydraulic lift a much wider range of equipment can be used. The following has been assumed:-

Item	Cost $	Annual Use	Cost/hour	Annual Cost	Life (years)
Tractor	6500	1340	1.50	2010	6
Rotary Cultivator	1000	300	1.00	300	5
Chisel Plough	1000	130	0.50	65	12
Ridger	300	130	0.20	26	10
Planter	2000	80	1.50	120	10
Sprayer	1050	30	0.75	23	10
Groundnut lifter	1500	53	0.75	40	12
Tapioca plough	500	40	0.50	20	12
Trailer	2000	400	0.50	200	10
	15850			2804	

Operations would be carried out as follows:-

<u>Cultivation</u>: 1 chisel plough - 1.3 hours/acre
1 rotovation - 3 hours/acre
Ridge - 1.3 hours/acre

Planting: sorghum and groundnuts 2 acres/hour. This would be carried out by a planter which put the seed into the top of the ridge and applied fertiliser. It would probably be mounted on a toolbar, with drive off a wheel to regulate seeding rate. It could be adapted as a fertiliser distributor by removing the seedboxes and it has been assumed that top-dressing is done in this way.

Tapioca planting has been assumed to be by hand at 6 man-days per acre, including set-cutting. Manuring with the modified planter as above.

<u>Weed and pest control</u>: tractor-mounted spray 6 acres per hour. A pre-emergence weedkiller such as Lasso has been assumed to be applied after planting. Allowance has been made for 3 sprayings of sorghums and two of groundnuts. Twelve dollars per acre has been allowed for cost of chemicals.

<u>Harvesting</u>: (a) sorghum - direct combining. A charge has been made of $30 per acre.

(b) groundnuts: mechanically lift (1.3 hours/ acre). The crop will need to be turned, possibly twice before combining. An ordinary swath-turner should cope with this and 1.3 hours/acre have been allowed. It has been assumed that it would be possible to dry the crop adequately in the windrow, as the probability of rain in February is low. Otherwise a lot of hard work and possible use of tripods would be needed.

(c) tapioca: roots loosened in the ground by special tines attached to the chisel plough frame. The roots could then possibly be pulled out of the ground fairly quickly. Haulage to pick-up point by tractor and trailer. It has been assumed that labour could be cut to 10 man-days per acre by these means.

Labour: hand labour and tractor hours per month are:-

Month	Tractor Hours	Hand Labour - hours
January	32	200
February	159	216
March	243	200
April	95	224
May	52	200
June	36	296
July	72	264
August	178	224
September	124	248
October	40	-
November	-	-
December	-	-

Some of the surplus labour in the October-December period could probably be used for hand weeding.

The operator of a holding of this type has been assumed to have had some training and probably be equivalent at least to a Junior Agricultural Assistant. Because of this a monthly salary of $240 per month has been charged to him. The additional worker has been charged at $120 per month.

It has also been assumed that yields on a farm of this type would be equal to those obtained by the top 10 percent of smallholders on the 15 and 24 acre holdings, and appropriate fertiliser applications have also been assumed.

The accompanying table shows the costs and sales for a 60 acre holding for the 20 year period. The internal rate of return has been estimated at 10 percent an improvement over that for the smaller holdings.

TABLE B5. SIXTY ACRE HOLDING. COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Buildings	Machinery Capital	Machinery Operating	Seed	Lime	Fertiliser	Sprays	Salaries Owner	Salaries Worker	E.P.F.	Premium & Rent	Other Expenses	Combine & Drier	Elec.& Water	Total Costs	Total Sales	N.C.F.
1	30,000	7,000	1,200	1,800	15,850	2,800	1,760	1,800	5,436	960	2,880	1,440	72	3,300	300	1,200	500	78,298	15,140	-63,158
2	-	105	30	27	-	2,800	1,760	1,800	5,436	960	2,880	1,440	72	198	300	2,400	500	20,708	20,140	- 568
3	-	105	30	27	-	2,800	1,760	1,800	5,572	960	2,880	1,440	72	198	300	2,400	500	20,844	22,000	1,156
4	-	105	30	27	-	2,800	1,760	1,800	5,711	960	2,880	1,440	72	198	300	2,400	500	20,983	23,670	2,687
5	-	105	30	27	-	2,800	1,760	1,800	5,854	960	2,880	1,440	72	198	300	2,400	500	21,126	25,340	4,214
6	-	105	30	27	1,000	2,800	1,760	1,800	6,000	960	2,880	1,440	72	198	300	2,400	500	22,272	26,852	4,580
7	-	105	30	27	6,500	2,800	1,760	1,800	6,150	960	2,880	1,440	72	198	300	2,400	500	27,922	29,670	1,748
8	-	105	30	27	-	2,800	1,760	1,800	6,304	960	2,880	1,440	72	198	300	2,400	500	21,576	31,810	10,234
9	-	105	30	27	-	2,800	1,760	1,800	6,462	960	2,880	1,440	72	198	300	2,400	500	21,734	23,771	12,037
10	-	105	30	27	-	2,800	1,760	1,800	6,624	960	2,880	1,440	72	198	300	2,400	500	21,896	35,056	13,160
11	-	105	30	27	6,550	2,800	1,760	1,800	6,790	960	2,880	1,440	72	198	300	2,400	500	28,612	36,162	7,550
12	-	105	30	27	-	2,800	1,760	1,800	6,959	960	2,880	1,440	72	198	300	2,400	500	22,231	37,017	14,786
13	-	105	30	27	9,500	2,800	1,760	1,800	7,133	960	2,880	1,440	72	198	300	2,400	500	31,905	38,024	6,119
14	-	105	30	27	-	2,800	1,760	1,800	7,311	960	2,880	1,440	72	198	300	2,400	500	22,583	38,828	16,245
15	-	105	30	27	-	2,800	1,760	1,800	7,494	960	2,880	1,440	72	198	300	2,400	500	22,766	39,408	16,642
16	-	105	30	27	1,000	2,800	1,760	1,800	7,681	960	2,880	1,440	72	198	300	2,400	500	23,953	40,085	16,132
17	-	105	30	27	-	2,800	1,760	1,800	7,873	960	2,880	1,440	72	198	300	2,400	500	23,145	40,513	17,368
18	-	105	30	27	-	2,800	1,760	1,800	8,070	960	2,880	1,440	72	198	300	2,400	500	23,342	40,942	17,600
19	-	105	30	27	-	2,800	1,760	1,800	8,272	960	2,880	1,440	72	198	300	2,400	500	23,544	41,619	18,075
20	-	105	30	27	-	2,800	1,700	1,800	8,478	960	2,880	1,440	72	198	300	2,400	500	23,750	42,048	18,298
																		523,190	658,095	134,905
N.P.V. at 15%	30,000	7,651	1,386	1,967	22,675	20,155	12,669	12,957	44,038	6,910	20,731	10,365	518	4,527	2,159	16,076	3,599	218,383	5%	43,785
% of Total Costs.	13.74	3.50	0.63	0.90	10.38	9.23	5.80	5.93	20.17	3.16	9.49	4.75	0.25	2.07	0.99	7.36	1.65	100	10%	- 1,046
																			I.R.R =9.90%	

1.4 1,000 Acre Units

1,000 acre, estate type units, have been evaluated for three different stations. Two of these are based upon the rotations suggested in section 3; the third is based upon grains and legumes only.

1.4.1 Rotation I

Cropping pattern: Sorghum 666
Groundnuts 333
Sweet potatoes 333
Tapioca 333

Cropping schedule: Sorghum - Plant March-April; harvest July-August

Groundnuts - (a) Plant March-April; harvest July-August
(b) Plant September-October; harvest January-February.

Sweet potatoes - Plant August-September; harvest January-March

Tapioca - see below.

Month	Tapioca planted (acres)	Tapioca harvested (acres)
January	-	40
February	-	40
March	-	40
April	40	40
May	40	40
June	40	40
July	40	30
August	70	30
September	70	35
October	35	-
November	-	-
December	-	-

Machinery requirements: these are set out below:

Item	Number	Capital Cost/Unit	Life-Years
90 hp. tractor	1	20,000	7
60 hp. tractor	6	12,000	7
Combine harvesters	2	40,000	8
Chisel plough	1	1,200	5
Rotovator (100")	1	5,000	6
Ridger	1	5,000	4
Potato planter	1	2,000	6
Grain planter	2	4,000	8
Sprayer	2	1,050	6
Fertiliser band spreader	1	1,200	8
Groundnut lifter	2	1,500	6
Turner	2	2,000	7
Potato lifter	1	1,500	6
Trailers	4	2,000	10
Tapioca harvester	1	10,000	5
Slasher	1	2,000	4

It is assumed that operations will be carried out as follows:

Cultivation: (1) chisel ploughing using 90 hp. tractor and 120 inch plough. This could cover about 2.6 acres per hour.

(2) Rotovate - 100" machine with 90 hp. tractor should again be able to handle about 2.5 acres per hour.

It is estimated that this large tractor with these two implements would be able to handle all primary cultivations. Some night work might be necessary particularly in August when some 290 hours of work are estimated to be required. It might be useful to have a smaller stand-by rotovator for work in this period.

Ridging: all crops are assumed to be ridged prior to planting using border discs, with a rate of work of 2 acres per hour. This operations is not required for sweet potatoes where ridging is done simultaneously with planting.

Planting: (1) sorghum and groundnut using a combined seed and fertiliser drill 2 acres/hour.

(2) Tapioca - by hand - 3 mandays/acre.

(3) Sweet potato - using potato planter, 2 row at 1 acre/hour.

Manuring: band spreader 3.6 acres/hour.

Spraying: mounted sprayer with 15 foot boom, 6 acres/hour. Allowance has been made for three sprayings of sorghum and groundnuts and one weed control spray on tapioca.

Harvesting: (1) sorghum direct combine 1 acre/hour.

(2) Groundnuts lift, dry in windrow, probably turning twice, combine from windrow, .75 acres per hour.

(3) Sweet potato: it will probably be necessary to chemically destroy haulm before harvesting by means of a chemical spray. An ordinary lifter will then be used to shake the tubers free of soil and leave them on the surface where they can be picked up by hands. The lifter would require about 1.5 hours per acre, and picking and hauling about 4 man days.

(4) Tapioca: tops will be slashed off using a rotary slasher except where they are needed for planting material. This will require about 1 hour per acre. The roots will then be lifted from the ground and left on the surface by the tapioca harvester, which has an assumed work rate of 2 hours per acre. The roots will be hauled off by a five man gang with a tractor who could handle one acre in about 3½ hours.

Required tractor hours and available hours assuming seven machines are as follows:-

Month	Tractor hours	Hours available Excluding overtime	Overtime hours
January	1065	980	85
February	1585	1225	360
March	1042	1225	-
April	854	735	119
May	703	735	-
June	451	980	-
July	906	980	-
August	1291	980	311
September	982	980	2
October	498	735	-
November	119	490	-
December	13	490	-

These figures are minimum requirements and should probably be increased by 10 percent to allow for contingencies, odd hauling jobs etc. In calculating tractor drivers' incomes 10 percent overtime has been added to basic pay.

Recurrent machinery costs for Year 2 onwards are as follows:

Item	Cost/hour ($)	Hours/Year	Cost/Year ($)
Tractor - 90 h.p.	3.50	1301	4,554
60 h.p.	3.00	8208	24,624
Combine harvesters	15.00	1100	16,500
Chisel ploughs	0.50	610	350
Rotovator	3.00	670	2,010
Ridger	2.40	675	1,620
Potato planter	1.50	330	495
Grain planter	2.00	770	1,540
Sprayer	0.71	720	511
Fertiliser spreader	0.67	300	201
Groundnut lifter	1.12	510	571
Swath turner	1.20	660	792
Potato lifter	1.12	500	560
Trailers	0.60	500	300
Tapioca harvester	6.00	440	2,640
Slasher	2.00	375	750
Total Implements			12,340

Labour requirements: a considerable quantity of hand labour is required for the tapioca and sweet potato plantings and harvests. The monthly total requirements are:-

Month	Hand labour required (man-days)
January	598
February	620
March	620
April	200
May	200
June	200
July	220
August	230
September	230
October	156
November	35
December	35

The extent of the labour peak during the sweet potato harvesting period is clear from the above table. A regular gang of 12 men could handle requirements in all months except January to March, but casual labour would be required at that time. In all 1,300 man-days of casual labour has been allowed for.

Labour force:
1 Manager at 1,500/month
1 Mechanic at 240/month
1 clerk storekeeper 160/month
2 tractor driver mandors at 175/month
7 tractor drivers at 160/month + 10% overtime
12 general men at 120/month + 10% overtime
1300 man-days casual at 3.50/day

Total regular labour force is 24 i.e. 1 man per 41.6 acres.

Table B6 shows the costs and sales for this enterprise over the 20 year period and the resulting cash flows. The internal rate of return has been estimated at 15 percent.

1.4.2 Rotation II

This rotation has no tapioca and has the following cropping pattern:

Sorghum	660 acres
Groundnuts	660 acres
Sweet potatoes	660 acres

The cropping schedule is similar to that in rotation I:-

Sorghum - plant April-May - harvest August-September
Groundnuts (a) plant March-April - harvest July.
(b) plant September-October - harvest February
Sweet potato - plant August-October - harvest January-March.

Operations are assumed to be carried out in the same way as for rotation

I. The following machinery would be required:-

Item	Number	Capital Cost/unit ($)	Life (Years)
Tractors - 90 h.p.	1	20,000	6
60 h.p.	7	12,000	9
Chisel Plough	1	1,200	4
Rotovator - 100"	1	5,000	5
60"	1	3,200	10
Ridger	1	5,000	4
Potato planter	2	2,000	6
Grain planter	2	4,000	12
Sprayer	2	1,050	5
Fertiliser spreader	1	1,200	5
Groundnut lifter	2	1,500	6
Swath turner	2	2,000	7
Potato lifter	2	1,500	8
Trailers	7	2,000	10
Combine harvester	3	40,000	8

Monthly tractor hours required are as follows:-

Month	Hours required	Hours available	Overtime
January	606	1120	-
February	1986	1400	586
March	1082	1400	-
April	690	840	-
May	594	840	-
June	249	1120	-
July	976	1120	-
August	1018	1120	-
September	1213	1120	93
October	449	840	-
November	110	560	-
December	-	560	-

TABLE B6. THOUSAND ACRE FARM, ROTATION 1. - COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Admin. Buildings	Mech. Buildings	Vehicles	Tractors Capital	Tractors Operating	Combines Capital	Combines Operating	Implements Capital	Implements Operating	Other Fuel	Seed	Lime	Fertiliser	Sprays
1	500,000	72,000	17,000	5,000	73,000	10,000	80,000	13,920	40,000	6,300	34,000	5,446	2,000	25,660	30,000	70,223	12,000
2	-	1,080	425	75	2,000	-	12,000	29,177	40,000	16,500	21,000	12,340	2,000	29,970	30,000	88,515	16,000
3	-	1,080	425	75	2,000	-	-	29,177	-	16,500	-	12,340	2,000	29,970	30,000	90,285	16,000
4	-	1,080	425	75	2,000	-	-	29,177	-	16,500	-	12,340	2,000	29,970	30,000	92,091	16,000
5	-	1,080	425	75	2,000	-	-	29,177	-	16,500	7,000	12,340	2,000	29,970	30,000	93,933	16,000
6	-	1,080	425	75	2,000	-	-	29,177	-	16,500	11,200	12,340	2,000	29,970	30,000	95,811	16,000
7	-	1,080	425	75	2,000	-	-	29,177	-	16,500	11,050	12,340	2,000	29,970	30,000	97,727	16,000
8	-	1,080	425	75	2,000	-	80,000	29,177	-	16,500	2,000	12,340	2,000	29,970	30,000	99,681	16,000
9	-	1,080	425	75	2,000	-	12,000	29,177	40,000	16,500	18,200	12,340	2,000	29,970	30,000	101,675	16,000
10	-	1,080	425	75	2,000	-	-	29,177	40,000	16,500	-	12,340	2,000	29,970	30,000	103,708	16,000
11	-	1,080	425	75	2,000	10,000	-	29,177	-	16,500	15,200	12,340	2,000	29,970	30,000	105,782	16,000
12	-	1,080	425	75	2,000	-	-	29,177	-	16,500	4,000	12,340	2,000	29,970	30,000	107,898	16,000
13	-	1,080	425	75	2,000	-	-	29,177	-	16,500	19,100	12,340	2,000	29,970	30,000	110,056	16,000
14	-	1,080	425	75	2,000	-	-	29,177	-	16,500	3,000	12,340	2,000	29,970	30,000	112,257	16,000
15	-	1,080	425	75	2,000	-	80,000	29,177	-	16,500	2,000	12,340	2,000	29,970	30,000	114,502	16,000
16	-	1,080	425	75	2,000	-	12,000	29,177	-	16,500	13,200	12,340	2,000	29,970	30,000	116,792	16,000
17	-	1,080	425	75	2,000	-	-	29,177	40,000	16,500	12,200	12,340	2,000	29,970	30,000	119,128	16,000
18	-	1,080	425	75	2,000	-	-	29,177	40,000	16,500	-	12,340	2,000	29,970	30,000	121,511	16,000
19	-	1,080	425	75	2,000	-	-	29,177	-	16,500	12,100	12,340	2,000	29,970	30,000	123,941	16,000
20	-	1,080	425	75	2,000	-	-	29,177	-	16,500	3,000	12,340	2,000	29,970	30,000	126,420	16,000
N.P.V. at 15%	500,000	78,695	19,634	5,465	85,399	12,472	137,209	194,766	107,224	108,571	86,386	81,932	14,399	211,420	215,946	681,401	111,171
% of Total Cost	15.14	2,38	0.59	0.17	2,59	0.38	4.15	5.90	3.25	3.29	2.62	2.48	0.44	6.40	6.54	20.63	3.35

contd. Table B6

Salaries and Wages: Managers	Clerks & Mechanics	Tractor Drivers	Mendors	General	Casual	E.P.F.	Elec. & Water	Premium & Rent	Other Expenses	Total Costs	Total Sales	N.C.F.	D.C.F. @ 15%	D.C.F. @ 25%	D.C.F. @ 10%
18,000	4,800	9,600	2,100	3,960	-	1,923	7,000	55,000	10,000	1,108,932	68,640	-1,040,292	-1,040,292	-890,292	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	387,954	386,430	- 1,524	- 1,325	- 1,219	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	316,724	421,278	104,554	79,053	66,915	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	318,530	447,496	128,966	84,795	66,031	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	327,372	476,074	148,702	85,028	60,908	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	333,450	508,497	175,047	87,033	57,363	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	335,216	544,170	208,954	90,331	54,767	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	408,120	564,531	156,411	58,795	32,799	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	398,314	584,067	185,753	60,723	31,169	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	370,147	597,366	227,219	64,598	30,493	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	357,421	610,665	253,244	62,602	27,198	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	338,337	627,429	289,092	62,126	24,833	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	355,595	634,491	278,896	52,126	19,160	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	341,696	641,388	299,692	48,700	16,483	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	422,941	652,162	229,221	32,389	10,086	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	368,431	658,812	290,381	35,688	10,221	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	397,767	665,461	267,694	28,616	7,552	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	387,950	676,236	288,286	26,782	6,486	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	362,480	682,885	356,405	28,789	6,415	
18,000	4,800	14,784	4,224	17,260	4,550	2,954	7,000	3,300	10,000	355,859	689,535	333,676	23,457	4,805	
										7,957,236	11,137,613	3,180,377	- 1,179	-357,857	
129,568	34,552	101,234	28,281	110,941	28,202	20,233	50,387	75,456	71,982						
3.92	1.05	3.06	0.86	3.36	0.85	0.61	1.53	2.28	2.18	3,302,914					471,558

I.R.R. = 15%

This indicates the severe peaking problem associated with this rotation during groundnut and sweet potato harvesting in February. It might be possible to push some of this into January and March, but this will depend upon climatic conditions.

Recurrent machinery costs are:-

Item	Cost/hour ($)	Hours/Year	Cost/Year ($)
Tractor 90 h.p.	3.50	1650	5,775
60 h.p.	3.00	7261	21,783
Combines	15.00	1510	22,650
Chisel plough	0.50	741	370
Rotovator 100"	3.00	700	2,100
60"	1.91	250	477
Ridger	2.40	664	1,594
Potato planter	1.50	665	1,000
Grain planter	2.00	470	940
Sprayer	0.71	748	531
Fertiliser spreader	0.67	462	310
Groundnut lifter	1.12	530	594
Swath turner	1.20	660	792
Potato lifter	1.12	500	560
Trailers	0.60	4000	2,400
Total Implements			11,668

Because of the absence of tapioca, the basic labour requirements of this scheme are lower and it is estimated that the unit could be handled by a basic complement of 18 men.

1 Manager
1 Mechanic
1 Clerk/storekeeper
2 Mandor tractor-drivers
8 Tractor drivers
5 General hands

In addition, however, about 2,600 man-days of casual labour would be required to cope with the sweet potato harvest in the January to March period, or a gang of about 50 individuals.

Because of the peaking of activity in the planting-harvesting periods, i.e. January-April, July-October, some of the regular labour force will be rather under utilised. These could be used for some hand weeding when use of machinery might damage the crop, e.g. when sorghum is beyond about 5 weeks old.

Table B7 shows the costs and sales for the 20 year period as before. The internal rate of return here is 19 percent.

1.4.3 <u>Rotation without root crops</u>

This scheme is perhaps slightly more ambitious than the other two. All these schemes contain elements of uncertainty, this perhaps more so than the others, since it is entirely based upon grain and legume crops. The cropping pattern is:-

Sorghum	1,000 acres
Maize	400 acres
Soya beans	850 acres

The total area cultivated per year is 2,250 acres, i.e. 250 acres actually carry three crops per year. This is done by planting soya beans in the last half of March, harvesting in late June, planting immediately with another 90 day soya bean and harvesting that crop at the end of September for immediate replanting with sorghum or maize. Whether this would be possible in practice is as yet an unknown.

Operations are carried out as for the other large-scale schemes. It is assumed that all crops are combined directly and the residues chopped and ploughed back into the soil. The following complement of machinery is assumed:-

Item	Number	Cost/unit ($)	Life (years)
Tractor 90 h.p.	1	20,000	10
60 h.p.	5	12,000	6
Combine harvesters	3	40,000	8
Chisel plough	1	1,200	6
Rotovator 100"	1	5,000	4
60"	1	3,500	7
Ridger	2	5,000	7
Planter	2	4,000	12
Sprayer	3	1,050	5
Fertiliser spreader	2	1,200	8
Trailers	3	2,000	12

TABLE B7. THOUSAND ACRE FARM, ROTATION II. - COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Admin. Buildings	Mech. Buildings	Vehicles	Tractors Capital	Tractors Operating	Combines Capital	Combines Operating	Implements Capital	Implements Operating	Other Fuel	Seed	Lime	Fertiliser	Sprays
1	500,000	60,000	17,000	5,000	73,000	10,000	80,000	13,393	80,000	8,100	39,200	6,090	2,000	51,320	30,000	20,614	10,000
2	-	900	425	75	2,000	-	24,000	27,558	40,000	22,650	14,500	11,668	2,000	39,140	30,000	101,791	16,000
3	-	900	425	75	2,000	-	-	27,558	-	22,650	-	11,668	2,000	39,140	30,000	103,827	16,000
4	-	900	425	75	2,000	-	-	27,558	-	22,650	-	11,668	2,000	39,140	30,000	105,903	16,000
5	-	900	425	75	2,000	-	-	27,558	-	22,650	6,200	11,668	2,000	39,140	30,000	108,021	16,000
6	-	900	425	75	2,000	-	-	27,558	-	22,650	8,300	11,668	2,000	39,140	30,000	110,181	16,000
7	-	900	425	75	2,000	-	20,000	27,558	-	22,650	5,500	11,668	2,000	39,140	30,000	112,384	16,000
8	-	900	425	75	2,000	-	-	27,558	-	22,650	3,500	11,668	2,000	39,140	30,000	114,632	16,000
9	-	900	425	75	2,000	-	-	27,558	80,000	22,650	8,200	11,668	2,000	39,140	30,000	116,925	16,000
10	-	900	425	75	2,000	-	60,000	27,558	40,000	22,650	3,000	11,668	2,000	39,140	30,000	119,264	16,000
11	-	900	425	75	2,000	10,000	24,000	27,558	-	22,650	17,500	11,668	2,000	39,140	30,000	121,649	16,000
12	-	900	425	75	2,000	-	-	27,558	-	22,650	8,000	11,668	2,000	39,140	30,000	124,082	16,000
13	-	900	425	75	2,000	-	20,000	27,558	-	22,650	19,700	11,668	2,000	39,140	30,000	126,564	16,000
14	-	900	425	75	2,000	-	-	27,558	-	22,650	1,500	11,668	2,000	39,140	30,000	129,095	16,000
15	-	900	425	75	2,000	-	-	27,558	-	22,650	2,000	11,668	2,000	39,140	30,000	131,677	16,000
16	-	900	425	75	2,000	-	-	27,558	-	22,650	10,300	11,668	2,000	39,140	30,000	134,311	16,000
17	-	900	425	75	2,000	-	-	27,558	80,000	22,650	6,200	11,668	2,000	39,140	30,000	136,997	16,000
18	-	900	425	75	2,000	-	-	27,558	40,000	22,650	3,000	11,668	2,000	39,140	30,000	139,737	16,000
19	-	900	425	75	2,000	-	80,000	27,558	-	22,650	5,500	11,668	2,000	39,140	30,000	142,532	16,000
20	-	900	425	75	2,000	-	24,000	27,558	-	22,650	1,500	11,668	2,000	39,140	30,000	145,383	16,000
N.P.V. at 15%	500,000	65,578	19,634	5,465	85,396	12,472	144,396	184,203	164,576	148,489	79,720	78,411	14,396	273,918	215,946	723,465	109,171
% of Total Cost.	14.43	1.89	0.57	0.16	2.46	0.36	4.17	5.31	4.75	4.28	2.30	2.26	0.42	7.90	6.23	20.87	3.15

Monthly tractor requirements are as follows:-

Month	Hours required	Hours available	Overtime
January	200	840	-
February	905	1,050	-
March	464	1,050	-
April	729	630	99
May	425	630	-
June	434	840	-
July	402	840	-
August	359	840	-
September	1,169	840	329
October	914	630	284
November	447	420	27
December	86	420	-

Again there is a major peaking problem, this time the major pressure is in September and October. This is partly aggravated by having to harvest the additional 250 acres of soyabeans.

Because of the absence of root crops requiring a lot of hand work the labour force required for this operation is small, amounting to only 14 men:

1 Manager
1 Mechanic
1 Clerk/storekeeper
7 Tractor drivers
4 General

In phasing this project it has been assumed that 500 acres will be available for planting in March of year 1 and the balance by September. Year 2, therefore, becomes a full crop year.

Table B8 shows the costs and sales for the 20 year planning period. The internal rate of return has been estimated as 24 percent.

In order to check the validity of the cropping patterns used a linear programming exercise was carried out using maize, sorghum, groundnuts, sweet potatoes and soybeans as possible crops. Land, labour and three types of machinery - cultivation and harvesting capacity and other needs, were used as constraints. Allowance was also made for planting and harvesting crops to maximise ground cover during

TABLE B8. THOUSAND ACRE FARM, ROTATION III. – COSTS, SALES AND CASH FLOWS ($)

Year	Land Clearance	Housing	Roads	Admin.	Mech. Buildings	Vehicles	Tractors Capital	Tractors Operating	Combines Capital	Combines Operating	Implements Capital	Implements Operating	Other Fuel	Seed	Lime	Fertiliser	Sprays
1	375,000	52,000	12,600	5,000	73,000	10,000	68,000	9,500	40,000	3,750	36,200	3,997	2,000	5,600	22,500	66,893	12,000
2	125,000	780	4,200	75	2,000	–	12,000	21,125	80,000	25,800	3,050	8,540	2,000	15,800	30,000	138,725	27,000
3	–	780	425	75	2,000	–	–	21,125	–	25,800	–	8,540	2,000	15,800	30,000	141,500	27,000
4	–	780	425	75	2,000	–	–	21,125	–	25,800	–	8,540	2,000	15,800	30,000	144,330	27,000
5	–	780	425	75	2,000	–	–	21,125	–	25,800	5,000	8,540	2,000	15,800	30,000	147,186	27,000
6	–	780	425	75	2,000	–	–	21,125	–	25,800	–	8,540	2,000	15,800	30,000	150,130	27,000
7	–	780	425	75	2,000	–	20,000	21,125	–	25,800	2,100	8,540	2,000	15,800	30,000	153,133	27,000
8	–	780	425	75	2,000	–	–	21,125	–	25,800	2,250	8,540	2,000	15,800	30,000	156,196	27,000
9	–	780	425	75	2,000	–	–	21,125	40,000	25,800	13,500	8,540	2,000	15,800	30,000	159,320	27,000
10	–	780	425	75	2,000	–	–	21,125	80,000	25,800	7,400	8,540	2,000	15,800	30,000	162,506	27,000
11	–	780	425	75	2,000	10,000	48,000	21,125	–	25,800	2,100	8,540	2,000	15,800	30,000	165,756	27,000
12	–	780	425	75	2,000	–	12,000	21,125	–	25,800	1,050	8,540	2,000	15,800	30,000	169,071	27,000
13	–	780	425	75	2,000	–	20,000	21,125	–	25,800	11,200	8,540	2,000	15,800	30,000	172,452	27,000
14	–	780	425	75	2,000	–	–	21,125	–	25,800	2,000	8,540	2,000	15,800	30,000	175,901	27,000
15	–	780	425	75	2,000	–	–	21,125	–	25,800	13,500	8,540	2,000	15,800	30,000	179,419	27,000
16	–	780	425	75	2,000	–	–	21,125	–	25,800	2,100	8,540	2,000	15,800	30,000	183,007	27,000
17	–	780	425	75	2,000	–	–	21,125	40,000	25,800	8,450	8,540	2,000	15,800	30,000	186,667	27,000
18	–	780	425	75	2,000	–	–	21,125	80,000	25,800	–	8,540	2,000	15,800	30,000	190,400	27,000
19	–	780	425	75	2,000	–	20,000	21,125	–	25,800	1,200	8,540	2,000	15,800	30,000	194,208	27,000
20	–	780	425	75	2,000	–	–	21,125	–	25,800	–	8,540	2,000	15,800	30,000	198,092	27,000
N.P.V. at 15%	483,700	56,835	18,514	5,465	85,396	12,472	106,880	140,437	157,096	163,664	56,311	56,930	14,396	103,532	208,446	1,024,642	179,351
% of Total Cost.	14.23	1.67	0.54	0.16	2.51	0.37	3.14	4.13	4.62	4.82	1.66	1.68	0.42	3.05	6.13	30.15	5.28

Contd. Table B8

Manager	Salaries Clerks & Mechanics	Tractor Drivers	General	Premium & Rent	Other Expenses	Elec. & Water	E.P.F.	Total Costs	Total Sales	N.C.F.
18,000	4,800	7,680	-	53,000	10,000	7,000	1,524	902,044	166,000	- 736,044
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	563,922	469,600	- 94,322
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	342,872	507,430	164,558
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	345,702	532,760	187,058
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	353,558	570,590	217,052
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	351,502	617,900	266,398
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	376,605	655,970	279,365
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	359,818	684,700	324,882
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	414,192	711,580	297,388
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	451,278	731,080	279,802
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	427,228	749,540	322,312
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	383,493	767,190	383,697
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	405,024	777,420	372,396
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	379,273	786,690	407,417
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	394,291	795,920	401,629
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	386,479	805,190	418,711
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	436,489	813,570	377,081
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	471,772	823,800	352,028
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	416,780	833,070	416,290
18,000	4,800	16,128	6,336	3,300	10,000	7,000	2,263	399,464	842,300	442,836
								8,561,786	13,642,300	5,080,514
129,563	34,551	107,645	39,272	75,454	71,982	50,387	15,551	3,398,477	20%	235,074
3.81	1.02	3.17	1.16	2.22	2.12	1.48	0.46	100	25%	- 25,049

I.R.R. = 24.50%

expected periods of heaviest rain. This was done by attaching penalties to planting in less desirable periods. The resulting cropping pattern was as follows:-

Sorghum	364	acres
Groundnuts	653	acres
Sweet Potatoes	491	acres
Soya Beans	448	acres
Total	1956	

Details of the matrix used and the results obtained are available in the Annual Crops working file.

Because of the uncertainties involved and the need for further research on the agronomic problems associated with these crops, it was felt that further work of this type on potential cropping patterns was not justified at this time.

1.5 General Comments

The enterprises discussed obviously do not exhaust the possibilities but illustrate the types of short-term cropping schemes which might be possible and indicate their relative rates of return. Enterprises of this type will not necessarily stand on their own but will perhaps be combined either with a perennial crop such as rubber and oil palm or with livestock enterprises. Further work will have to be done on phasing of short-term cropping with perennial crops and on livestock combinations. A number of general points may, however, be made:-

1.5.1 Training

Short-term crops (except padi) are not grown on any large scale in Malaysia. Thus there is no fund of knowledge about their production. Some training will thus almost certainly be necessary for those who have to make decisions about these new crops.

For smallholding: the 24 acre holding discussed above would require full-time effort by its operator, plus some help from his family. It is clear that care would have to be taken in utilising time at peak periods otherwise the rather tight schedule would not be achieved. The importance of obtaining high yields is seen in the difference in the rate of return between the average and high yield examples. This requires considerable attention to detail and knowledge of the crops being grown. A training period of at least a year, i.e. taking future operators through a year's operations on a holding of this type, with some fairly elementary theoretical background e.g. on crop growth, pests and diseases, use and maintenance of machinery and simple accounts, would be required.

<u>For medium farms</u>: the operator of a 60 acre, 2 man holding would require a background at least as strong as the smallholder. While a three-year course such as that given by the School of Agriculture might be useful a more practically oriented training of a year or two as above would perhaps be preferable. It may also be desirable to require some specified academic level of attainment, e.g. form III, for those entering this type of scheme.

Small and medium farms of these types would also require fairly close extension supervision in the early stages, possibly 1 man per 1,000 acres or 25 operators, whichever is the greater, in order to spot disease or other husbandry problems.

<u>For large farms</u>: in the schemes analysed 1 manager was allocated per 1,000 acres. The actual management structure will obviously vary. A more likely organization is 4-5,000 acres of short-term crops, perhaps within a larger scheme. This division would have a manager with one assistant per 1,000 acres or so. This manager would probably have to be an expatriate with experience in crops such as sorghum, soya beans etc. The assistants could be local diploma or degree holders (Serdang or M.I.T.), who could subsequently progress to management positions through experience and in-service training in management.

Mechanics would, of course, have to have adequate training before being employed on the scheme. Tractor-drivers could perhaps receive instruction for 2-4 weeks on use of machines and simple maintenance. Specific instructions would also have to be given on the use of individual items of machinery at the appropriate time e.g. planting and harvesting equipment.

1.5.2 Yields

The initial analyses presented in this paper indicate that short-term cropping could be fairly profitable on a strict financial basis. However, because of the high level of fixed costs, land development and machinery profitability depends greatly on the level of yield obtained. As the smallholder examples indicated low yields rapidly reduce the rate of return to sub-economic levels.

APPENDIX C

TAPIOCA ENTERPRISE EVALUATIONS

1 INTRODUCTION

In Appendix B various mixed cropping enterprises were evaluated. The three smallholdings and one of the three large farms included tapioca in the rotation. Because of its long period in the ground tapioca is not an easy crop to fit into a farm rotation. It is widely grown in kampongs in Malaysia and in many other tropical countries as a monocrop, and it is commonly grown year after year on the same piece of land, without receiving any manure, until progressively declining yields reach the level which the grower regards as uneconomic. The exhausted land then returns to a weed fallow.

In recent years there has been a marked interest in the possibility of large scale production of tapioca for starch and as a carbohydrate animal feedstuff. The crop has received attention of several Federal Agencies e.g. FLDA, MARA and State governments e.g. Johor, Pahang and Negri Sembilan. It seemed, therefore, desirable to examine the market for tapioca in some detail and to evaluate a few possible monocultural tapioca production enterprises.

2 MARKET

2.1 Present Domestic Demand

Tapioca is in demand for the following purposes:-

(1) As fresh roots, for direct human or stock consumption

(2) As dried roots for animal feed. The dried roots may be fed as chips, pellets or meal.

(3) As tapioca starch in the form of flour, flake and pearls. These are used (a) for human consumption either directly or in prepared foods (b) for industrial purposes, mainly as adhesives, but also for laundry work.

2.1.1 Fresh roots

It is difficult to get an accurate picture of the present production of tapioca in Malaysia. First because a large amount of tapioca is cultivated illegally which probably means that statistics of acreage are not very reliable and secondly because the statistics of acreage do not distinguish between sweet tapioca grown for human consumption and the bitter variety used for animal feed and starch products. Wahby and Eriksen (1969) quote the following estimate of acreage of tapioca (Table C1).

TABLE C1 ESTIMATED ACREAGE OF TAPIOCA IN WEST MALAYSIA

	Sole Crop			Mixed Crop			Sole Crop Equivalent		
Year	Total W.M. acre	Perak acre	% of Total	Total W.M. acre	Perak acre	% of Total	Total W.M. acre	Perak acre	% of Total
1961	22,570	10,130	45.6	17,714	1,790	10.1	31,427	11,025	35.1
1962	37,563	24,718	65.8	18,072	1,740	9.6	46,599	25,588	54.9
1963	47,078	32,845	69.8	17,625	4,580	26.0	55,891	35,135	62.9
1964	35,245	25,740	73.0	20,563	4,070	19.8	45,527	27,775	61.0
1965	30,592	20,880	68.3	19,528	5,850	30.0	40,356	23,805	59.0
1966	26,432	18,770	71.0	19,576	6,335	32.4	36,220	21,938	60.6
1967	34,567	22,665	65.6	20,434	6,122	30.0	44,784	25,726	57.4
1968	26,502	19,352	73.0	31,124	10,860	34.9	42,064	24,782	58.9

Source: Ministry of Agriculture and Cooperatives, Statistical Digests, 1967, 1969.

The same authors quote the FAO Production Year Book as follows for 1968:-

Acres	Production (tons)
49421	314975

This is an average yield of 6-4 tons per acre.

The Department of Statistics carried out a Household Budget Survey in 1957/58, which indicated an average monthly consumption per family of between 1 and 2 katis of starchy root crops. The proportion of this made up by tapioca is not known, but assuming it to be 50 percent and assuming the average family to contain 6 persons, the total consumption would amount to 10,000 tons per annum. It probably lies between 10,000 tons and 20,000 tons. There are no records of the quantities of fresh roots fed direct to livestock, but an estimate may be obtained by assessing all the other uses and deducting the figure from estimated total production.

2.1.2 Tapioca starch

According to Wahby and Eriksen (1969) 43,000 tons of starch were produced in 1968. Overall recovery rate was said to be 18.9 percent of the quantity processed. Thus some 227,500 tons of fresh roots were used for starch production. Exports of flour, flakes and pearl in 1968 amounted to 18,234 tons or 42.4 percent of the production, leaving domestic consumption at 24,766 tons. Of this, 3600 tons were used to make monosodium glutamate and 3,240 tons went for glucose. Some 8,800 tons were used by biscuit, bakery and noodle manufacturers. The remainder (9000 tons) went to various domestic outlets, such as provision shops selling directly to consumers; the paper and textile industries; the laundry industry; and finally to the feed millers, whose purchases are estimated to be anything up to 4000 tons (section 2.1.3).

2.1.3 Tapioca chips

Virtually all the chip factories are in Perak State. In 1968 production of chips by 27 out of the 31 factories in Perak amounted to 18,000 tons. Overall recovery rate was 41 percent of the quantity sliced. Thus purchases of fresh roots by these factories in 1968 was just over 45,000 tons.

About one third of the chips (6000 tons) were sold to feed mills. Total purchases of tapioca products by feed millers in 1968 is reported by the Department of Statistics to have been 9940 tons. Thus purchases of tapioca flour may have amounted to some 4000 tons. Moreover it is not clear whether this figure may not include tapioca waste, which is a by-product from the starch factories.

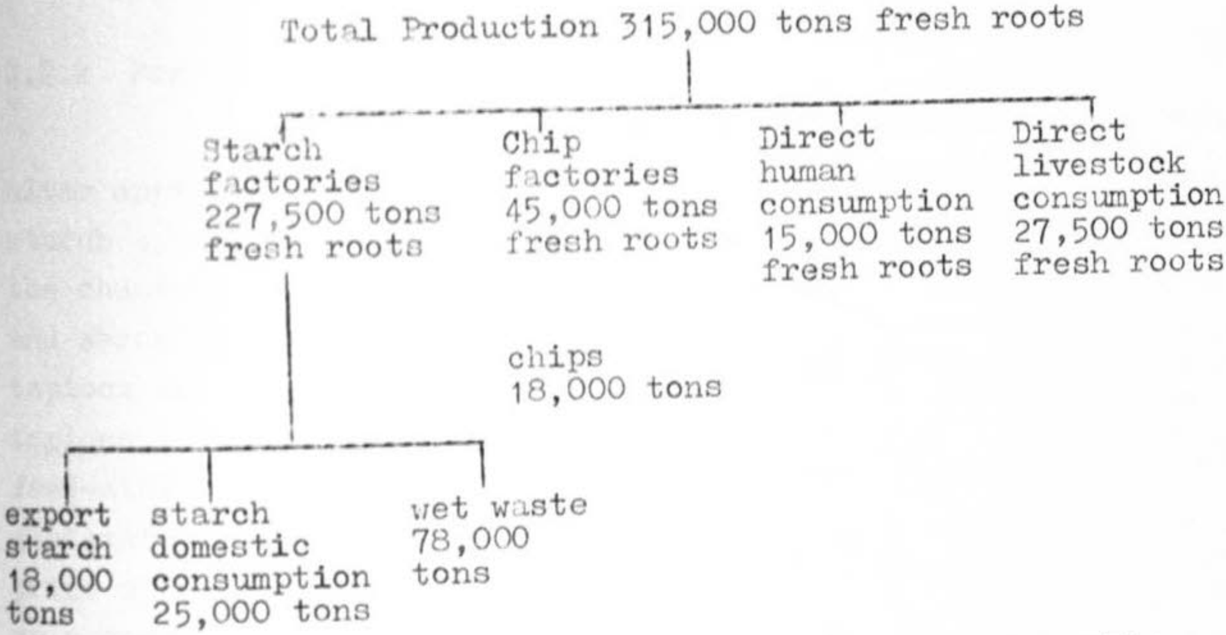
2.1.4 Tapioca waste

Fresh cassava roots contain about 33 percent of dry matter, composed of starch (18.9 percent) and waste (14 percent). Thus the starch factories' throughput of 227,500 tons in 1968 would have produced 32,000 of dry matter waste. This is compatible with the reported production of 78,000 tons of wet waste sold by the factories in 1968; it would mean that the wet waste contained about 60 percent water.

Commercial dried tapioca waste contains some 15 percent moisture. Some 11,500 tons were imported from Thailand in 1968, equivalent to 9,800 tons of dry matter waste.

2.1.5 Domestic uses 1968

The diagram below summarises the apparent disposal of the 1968 crop.



From this it would appear that the 1968 domestic consumption by livestock was of the following order:-

27,500 tons fresh roots	=	9,000 tons dry matter
78,000 tons local wet waste	=	32,000 tons dry matter
11,500 tons imported waste	=	9,800 tons dry matter
18,000 tons chips	=	16,900 tons dry matter
4,000 tons tapioca starch	=	3,600 tons dry matter
		71,300 tons dry matter

Domestic consumption for human use was:

15,000 tons of fresh roots

25,000 tons of starch

2.2 Future Domestic Demand

2.2.1 For animal feedstuffs

In section 2.2.3 of this report the demand for compound carbohydrate feedstuffs was projected to rise at 7.2 percent per annum from 371,000 tons dry matter in 1970 to 1,465,000 tons in 1990. Assuming the tapioca proportion of the ration to have risen at the same rate since 1968, then consumption in 1970 would have been 82,000 tons, that is about 20 percent of the ration. Provided that the price is competitive there seems to be no reason why tapioca should not continue to supply 20 percent of the future carbohydrate feedstuff supply. On this assumption future demand could be as follows in terms of dry matter (tons):-

1970	1975	1980	1985	1990
82,000	104,000	152,000	213,000	293,000

2.2.2 For human use

It is not expected that fresh root consumption will alter appreciably. However the domestic demand prospects for starch appear to be good. These prospects depend first upon the change in demand for the products incorporating tapioca and secondly upon the relative movement of the price of tapioca and substitute products. In virtually all its uses tapioca is easily substitutable by other products - in feed-stuffs by maize and other grains, and in monosodium glutamate, glucose and alcohol by molasses. At present the price of molasses is high relative to the price of tapioca; as a result the monosodium glutamate factory is expected to require 6600 tons of tapioca starch in 1970 and 10,000 tons per annum from 1972 compared with 3,600 tons in 1968. On the other hand Wahby and Eriksen (1969) do not consider that glucose production is likely to expand unless new industrial uses are created in which glucose can be substituted for sucrose.

It seems reasonable to assume the demand for tapioca for biscuits, noodles and baking will increase in line with population growth, say 3 percent per annum. This would raise demand for these purposes as follows:

1968	8800 tons
1970	9336 tons
1975	10820 tons
1980	12540 tons
1985	14534 tons
1990	16845 tons

Similarly direct sales to consumers from provision shops may rise in the same way. These requirements are at present about half of those just quoted. Thus future demand for these would be

1968	4400 tons
1970	4668 tons
1975	5410 tons
1980	6270 tons
1985	7267 tons
1990	8422 tons

Thus domestic demand for human use is projected to be as follows:-

	Starch tons	Fresh roots tons
1970	23844	15000
1975	29470	15000
1980	32050	15000
1985	35041	15000
1990	38507	15000

2.2.3 Total future demand and new acreage requirements

In terms of fresh tapioca roots the demands projected in sections 2.2.1 and 2.2.2 total as follows (tons):

	For stock	For human consumption	Total
1970	246,000	135,000	381,000
1975	312,000	162,000	474,000
1980	456,000	175,000	631,000
1985	639,000	190,000	829,000
1990	879,000	208,000	1,087,000

The existing area of 49,000 acres produces 315,000 tons; with a normally active extension service it should be possible by 1990 to raise the existing average yield from 6.4 tons per acre to 10 tons per acre. This 49,000 acres could produce as follows:-

From 1,500 acres	15,000 tons of fresh roots
From 20,000 acres	38,000 tons of starch and 28,000 tons (dry matter) of waste
From 27,500 acres	102,000 tons (dry matter) of chips

The balance required for stock feed from new commercially oriented tapioca farms would then be 163,000 tons of dry matter, equivalent to 489,000 tons of fresh roots.

In Appendix B yields of tapioca were projected to rise over 20 years from 12 to 17½ tons per acre and from 10 to 16 tons per acre on commercial large farms and small-holdings respectively. Taking the overall yield in 1990 at 15 tons per acre, the new acreage required to supply 489,000 tons would be 32,600 acres.

In Negri Sembilan 10,000 acres have recently been alienated for tapioca and other food crops and there are plans for planting about 11,000 acres in Pahang. The scope for further planting in Johor is thus limited unless the export market can be expanded. The prospects for such an expansion are discussed in section 2.3. The present level of exports, 90,000 tons, are being met by the production from 15,000 acres out of the total of 315,000 acres under the crop. Taking into account the expected increases in yield over the next 20 years, exports would have to expand to four times their present level to increase the area for export by 9000 acres.

2.3 Export Prospects

Table C2 shows exports of tapioca products from West Malaysia between 1963 and 1968.

TABLE C2 EXPORTS OF TAPIOCA PRODUCTS 1963-1968 (TONS)

	1963	1964	1965	1966	1967	1968
Tapioca Pearl	14719	14462	12506	9776	11850	13082
Tapioca Flour	6031	8756	8254	7516	3726	4355
Tapioca Flakes	1040	1354	2162	860	647	797
Roots and Waste	209	277	912	80	16	-
Total	21999	24849	23834	18232	16239	18234

Source: External Trade Statistics, Department of Statistics, Malaysia.

In terms of fresh roots the above totals are ('000 tons):-

1963	1964	1965	1966	1967	1968
110	120	115	90	80	90

This is a very small share of the world exports (Table C3).

TABLE C3 WORLD EXPORTS OF TAPIOCA ('000 TONS FRESH ROOT TERMS)

	1963	1964	1965	1966	1967
Thailand	1331	2205	1956	1972	2390
Indonesia(1)					393
Brazil	53	323	498	374	104
Malaysia	110	120	115	90	80
Total	1494	2648	2569	2436	2967

(1) Indonesian exports of dried roots to EEC countries.

Table C4 gives some information about the size and recent rate of growth of international trade in tapioca.

TABLE C4 WORLD IMPORTS OF TAPIOCA ('000 TONS FRESH ROOT TERMS) 1962-1967

	1962	1963	1964	1965	1966	1967
Chips, meal, roots, pellets						
Germany	929	983	1174	1321	1784	1354
Belgium	58	183	267	254	180	287
Netherlands	3	13	43	193	241	404
France	58	51	46	43	41	na
Sub-total	1048	1230	1530	1811	2246	2045
Starch						
U.S.A.	370	555	670	810	775	690
Canada				22		45
Japan				85		280
Sub-total	370	555	670	917	775	1015
Total	1418	1785	2200	2728	3021	3060

Thailand exports dominate world trade, and if Malaysia is to obtain a larger share of the present market, she will have to produce a product that competes with that from Thailand.

It must be recognised that the present world trade in tapioca products does not in any sense represent the potential market. Tapioca is a very small part of the enormous market for starch and carbohydrate feedstuffs. The principal other products in this market are the coarse grains, such as maize, sorghum, barley, oats, rye. Tapioca can substitute for and be substituted by any or all of these crops for animal feeding and by most (perhaps all) of them for starch production.

Most of the trade in coarse grains is between U.S.A. and Europe and Japan. The average 1961-1963 trade showed that U.S.A. exported 15 million tons of coarse grains and Europe and Japan imported 20 million tons. By 1975 imports into Europe and Japan are projected to be 35 million tons.

The extent to which tapioca will substitute for coarse grains will be determined by (1) its price relative to that of the grains (2) the availability of the grains (3) financial policies of importing countries.

Insofar as the animal feedstuff market is concerned the main importers of tapioca chips in recent years have been EEC countries, particularly Germany. Imports in 1967 to EEC were double the 1962 level. Between 1963 and 1965 consumption per animal increased markedly in Germany and Belgium, and this growth is likely to continue for some time before consumption reaches the level in the Netherlands.

For starch purposes the main user is U.S.A., but tapioca starch makes up only 4 percent of the starch market in that country. Over 90 percent of the starch used is obtained from corn. Between 1965 and 1967 there was a decline in the use of tapioca starch in U.S.A., but this was more than offset by a rapid rise of demand in Japan.

2.4 Price Projections

2.4.1 Tapioca chips

According to the Federal Agricultural Marketing Authority feedmillers would substitute tapioca for maize in part of the animal rations if the price of tapioca chips was not more than 83 percent of the price of maize. In the U.K. in 1954/55 some substitution of barley by tapioca took place when the respective prices were £28 and £23 per ton respectively i.e. the price of chips was 82 percent that of barley. Maize is now imported at $180 per ton; therefore tapioca chips would have to be not more than $150 per ton at the mill to compete. In 1968 ex factory chip prices averaged $7.50 per pikul. This is probably equivalent to a price of $2 per pikul for fresh roots at the farm gate.

The price of Thai chips sets the tone of the export market. From 1963 to 1967 these were as follows:- ($ ton FOB)

1963	1964	1965	1966	1967
121	110	117	114	104

The 1967 price is equivalent to $6.20 per pikul FOB, equivalent to a farm gate price of $1.40 per pikul.

2.4.2 Tapioca starch

Ex-factory prices for tapioca flour in 1968 were reported to be $13.08 per pikul. For each pikul of starch it is possible to obtain $\frac{3}{4}$ pikul of dried waste which was worth $8 per pikul in 1968. The total revenue therefore for every ton of starch produced can be taken at $19 per pikul.

Most of the starch processing factories contain old and out-dated machinery and do not produce a starch of high enough quality to meet international standards in competitive markets. However MARA have installed a modern starch plant at Kuantan, and also a factory for pelletizing waste. It is estimated that the cost of producing one ton of starch will be about $60 and of producing one ton of waste $28. The cost therefore of a pikul of starch and $\frac{3}{4}$ pikul of waste will be $4.75, leaving $14.25 for the purchase of raw materials. At an extraction rate of 19 percent starch this would mean a price of $2.70 per pikul for fresh roots at the factory, say $2.50 per pikul at the farm gate.

In the export market tapioca has to compete with corn starch, which means an FOB price of $250-300 per ton. This is equivalent to about $14.70 per pikul ex factory and a farm gate price of $2.80 per pikul.

3 PRODUCTION

3.1 <u>Problems and General Assumptions</u>

3.1.1 Varieties

There are many varieties known at present and these have different characteristics in terms of yields of both starch and roots, and of the relationship of length of growing season to optimum yields. A standard 11 months growing season has been taken. Within any one variety this can vary within a month either way and there is more variation possible between varieties. A major objective on a commercial scale would be to provide level deliveries to a factory processing roots all the year round. A large scale operation could have difficulties in doing this and at the same time maintaining an economic level of machinery and labour all the year round. Plantings of different varieties at different times of the year should be tried to alleviate this problem. Investigations of this nature should only take 2-3 years to carry to a successful conclusion.

Table C5 gives performance details of five well-known varieties.

3.1.2 Yields

That high yields of tapioca are obtainable has been demonstrated in numerous trials. However in practically all of them yields fell after the second or third crop, and methods of ensuring the maintenance of high yields under continuous cropping with tapioca have still to be discovered. Among several possible reasons for this loss of yield are:

i) Deterioration of soil structure
ii) Depletion of soil nutrient reserves
iii) Depletion of organic matter with consequent effects on soil nutrient and water holding capacity.

In all the proposed schemes provision has been made for the incorporation of chopped stems and leaves into the soil to return the nutrients contained in these parts and to build up organic matter. A rough calculation indicates a volume of 6,000 cubic feet of fresh organic matter per acre from tapioca tops - equivalent to a mulch of about 1½ inch depth. This will be very much easier to produce on the mechanised schemes than on the hand labour schemes. Thus two yield curves have been assumed, one for large units, and a lower one for smallholdings. These yield curves are shown in Table C6. The yield is assumed to be obtained for 11 month varieties, which may be harvested any time between 10½ and 11½ months from planting without the yield being affected.

TABLE C5 PERFORMANCE OF TAPIOCA VARIETIES

Variety	Growing period	Tons starch/ac.	lbs starch/day	Root yield	Percentage starch to roots	Tons chips	% starch in chips
Green Twig	156	1.59	22.83	7.29	21.8	2.9	54.82
	190	2.16	25.46	9.39	23.0	3.8	41.84
	219	3.11	31.81	12.49	24.9	5.0	62.20
	248	3.78	34.14	15.53	24.3	6.2	61.00
	281	4.54	36.19	16.75	27.1	6.7	67.80
	312	4.36	31.30	18.94	23.0	7.6	57.40
	353	3.58	22.71	15.90	23.0	6.4	56.00
Black Twig	156	2.07	29.72	7.39	28.0	3.0	69.00
	190	1.99	23.46	7.33	27.1	29.0	68.60
	219	3.24	33.13	11.07	29.2	4.4	73.60
	248	2.94	26.55	9.89	29.9	4.0	73.50
	281	3.87	30.84	16.37	23.6	6.5	59.50
	312	4.90	35.17	19.08	25.7	7.6	64.50
	353	4.60	29.18	15.40	29.9	6.2	74.20
Berat	161	2.86	37.79	9.66	29.6	3.9	73.50
	192	3.38	39.43	9.69	34.9	3.9	86.70
	218	3.83	39.35	11.38	33.7	4.6	83.30
	261	5.34	45.82	14.55	36.7	5.8	92.10
	282	6.55	52.02	17.29	37.9	6.9	94.90
	316	6.01	42.60	16.24	37.0	6.5	92.50
	356	4.67	29.38	14.75	31.7	5.9	79.20
	372	4.93	29.68	15.28	32.3	6.1	80.80
Kekabu	156	2.49	35.75	7.90	31.5	5.2	77.80
	190	3.06	36.07	9.72	31.5	3.9	78.50
	219	5.09	52.06	13.88	36.7	5.6	90.90
	248	5.34	48.23	14.59	36.6	5.8	93.00
	281	6.12	48.78	16.88	36.3	6.8	90.00
	312	6.07	43.57	16.75	36.0	6.7	90.60
	353	3.67	23.28	10.47	35.0	4.2	87.40
Jurai	156	2.01	28.86	7.23	27.8	2.9	69.31
	190	2.88	33.95	9.72	29.6	3.9	73.80
	219	3.90	39.89	10.77	36.21	4.3	90.70
	248	4.98	44.98	13.81	36.1	5.5	90.50
	281	4.86	38.74	13.34	36.4	5.3	91.70
	312	5.03	36.11	15.13	33.2	6.1	82.40
	353	6.02	38.02	16.48	36.5	6.6	91.20

TABLE C6 ASSUMED YIELDS

	Large scale estates		Smallholders	
Harvest No.	Yield tons roots/ac.	Output M$/acre	Yield tons roots/ac.	Output M$/acre
1	12	300	10	250
2	13	325	10	250
3	14	350	11	275
4	15 variety change	375	12	300
5	15	375	13	325
6	15	375	13	325
7	15	375	13.5	337
8	16 variety	400	13.5	337
9	16	400	14	350
10	16	400	14	350
11	16	400	14.5	362
12	16	400	14.5	362
13	16.5	412	15	375
14	16.5	412	15	375
15	16.5	412	15	375
16	17 variety change	425	15.5	387
17	17	425	15.5	387
18	17	425	15.5	387
19	17.5	437	16	400
20	17.5	437	16	400

3.1.3 Prices

The price projections made in section 2.4 of this appendix showed that the farm gate price of fresh roots could be as high as $2.80 per pikul when produced for starch and as low as $1.40 per pikul when produced for chips. In the schemes evaluated a farm gate price of $1.75 per pikul ($29.40 per ton) has been assumed.

3.1.4 Fertilizer inputs

Kanapathy et al (1969) measured nutrient removal by tapioca. At the present costs of nutrients one ton of crop removes nutrients to the value of:

Tubers	-	$3.73
Stems	-	$2.85
Leaves	-	$4.45
TOTAL	-	$11.03

On 6.2 percent of the area the whole plant is assumed to be removed to provide planting material. On the remaining 93.8 percent of area tubers only are removed. Therefore the cost of nutrients per overall acre is $4.18/ton tubers.

Tons yield	Cost of nutrients $/acre	+10%
10	42	46
11	46	50
12	50	55
13	54	59
14	58	64
15	63	69
16	67	74
17	71	78
18	75	83

Ten percent extra fertilizer is added for the first two years of planting in order to build up fertility status. Thereafter it is held at the current costs of replacing nutrients removed annually.

Time and frequency of application may be important; a split application and four months later has been assumed. Experiments to test alternatives should be laid down. No advantage in yield has been obtained by placement of fertilizer at planting. However, mechanical planting lends itself to mechanical placement methods at a relatively low cost. Hand labour can also be used and would cost about $3.25 per acre.

Fertilizer placement could be important eventually if it is proven that accurate placement induces a tuber growth habit which eases mechanical harvesting problems. The machine would cost $1,200 with a 2,500 hour or 10 year life.

Operating costs for placement in combination with planting are expected to be 18 cts/acre. For the second application at 3-4 months, the operating costs of the machine would be about 10 cents per acre + the variable costs of the tractor at $3,000/hour or 50 cents per acre at an operating rate of 6 acres/hour.

The comparison between hand and mechanical application is:

Total hand - \$6.50/acre (two applications).
Total mechanical - \$0.78/acre (two applications).

3.1.5 Planting material and planting

It is assumed that planting material will be bought for the first year's planting. After this 6.2 percent of the area will be used annually for planting material for the following crop. On the remainder of the farm all tops and leaves will be incorporated in the soil to reduce nutrient removal and thus fertiliser costs.

Research is needed into planting methods. This has been done for some aspects of planting but there are conflicting views on planting density and the clarification of these would allow work on mechanisation of planting to be carried forward. Meanwhile it is assumed that planting will be at 2'x3' spacing giving a requirement of 7,200 setts per acre. Material for this is estimated at \$17.50 per acre including an average delivering charge.

<u>Purchase or selection of planting material</u>: in Perak and Kedah, tapioca planting material is usually sold in bundles of 30 x 6 ft. stems and each stem will provide 10 setts (Luloffs 1969). Planting material obtained through a mill was obtained at 30-35 cents per bundle with transport at 30 cts./bundle for 12 miles - a total of 65 cts./bundle. In another example planting material was obtained from a landowner at 21 cts per bundle plus labour and transport. For these schemes it is assumed that the price in the first year will be 30 cts./bundle and the average transport distance is 15 miles - say 75 cts. per bundle of 300 setts.

<u>Preparation of setts</u>: the same source suggests that one woman can prepare an average of 400 setts per hour. At a current cost of \$2.90 per 7 hour day this is equivalent to \$1.03 per 1,000 setts.

<u>Transport of setts to field</u>: it would seem logical to organise the packing and transport of setts to ensure maximum planting time and minimum waiting and walking. This will be assumed to be incorporated in the general labour charges on any enterprise.

Field planting: if this is done by hand, it is assumed that 1 man will plant and cover 600 setts per hour. An attachment on the rear of the ridger could be devised to form a furrow so the only operations would be dropping the sett and covering.

Machinery to plant tapioca, if not immediately available, is readily modified from the Universal Transplanter. This machine (single row version) would cost about $1,500 and have a working life of up to 12 years with a 2,500 hour replacement rate. The cost pattern is likely to be as follows:

Field costs - depreciation and interest - $178/annum.

Spares	60 cts/hour used or $1.00 per acre.
Other variable maintenance	23 cts/hour or 38 cts/acre.

Working speed at say .6 acres/hr. = 1.5 m.p.h.

This would require 1 extra man on the transplanter full time at the rate of 45 cts. per hour or 73 cts. per acre.

Modification of a sugar cane planter, which is able to cut setts from lengths of stem just prior to planting would reduce total planting costs appreciably.

	Hand planting	Machine planting(1)	Machine planting(2)
Material	$17.50	$17.50	$17.50
Sett preparation	7.40	7.40	-
Field planting	6.00	6.30	6.80
	30.90	31.20	24.30

(1) Universal transplanter + 1 operator

(2) Sugar cane transplanter + 1 operator

3.1.6 Weeding

Weeds may be controlled by cultivations and or by chemicals. Both hand and mechanical methods can be used. Hand weeding is likely to take about 3 rounds at 2 man days per acre per round. This will cost about $7/acre round or $21 in total. The same labour would be able to use mechanical spraying equipment whilst walking through the crop. There is little to choose between the motorised and hand knapsack sprayers in terms of costs per acre but a large difference in health hazard and efficiency of operations within the tapioca crop. The hand sprayer is to be preferred though a disadvantage is that more frequent filling is necessary.

Three men will spray about 3 acres/day on average (1 man mixing and filling + 2 men spraying). Two sprayings would be necessary at a materials cost of say \$6 per acre per round - a total cost of say \$20 per acre for two rounds.

Tractor spraying would cost (with 15 ft boon sprayer at 4 m.p.h. = 6 acres/hour) about \$13.20 per acre for two rounds including materials.

3.1.7 Harvesting

Harvesting is a major cost in both mechanised and labour intensive schemes. The tapioca root is spread throughout the soil and is rather loosely attached to the stem. The possibility of reducing root spread by fertiliser placement and of breeding for compact roots with firm tuber/stem attachment should be pursued.

No mechanical harvester is yet available. Trials are underway at the University of Malaya with a vibratory system of soil loosening and a prototype harvester is said to be on its way out from UK to Howard Rotovators in Kuala Lumpur. Little is known about this latter machine except that it uproots the whole plant and leaves it on the ground. It is possible that the combination of vibratory soil loosening with a sugar beat harvester type of lifting device would allow a satisfactory mechanical harvester to be developed fairly quickly.

The absence of a proven mechanical harvester makes cost comparisons between mechanical and hand harvesting very difficult. For the sake of comparison the following assumptions are made for a future complete mechanical harvester.

Harvester - Cost \$20,000
Life in years 5
Life to wear 2,500
Salvage value \$2,000
Operating speed 1 m.p.h.
Rate of work 4 x 3 = .72 ac/hr.
2' x 3' = .36 ac/hr.

∴ Depreciation = \$3,600/year
Interest @ 8%= \$800/year
Spares \$8/hour

One machine should harvest at least 500 acres/year; the total cost will therefore be in the region of \$33/acre for the machine of which variable costs are about \$28/acre. Tractor variable costs in addition at \$8/acre bring the total cost to \$41/acre for mechanical harvesting.

Hand harvesting costs vary with source though a wide range of values:

Beeny	-	\$45/acre minimum.
Luloffs	-	\$54/acre - including topping and loading.
Private source (suspect)	-	\$90 - pulling only.

It would seem reasonable to take \$50/acre - 14 man days/acre as a cost of hand harvesting and loading at this stage.

3.1.8 Transport

Transport costs to factory will obviously depend on distance to factory. Trailer costs will be very low - say \$200/year in depreciation and \$200 in spares. Tractors costs are calculated on hours of running time only.

At an average load of 3.75 tons/trailer (4 trailers loads per acre), costs for 2, 5 and 10 mile runs are taken to be as follows:

	2 mile run	5 mile run	10 mile run
Loading time	.34 hour	.34	.34
Empty time	.13 hour	.13	.13
Waiting and unloading	.20 hour	.20	.20
Running time @ 10 mph full	.20	.50	1.00
& 15 mph	.13	.32	.64
	1 hour/3.75 tons	1.50	2.30 hours
Tractor variable costs/ac.	\$12/acre	\$18/acre	\$27.60/acre
Contract lorry rate - 22 cts/ton mile	\$6.60/ac.	\$16.50/ac.	\$33.00/acre
Tractor and trailer output in 8 hour day	2 acres	1.3 acre	0.9 acre/day

3.2 Some Tapioca Enterprise Evaluations

Five enterprises have been evaluated:-

(a) A fully mechanised 1000 acre (net) unit.
(b) A partially mechanised 1000 acre (net) unit, with all labour housed and permanently employed.
(c) A partially mechanised 1000 acre (net) unit, assuming casual labour to be available when required.
(d) A one-tractor unit, (200 acres net), partially mechanised.
(e) A 10-acre (net) smallholding.

3.2.1 Fully mechanised 1000-acre unit

In this enterprise it has been assumed that one tractor will undertake all cultivation work using a chisel plough followed by a rotovator and ridger. The ridged land will be planted using a two row modified sugar cane planter which cuts the stems to length just prior to planting. Manuring can be done at this stage with a placement attachment but use of a separate fertiliser distributor is envisaged. Weed control is mainly done by spraying, first with a pre-emergence spray after planting and then with a general spray applied with a drop nozzle boom sprayer. One short weeding round by hand is assumed to keep down spray resistant weeds.

Harvesting will be preceded by the slashing down of tops, thereby returning both nutrients and organic matter to the soil in a mulch of 1"-1½" depth per season. This should break down sufficiently within a month or two to release the nutrients and to improve structure, water holding capacity and nutrient retention.

All costs are worked out on the basis of current market prices. It is assumed that all sales are made ex farm and that no processing occurs.

Land clearance: this is assumed to be done by contract @ $350 per acre. A gross area of 1120 acres has been taken.

Roads: access roads; 20 chains @ $180 per chain, ($4 per acre), have been provided. Internal roads; 260 chains @ $45 per chain, ($12 per acre), are assumed. $500 per annum has been allowed for maintenance of all roads.

Buildings: $22,000 has been provided. Maintenance costs have been taken at 2½ percent per annum.

Máchinery: machinery performance and resulting annual work requirement in hours are assumed to be

Implement	Output	Annual Use (hours)
Plough	2.25 ac/hr	450
Rotovator and Ridger	1.0	1,000
Planter	6	166
Fert. Dist.	6	166
Sprayer	6	166
Slasher	2.5 ac/hr	400
Harvester	.36	2,777
Trailer 2 mile carry		3,200
		8,225

Table C7 shows the hours available each month for field operations and the number of implements required on the assumption that the operations are planned and performed so as to maintain as even a flow as possible of tapioca to the factory from January to October every year.

TABLE C7 AVAILABLE HOURS FOR FIELD WORK AND IMPLEMENT REQUIREMENTS

Hours available for field operations		Chisel Plough	Roto-vate Ridge	Planter	Fert. Dist.	Spray-er	Slash-er	Har-ves-ter	Trai-lers
J	160	.27	.62	1.04	.1	.1	.25	1.72	2
F	200	.22	.5	0.83	.08	.08	.20	1.38	2
M	200	.22	.5	0.83	.08	.08	.20	1.38	2
A	120	.36	.83	1.38	.13	.13	.33	2.32	2
M	120	.36	.83	1.38	.13	.13	.33	2.32	2
J	160	.27	.62	1.04	.1	.1	.25	1.72	2
J	160	.27	.62	1.04	.1	.1	.25	1.72	2
J	160	.27	.62	1.04	.1	.1	.25	1.72	2
A	160	.27	.62	1.04	.1	.1	.25	1.72	2
S	160	.27	.62	1.04	.1	.1	.33	2.32	2
O	120	.36	.83	1.38	.13	.13	.50		2
N	80	.55	1.25	2.08	.2	.2	.50		2
D	80	.55	1.25	2.08	.2	.2			2
No. required		1	1	1	1	1	1	2	2

Full detail of the tractor, implement, plant and vehicle requirements and costs are given in Table C8 and summarised below:

			Replaced after
7 tractors @ $12,000 each	=	$84,000	8 years
1 plough	=	1,300	12 years
1 ridger	=	5,000	7 years
1 rotovator	=	4,000	7 years
1 planter @ $2,500	=	2,500	5 years
1 fert. distributor	=	1,200	10 years
1 sprayer 15 ft.	=	1,000	10 years
2 harvesters @ $20,000	=	40,000	5 years
2 trailers @ $3,000	=	6,000	10 years
1 slasher @ $2,500	=	2,500	5 years
1 landrover @ $12,000	=	$12,000	10 years
Water and electricity @ $15,000	=	$15,000	

Variable costs have been taken at the following rates:

tractors	- $3.00 per hour
landrover	- $0.80 per mile
Chisel plough	- $0.50 per hour
Rotovator/ridger	- $3.50 per hour
Slasher	- $2.00 per hour
electricity/water	- $2500 per year

Planting material: this is purchased only for the initial planting. The cost of material is taken to be $17.50 per acre, and is spread equally over the first two years of the project.

Fertilizers: these are charged in accordance with the criteria set out in section 3.1.3 of this appendix, and rise progressively from $55 to $73 per acre.

Spray chemicals: $12 per acre has been allowed for herbicides.

Salaries and wages:
1 Manager @ $1,500/month
2 Mechanics @ $240/month
7 Tractor drivers @ $160/month
1 Storekeeper/clerk @ $130/month
1 Mandor @ $130/month
18 General labourers @ $100/month

TABLE C8

SCHEDULE OF IMPLEMENT/TRACTORS COSTS - 1,000 ACRE MECHANISED TAPIOCA ($000)

Year	1 @ 1,300 Plough	1 @ Rotovator/ Ridger	1 @ 2,500 Planters	1 each @ 1,200 Fert/ Dist. and 1,000 Sprayer	2 @ 20,000 Harvester	Slasher @ $2,500	2 @ 3,000 Trailer	1 @ 12,000 Landrover	7 @ 12,000 Tractors	Electricity & Water	Total Costs
1	1.3 + .1	11	2.5 + 0.4	2.2 +.2			6 +.2	12 +.8	60 + 10	18	125
2	.2	3.5	0.7	.4	40 + 14	3.3	.5	.8	24 + 28	2.5	118
3	.2	3.5	0.7	.4	28	.8	.5	.8	28	2.5	65
4	.2	3.5	0.7	.4	28	.8	.5	.8	28	2.5	65
5	.2	3.5	0,7	.4	28	.8	.5	.8	28	2.5	65
6	.2	3.5	2.5 + 0.7	.4	28	.8	.5	.8	28	2.5	68
7	.2	3.5	0.7	.4	40 + 28	3.3	.5	.8	28	2.5	108
8	.2	12.5	0.7	.4	28	.8	.5	.8	28	2.5	74
9	.2	3.5	0.7	.4	28	.8	.5	.8	36 + 28	2.5	101
10	.2	3.5	0.7	.4	28	.8	.5	12 +.8	24 + 28	2.5	101
11	.2	3.5	2.5 + 0.7	2.2 +.4	28	.8	6 +.5	.8	24 + 28	2.5	100
12	.2	3.5	0.7	.4	40 + 28	3.3	.5	.8	28	2.5	108
13	1.3 + .2	3.5	0.7	.4	28	.8	.5	.8	28	2.5	68
14	.2	12.5	0.7	.4	28	.8	.5	.8	28	2.5	74
15	.2	3.5	0.7	.4	28	.8	.5	.8	28	2.5	65
16	.2	3.5	2.5 + 0.7	.4	28	.8	.5	.8	28	2.5	68
17	.2	3.5	0.7	.4	40 + 28	3.3	.5	.8	36 + 28	2.5	144
18	.2	3.5	0.7	.4	28	.8	.5	.8	24 + 28	2.5	89
19	.2	3.5	0.7	.4	28	.8	.5	.8	24 + 28	2.5	89
20	.2	3.5	0.7	.4	28	.8	.5	12 +.8	28	2.5	77
	Spares Maint. .2	Spares 3.0 Maint. .5	Spares 0.6 Maint. 0.1	Spares.2 Maint..2	Spares 22.0 Maint. 6.0	Spares.6 Maint..2	Spares.0 Maint 0.5	Spares .1 Maint. .2 Fuel .5	Fuel 7.4 Spares 11.6 Maint. 9.0		

Housing: costs of housing are based on building duplex type houses at rates paid by private estates as follows:-

Manager's house	-	$20,000
Mechanic's house	-	$ 1,600
Other staff and labour house		$ 1,200

Maintenance is assumed to cost 2½ percent per annum.

Taxes, insurance, EPF and office expenses: provident fund has been taken at 5 percent of the wages bill and $2500 provided for other expenses.

Net cash flow: the costs, returns and net cash flow are shown in Table C9. The internal rate of return is 19 percent.

3.2.2 Partially mechanised 1000 acre scheme, with full permanent and housed labour force.

In this scheme land preparation is carried out mechanically by tractor, chisel plough, rotovator and ridger, and the stems are slashed before harvest with a mechanical slasher. Planting, fertilising, weeding and harvesting are done by hand by permanent labour gangs, who are housed on the estate and are retained full time even when little work is available.

Land clearance: costs as for the fully mechanised 1000 acre unit.

Roads: assumed to cost $15 per acre to construct. Maintenance provision $500 per year.

Buildings: provision of $20,000 is made for an office, store, tractor shed and workshop at $5,000 per building. Annual maintenance has been provided at 2½ percent.

Machinery: output performance by tractor for ploughing, rotovating and slashing is as given for the previous scheme. One tractor will be required for this work, and two primarily for pulling trailers. In months when harvests are small the latter tractors will be available to help with land preparation and/or slashing. However the need to slash through most months of the year imposes some constraint on cultivating and in some months less than 100 acres can be prepared. With the assumed machine performances and with available hours as given in Table C10 (column 1), the normal working programme will be as in columns 2 and 6 of that table.

TABLE C9 COSTS, RETURNS AND NET CASH FLOW OF 1,000 ACRE FULLY MECHANISED TAPIOCA SCHEME ($'000)

Year	Land Clearance, Roads, Buildings	Vehicles, Tractors, Impl. Maint.	Planting Material Chemical Fert.	Salaries Wages	Housing	Taxes Insurance Office E.P.F.	Survey Premium Rent	Total Exp.	Income x 1.1167 Total Inc.	N.C.F.
1	430	125	42	40	56	5	50	748	-	- 748
2	1	118	80	63	1	6	6	275	175	- 100
3	1	65	70	63	1	6	6	212	379	167
4	1	65	75	64	1	6	6	218	408	190
5	1	65	75	64	1	6	6	218	438	220
6	1	68	75	65	1	6	6	222	438	216
7	1	108	75	65	1	6	6	262	438	176
8	1	74	79	66	1	6	6	233	438	205
9	1	101	79	66	1	6	6	260	467	207
10	1	101	79	67	1	6	6	261	467	206
11	1	100	79	67	1	6	6	260	467	207
12	1	108	79	68	1	6	6	269	467	198
13	1	68	81	68	1	6	6	231	467	236
14	1	74	81	69	1	6	6	238	481	243
15	1	65	81	69	1	6	6	229	481	252
16	1	68	83	70	1	6	6	235	481	246
17	1	144	83	70	1	6	6	311	496	185
18	1	89	83	71	1	6	6	257	496	239
19	1	89	85	71	1	6	6	259	496	237
20	1	77	85	72	1	6	6	248	510	262
Total	449	1,772	1,549	1,318	75	119	164	5,446	8,490	3,044
N.P.V. at 15%	436.3	653.1	520.3	445.2	62.3	42.1	87.1	2,246.4	2,498.2	251.8
% Discounted Costs	19%	29%	23%	20%	3%	2%	4%		I.R.R. = 19.55%	

TABLE C10 SCHEDULE OF MECHANISED FIELD OPERATIONS

Month	Time Available for machine work	Monthly harvest	Time required for salshing	Time available for cultivations	Time required for cultivations	Monthly Acreage cultivated	Cumulative Acreage cultivated
	Hrs.	Acres	Hrs.	Hrs.	Hrs.	Acres	Acres
Jan	180	115	46	134	145	90	90
Feb	225	115	46	179	145	125	215
Mar	225	85	34	191	145	130	345
Apr	135	75	30	105	145	70	415
May	135	90	36	99	145	70	485
June	180	95	38	142	145	100	585
July	180	100	40	140	145	100	685
Aug	180	110	42	138	145	95	780
Sept	180	85	34	190	145	110	890
Oct	135	30	12	300	145	110	1,000
Nov	90	25	10	-	-	-	-
Dec	90	75	30	-	-	-	-

Full details of machinery costs are given in Table C11, and requirements and cost assumptions are summarised below.

3 tractors @ 1,600 hrs/year - replaced at 8 years cost \$12,000 each.

1 landrover @ 10,000 miles/year - replaced at 10 years cost \$12,000

1 chisel plough 10 years cost \$1,100
1 rotovator, ridger unit 7 years cost \$9,000
2 trailers 10 years cost \$3,000
1 slasher 5 years cost \$2,500

Tractor variable costs - \$3.00/hour = \$4,800/year x 3 = \$14,400
Landrover variable costs - 8 cts/mile = \$ 800/year
Chisel plough 450 hrs/yr - \$0.50/hour \$ 230/year
Rotovator/ridger - 1,000 hrs/yr. \$3.50/hour 3,500/year
Electricity/water \$15,000 capital @ \$2,500/year
Slasher 400 hours/year @ \$2 per hour = \$800/year.

TABLE C11 SCHEDULE OF MACHINERY COSTS PARTIALLY MECHANISED SCHEME ($ '000)

Yr.	Tractors	Land-rover	Chisel Plough	Rotovator/ridger	Slasher	Trailers	Elec/Water	Total
1	43.2	12.5	1.3	11	2.7	6.2	18	95
2	14.4	.8	.2	3.5	.8	.5	2.5	23
3	14.4	.8	.2	3.5	.8	.5	2.5	23
4	14.4	.8	.2	3.5	.8	.5	2.5	23
5	14.4	.8	.2	3.5	.8	.5	2.5	23
6	14.4	.8	.2	3.5	3.5	.5	2.5	25
7	14.4	.8	.2	12.5	.8	.5	2.5	32
8	26.4	.8	.2	3.5	.8	.5	2.5	35
9	38.4	.8	.2	3.5	.8	.5	2.5	47
10	14.4	.8	.2	3.5	.8	.5	2.5	23
11	14.4	12.8	1.3	3.5	3.5	6.5	2.5	44
12	14.4	.8	.2	3.5	.8	.5	2.5	23
13	14.4	.8	.2	3.5	.8	.5	2.5	23
14	14.4	.8	.2	12.5	.8	.5	2.5	32
15	26.4	.8	.2	3.5	.8	.5	2.5	35
16	38.4	.8	.2	3.5	3.5	.5	2.5	49
17	14.4	.8	.2	3.5	.8	.5	2.5	23
18	14.4	.8	.2	3.5	.8	.5	2.5	23
19	14.4	.8	.2	3.5	.8	.5	2.5	23
20	14.4	.8	.2	3.5	.8	.5	2.5	23

Planting: the cost of planting material is for initial planting only and is $17.50 an acre as in the previous scheme. For the monthly planting schedule set out in Table C10, Column 6, the following labour will be required:

	Acres to be planted	Man days required for planting	Days available	Men needed
J	90	135	20	7
F	125	188	25	8
M	130	195	25	8
A	70	105	15	7
M	70	105	15	7
J	100	150	20	8
J	100	150	20	8
A	95	143	20	8
S	110	165	20	9
O	110	165	15	11
N	-	-	-	-
D	-	-	-	-

A regular gang of 9 men will be required for planting. A further 9 will be needed to prepare setts.

Manuring: the same provision for fertilizers is made as in the previous scheme. For application at planting, followed by a second (broadcast) 3-4 months later the following labour will be required:-

	Acres	Man days 1st appl.	Man days 2nd appl.	Total	Days available	Gang size
J	90	90	55	145	20	8
F	125	125	-	125	25	5
M	130	130	-	130	25	6
A	70	70	45	115	15	8
M	70	70	63	133	15	9
J	100	100	65	165	20	9
J	100	100	35	135	20	7
A	95	95	35	130	20	7
S	110	110	50	160	20	8
O	110	110	-	110	15	7
N	-	-	73	73	10	8
D	-	-	80	80	10	8

A regular gang of 9 men will be required

Spraying: cost of spray materials is assumed to be $12 per acre for 2 rounds. Assuming a four-man team (3 spraying and 1 mixing and filling) will cover 15 acres a day, labour requirements will be as follows:

	Acres	Gang days 1st appl.	Gang days 2nd appl.	Total	Days available
J	90	6	-	6	20
F	125	8	-	8	25
M	130	9	6	15	25
A	70	5	8	13	15
M	70	5	9	14	15
J	100	7	5	12	20
J	100	7	5	12	20
A	95	7	7	14	20
S	110	7	7	14	15
O	110	7	7	14	10
N	-	-	7	7	10
D	-	-	7	7	

One regular gang of four men is required.

Harvesting: it has been assumed that 14 man days per acre are needed for pulling, tapping and loading.

Since regular gangs have been maintained for the maximum monthly requirement of planting, manuring and spraying, there will be some surplus labour available from these operations to undertake harvesting. This surplus labour is as follows: (man/days)

	From planting	From manuring	From spraying	Total surplus
J	40	20	56	116
F	25	100	68	193
M	25	75	40	140
A	30	15	8	53
M	30	0	4	34
J	20	0	32	52
J	20	40	32	92
A	20	40	24	84
S	0	20	24	44
O	-30	30	4	4
N	90	10	12	112
D	90	10	12	112

Thus labour requirements for harvest will be as follows:-

	Acres to be harvested	Total man-days required	Mandays available from other jobs	New man/days required	Days available	Gang size
J	115	1,610	116	1,494	20	75
F	115	1,610	193	1,417	25	59
M	85	1,190	140	1,050	25	42
A	75	1,050	53	997	15	67
M	90	1,260	34	1,226	15	82
J	95	1,330	52	1,278	20	64
J	100	1,400	92	1,308	20	66
A	110	1,540	84	1,456	20	73
S	85	1,190	44	1,146	20	58
O	30	420	4	416	15	28
N	25	350	112	238	10	24
D	75	1,050	112	938	10	94

The optimum time of harvest is 11 months from planting. It has been assumed the crop can be taken when it is between 10-12 months old without adverse effects; thus the harvesting of any one month's planting may be spread over three months. If every month's planting is so harvested the monthly gang size will be as above, averaging 61 per month, varying between 24 and 94. By further adjusting the harvesting rate in October, November and December, the variations in gang size can largely be eliminated and a permanent gang of 70 should be adequate and leave a surplus for holiday, sick leave and miscellaneous jobs. Little casual labour should be necessary.

		$ p.m.	$ per year
Management and labour:	1 Manager	1,500	18,000
	1 Field Mandor	130	1,600
	2 Harvest Mandors	260	3,200
	3 Tractor drivers	510	6,100
	1 Mechanic	250	3,000
	1 Storekeeper	130	1,600
	1 Clerk	130	1,600
			$35,100
	70 labourers - harvesting @ 100		84,000
	9 labourers - planting @ 100		10,800
	9 labourers - sett prep. @ 100		10,800
	9 labourers - manuring @ 100		10,800
	4 labourers - weed control @ 110		5,200
	Casual labour cost @ $3.50/day		2,100
		Total labour =	123,700
	Total Management and labour =		158,700

Housing:- housing standards are as in the previous scheme: Requirements are

1 (manager) @ $20,000
1 (mechanic) @ $ 1,600
68 (other) @ $ 1,200

It has been assumed that 60 percent of the labourers will require housing. The remainder will be members of the same families or in their own houses in nearby-villages. Maintenance has been taken at 2½ percent per annum.

Taxes, insurance, provident fund and office expenses: these have been taken on the same basis as in the previous scheme.

TABLE C12 1000 ACRES PARTIALLY MECHANISED FULL TIME LABOUR COSTS, RETURNS AND NET CASH FLOW ($'000)

Year	Land Clearance Roads Buildings.	Vehicles Tractors Imp. Maint.	Planting Materials Fert./ Chem.	Salaries Wages	Housing	Tax. Ins., office exp. E.P.F. etc.	Survey Premium Rent	Total Exp.	Total Inc.	N.C.F.
1	420	95	42	115	67	8	50	797	-	- 797
2	1	23	80	157	36	10	6	313	175	- 138
3	1	23	70	160	3	10	6	273	379	106
4	1	23	75	163	3	11	6	282	408	126
5	1	23	75	166	3	11	6	285	438	153
6	1	25	75	169	3	11	6	290	438	148
7	1	32	75	172	3	11	6	300	438	138
8	1	35	79	175	3	11	6	310	438	128
9	1	47	79	178	3	11	6	325	467	142
10	1	23	79	181	3	12	6	305	467	162
11	1	44	79	184	3	12	6	329	467	138
12	1	23	79	187	3	12	6	311	467	156
13	1	23	81	190	3	12	6	316	467	151
14	1	32	81	193	3	12	6	328	481	153
15	1	35	81	196	3	12	6	334	481	147
16	1	49	83	199	3	13	6	354	481	127
17	1	23	83	202	3	13	6	331	496	165
18	1	23	83	205	3	13	6	334	496	162
19	1	23	85	208	3	13	6	339	496	157
20	1	23	85	211	3	13	6	342	510	168
Total	439	647	1,549	3,611	157	231	164	6,798	8,490	1,692
N.P.V. at 15%	426.3	266.3	520.3	1,185.5	114.3	76.9	87.2	2,676.8	2,498.2	- 178.6
% Discounted Costs	15.9%	9.9%	19.4%	44.3%	4.3%	2.9%	3.3%	I.R.R. = 12.15%		

3.2.3 Partially mechanised 1000 acre scheme, using casual labour.

The difference between this scheme and that outlined in section 3.2.2 is that casual labour is assumed to be available for planting, manuring, spraying and harvesting, and these operations are costed on their actual labour requirements, instead of on the cost of keeping regular gangs for these operations. Table C13 shows the costs, returns and net cash flow of this scheme. The substantial savings on wages and housing raise the internal rate of return to 21 percent.

3.2.4 Partially mechanised, one tractor unit.

A one tractor unit is calculated to be 200 acres. The tractor is mainly used for cultivation, planting and carting roots from the field. The input of the farmer's time is not costed in this example. Most of this is likely to be supervisory. Table C14 shows the costs, returns and net cash flow. The internal rate of return is 22 percent.

3.2.5 A 10-acre (net) smallholding

Land is cleared at the same cost per acre as in the large schemes. Preparation is assumed to be done mechanically at a cost of $20 per acre for one chisel ploughing followed by one rotogation.

Labour requirements peak at harvest and planting time. Planting is particularly demanding with sett preparation, planting, manuring and spraying to be done.

It is assumed that over this period - planned between January and early April in this example - both the farmer and either his wife or another family member will be working + casual labour at $3.50 per day for a total of 44 man days.

Total labour requirement is:
January and February - harvesting 140 man days
March - beginning of April - planting 55 man days
August/September - manuring and spraying 10 man days
205 man days of which farmer provides 161.

TABLE C13 1,000 ACRES, PARTIALLY MECHANISED CASUAL LABOUR, COSTS, RETURNS NET CASH FLOW ($'000)

Year	Land Clearance Roads Buildings	Vehicles Tractors Imp. Maint.	Planting Material Fertilizer Chemicals	Salaries Wages	Housing	Tax. Ins. office E.P.F. etc.	Survey Premium Rent	Total Exp.	Total Income	N.C.F.
1	420	95	42	70	31	6	50	714	-	- 714
2	1	23	80	104	1	8	6	223	175	- 48
3	1	23	70	106	1	8	6	215	379	164
4	1	23	75	108	1	8	6	222	408	186
5	1	23	75	110	1	8	6	224	438	214
6	1	25	75	112	1	8	6	228	438	210
7	1	32	75	114	1	8	6	237	438	201
8	1	35	79	116	1	8	6	246	438	192
9	1	47	79	118	1	8	6	260	467	207
10	1	23	79	120	1	8	6	238	467	229
11	1	44	79	122	1	9	6	262	467	205
12	1	23	79	124	1	9	6	243	467	224
13	1	23	81	126	1	9	6	247	467	220
14	1	32	81	128	1	9	6	258	481	223
15	1	35	81	130	1	9	6	263	481	218
16	1	49	83	132	1	9	6	281	481	200
17	1	23	83	134	1	9	6	257	496	239
18	1	23	83	136	1	9	6	259	496	237
19	1	23	85	138	1	9	6	263	496	233
20	1	23	85	140	1	9	6	265	510	245
Total	439	647	1,549	2,388	50	168	164	5,405	8,490	3,085
N.P.V. at 15%	426.3	266.3	520.3	779.3	37.1	57.1	87.2	2,173.6	2,498.2	324.6
% Discounted Costs	19.6%	12.3%	23.9%	35.9%	1.7%	2.6%	4.0%		I.R.R. = 21.30%	

A cost of $2,000 has been included for a house. This can be deducted from total costs if the farmer builds his own house. A self-built house is likely to be much cheaper initially and may be borne out of the farmer's resources.

The costs, returns and net cash flow are shown in Table C15. The internal rate of return is 29 percent. The calculations relate to only one farm. In practice farms are likely to be grouped to facilitate block cultivation by tractors. This will increase overall costs, as infrastructure will be required, and the returns will approximate more closely to those obtained in the partially mechanised 1000 acre scheme employing full time labour.

Earning capacity of farmers is influenced by repayment and by cost of infrastructure. An alternative to loan repayment is long term renting of land with the government as landowner. Many variations are possible; below the monthly net incomes are shown assuming:

(a) Repayment of loan to include infrastructure element - Capital/10 acres say 6,500 @ 7½ percent - 15 years.

(b) Repayment of loan excluding infrastructure and housing. Capital/10 acres say 4,000 @ 7½ percent - 15 years.

(c) Rented only. Eight and a half percent on $4,000.

Year	Net monthly income (a)	Net monthly income (b)	Net monthly income (c)
1	63	83	96
2	84	107	116
3	93	116	126
4	118	141	151
5	101	125	134
6	118	141	151
7	126	150	159
8	134	158	167
9	126	150	159
10	126	150	159
11	143	166	176
12	143	166	176
13	150	174	183
14	150	174	183
15	133	157	166
16	220	220	191
17	220	220	191
18	220	220	191
19	227	227	200
20	227	227	200
NPV @ 15%	717.2	851.3	897.7

TABLE C15 SMALLHOLDER - 10 ACRES (NET) COSTS, RETURNS AND NET CASH FLOW ($)

Year	Land Clearance Roads	Housing	Planting Material Fert/Sprays	Land prep. Contract	Equipment Tools etc.	Casual Labour	Survey Premium Rent	Total Exp.	Total Income at $25/ton	N.C.F.
1	3,920	2,000	710	150	200	154	500	7.634	-	- 7,634
2	-	-	590	200	-	157	60	1,007	2,917	1,910
3	-	-	590	200	-	160	60	1,010	2,917	1,907
4	-	100	630	200	-	163	60	1,153	3,208	2,055
5	-	-	670	200	-	166	60	1,096	3,500	2,404
6	-	-	670	200	200	169	60	1,299	3,792	2,493
7	-	100	690	200	-	172	60	1,222	3,792	2,570
8	-	-	690	200	-	175	60	1,125	3,938	2,813
9	-	-	710	200	-	178	60	1,148	3,938	2,790
10	-	100	710	200	-	181	60	1,251	4,083	2,832
11	-	-	730	200	200	184	60	1,374	4,083	2,709
12	-	-	730	200	-	187	60	1,177	4,229	3,052
13	-	100	750	200	-	200	60	1,310	4,229	2,919
14	-	-	750	200	-	203	60	1,213	4,375	3,162
15	-	-	750	200	-	206	60	1,216	4,375	3,159
16	-	100	770	200	200	209	60	1,539	4,375	2,836
17	-	-	770	200	-	212	60	1,242	4,521	3,279
18	-	-	770	200	-	215	60	1,245	4,521	3,276
19	-	100	790	200	-	218	60	1,368	4,521	3,153
20	-	-	790	200	-	221	60	1,271	4,667	3,396
Total	3,920	2,600	14,260	3,950	800	3,730	1,640	30,900	75,981	45,081
N.P.V at 15%	3,920	2,176.5	4,864.5	1,389.6	373.4	1,234.2	871.9	14,830.1	22,477.8	7,647.7
% Discount costs	26%	15%	33%	9%	3%	8%	6%		I.R.R. = 29.6%	

The calculations assume that the smallholder was able to finance annual working capital charges from his own resources. If he had to take money on credit for this, the increased charges, at say 10-12 percent interest/annum, would be in the region of $10/month.

On the other hand if casual labour is available on a give and take basis from surrounding farmers due to staggered planting and harvesting there could be a monthly increment of $15/month from casual labour.

Net income per manday used by farmer ranges between $10 and $17. In addition the farmer has some 160 unused mandays available for other work.

3.3 Conclusions

The outcomes of the three 1000 acre units and the 200 acre unit are summarised in Table C16.

The above table suggests that higher returns and generally more desirable outcomes spring from the 1000 acre partially mechanised scheme, employing casual labour. Provided that such labour were readily available, management costs would have to be 50-60 percent higher than shown to induce a private investor to adopt full mechanisation.

The organisation employing casual labour could be a suitable one to establish in the vicinity of existing or proposed public sector oil palm estates, where underemployment may become a problem once the palms come into bearing. Every 1000 acres planted to tapioca could provide over 100 workers an average income of some $50-60 per month.

Where casual labour is likely to be difficult to obtain the mechanised scheme could provide a reasonably attractive alternative but only when the problems of mechanised harvesting are sorted out. At the present state of knowledge, the major work input is likely to be in harvesting. On a labour use basis, 62 percent of total labour requirement is for harvesting and 38 percent for the easily mechanised planting, manuring and weed control.

Smallholder activity in newly opened areas is feasible, given good marketing arrangements but the crop should only be considered as a smallholder crop in the short term. Labour use is intensive for a few months of the year and the long term income prospects are relatively low. Agronomic considerations make it desirable to grow the crop as one of a number of enterprises if suitable rotations can be devised.

TABLE C16 SUMMARY OF TAPIOCA SCHEME OUTCOMES

	I	II	III	IV
Size of unit - net	1,000 acres	1,000 acres	1,000 acres	200 acres
Capital cost (1)	$848,000	$935,000	$762,000	$164,000
No. Management	1	1	1	1
No. skilled workers (2)	9	4	4	2
No. unskilled workers (3)	20	104	51	9
Cost/total employee	$ 28,267	$ 8,578	$ 13,607	$ 13,667
Cost/unskilled worker	$ 42,400	$ 8,990	$ 14,941	$ 18,222
Average output/ man year	$ 14,584	$ 4,013	$ 7,817	$ 7,292
NPV/acre @ D.R. 15%	252	- 179	325	388
I.R.R.	19%	12%	21%	22%
Acres/total worker	35	9	18	17

(1) Capital cost taken as negative element of Net Cash Flow at 15 percent discount rate.

(2) Skilled workers taken as all earning more than $150/month.

(3) Unskilled workers includes semiskilled with salaries or wages below $150 per month. Where casual labour is used, this is converted to full time basis by assuming 1 man year is equivalent to $1200 in wages.

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