Table F-36 FINANCIAL FARM OPERATION COST OF MOTHER FARM

I. Soya Bean

(Unit: J$)

Farm Operation	Unit Price	Quantity	Amount
1. Tillage	22.7	3.0 hr	68.1
2. Pulverizing	29.5	1.5 hr	44.3
3. Ridging	26.6	1.5 hr	39.9
4. Moulding	27.9	2.0 hr	55.8
5. Planting	22.5	1.0 md	22.5
6. Weed Control	22.5	3.0 md	67.5
	9.5	8.0 hr	76.0
7. Pest Control	22.5	3.0 md	67.5
	9.5	12.0 md	114.0
8. Fertilizing	22.5	1.0 md	22.5
9. Water Management	22.5	8.0 md	180.0
10. Harvesting	99.4	2.0 hr	198.8
11. Transporting	35.2	1.0 hr	35.2
Total	-	-	992

II. Rice

Farm Operation	Unit Price	Spring Rice Quantity	Spring Rice Amount	Fall Rice Quantity	Fall Rice Amount
I. Mineral Soil					
1. Tillage	22.7	3.0 hr	68.1	3.0 hr	68.1
2. Pluverizing or Paddling	29.5	3.0 hr	88.5	3.0 hr	88.5
3. Leveling	33.1	2.0 hr	66.2	0	0
4. Pregerminate and Planting	22.5	1.0 md	22.5	1.5 md	33.8
5. Weed Control	22.5	3.0 md	67.5	3.0 md	67.5
	9.5	8.0 hr	76.0	8.0 hr	76.0
6. Fertilizing	22.5	3.0 md	67.5	3.0 md	67.5
7. Pest Control	22.5	1.0 md	22.5	2.0 md	45.0
	9.5	4.0 hr	38.0	8.0 hr	76.0
8. Supplementary Transplanting	22.5	1.0 md	22.5	1.0 md	22.5
9. Water Management	22.5	5.0 md	112.5	5.5 md	123.8
10. Harvesting	99.4	3.2 hr	318.1	2.6 hr	258.4
11. Transportation	35.2	1.6 hr	56.3	1.3 hr	45.8
12. Total			1,026		973
II. Peat Soil					
1. Tillage	28.0	3.0 hr	84.0	3.0 hr	84.0
2. Pluverizing or Paddling	29.3	2.0 hr	58.6	3.0 hr	87.9
3. Leveling	32.8	2.0 hr	65.6	0	0
4. Pregerminate and Planting	22.5	1.0 md	22.5	1.5 md	33.8
5. Weed Control	22.5	3.0 md	67.5	3.0 md	67.5
	9.5	8.0 hr	76.0	8.0 hr	76.0
6. Fertilizing	22.5	1.0 md	22.5	1.0 md	22.5
7. Pest Control	22.5	2.0 md	45.0	2.0 md	45.0
	9.5	8.0 hr	76.0	8.0 hr	76.0
8. Supplementary Transplanting	22.5	1.0 md	22.5	1.0 md	22.5
9. Water Management	22.5	4.5 md	101.3	5.0 md	112.5
10. Harvesting	138.2	3.2 hr	442.2	2.6 hr	359.3
11. Transportation	40.4	1.6 hr	64.6	1.3 hr	52.5
12. Total			1,148		1,040

Table F-37 ANNUAL NET PRODUCTION VALUE PER HA UNDER WITHOUT PROJECT CONDITION

I. Sugarcane

(Unit : J$)

Description	Unit Cost	Replanted (87%)	Ratoon (13%)	Production Cost (100%)
1. Farm Input Cost				
- Seed	72.9/ton	7.4 ton	1.9 ton	487
- Fertilizer	0.9/kg	203 kg	203 kg	183
- Agro-Chemicals	31/lit	8.6 lit	8.6 lit	267
2. Labour Operation Cost				
- Land preparation	124/time	4 operations	-	432
- Planting	185/time	1 time	-	161
- Molding	35/time	1 time	1 time	35
- Weeding	49/time	2 times	2 times	98
- Sparying and Fertilizing	11/time	2 times	2 times	22
- Supplying field	44/time	1 time	1 time	44
- Harvesting	4.3/ton	62 ton	62 ton	227
- Transportation	4.3/ton	62 ton	62 ton	227
3. Over Head Cost	-	-	-	1,151
4. Total Production Cost	-	-	-	3,334
5. Gross Production Value	68/ton	62 ton	62 ton	4,216
6. Net production Value	-	-	-	882

II. Other Crops

	Gungo Peas (25%)	Peanuts (20%)	Corn (10%)	Yams (15%)	Cassava (30%)	Weighted Average of Upland Crops (100%)	Rice (100%)
1. Farm inputs cost							
- Seed	75	1,017	43	4,627	315	1,015	42
- Fertilizer	-	251	-	-	-	50	-
- Agro - Chemicals	-	55	55	-	-	17	-
2. Labour operation cost	1,501	1,738	1,185	3,871	2,054	2,038	2,070
3. Total Production cost	1,576	3,061	1,283	8,491	2,369	3,120	2,112
4. Gross Production Value	5,208	6,048	1,400	10,800	5,376	5,885	1,673
5. Net Production Value	3,632	2,987	117	2,309	3,007	2,765	-439

Table F-38 ANNUAL NET PRODUCTION VALUE PER HA UNDER WITH PROJECT CONDITION

I. Economic

(Unit : J$)

	Cost of Farm Input	Cost of Farm Operation	Gross Production Cost	Gross Production Value	Net Production Value
I. Mineral Soil					
1. Small Farm					
Spring Rice	1,236	974	2,210	8,366	6,156
Fall Rice	1,236	900	2,136	8,366	6,230
Soya Bean	2,063	918	2,981	5,943	2,962
Total	4,535	2,792	7,327	22,675	15,348
2. Mother Farm					
Spring Rice	1,236	1,068	2,304	8,366	6,062
Fall Rice	1,236	1,008	2,244	8,366	6,122
Soya Bean	2,063	1,025	3,088	5,943	2,855
Total	4,535	3,101	7,636	22,675	15,039
II. Peat Soil					
1. Small Farm					
Spring Rice	957	1,122	2,079	6,845	4,766
Fall Rice	957	997	1,954	6,845	4,891
Total	1,914	2,119	4,033	13,690	9,657
2. Mother Farm					
Spring Rice	957	1,206	2,163	6,845	4,682
Fall Rice	957	1,088	2,045	6,845	4,800
Total	1,914	2,294	4,208	13,690	9,482

II. Financial

	Cost of Farm Input	Cost of Farm Operation	Gross Production Cost	Gross Production Value	Net Production Value
I. Mineral Soil					
1. Small Farm					
Spring Rice	754	711	1,465	6,050	4,585
Fall Rice	754	613	1,367	6,050	4,683
Soya Bean	1,450	632	2,082	3,250	1,168
Total	2,958	1,956	4,914	15,350	10,436
2. Mother Farm					
Spring Rice	754	1,026	1,780	6,050	4,270
Fall Rice	754	973	1,727	6,050	4,323
Soya Bean	1,450	992	2,442	3,250	808
Total	2,958	2,991	5,949	15,350	9,401
II. Peat Soil					
1. Small Farm					
Spring Rice	610	867	1,477	4,950	3,473
Fall Rice	610	736	1,346	4,950	3,604
Total	1,220	1,603	2,823	9,900	7,077
2. Mother Farm					
Spring Rice	610	1,148	1,758	4,950	3,192
Fall Rice	610	1,040	1,650	4,950	3,300
Total	1,220	2,188	3,408	9,900	6,492

Table F-39 INCREMENTAL EFFECT OF LAND USE

(Unit: ha)

Description	Mineral Soil		Peat Soil				Total
	Holland	Hatfield	Styx River	Frenchman & Holliday Pen	Broad River Right	Broad River Left	
I. Without Project	680	300	400	500	1,000	1,000	3,880
- Sugar cane	310	-	-	-	-	-	310
- Rainfed rice	22	-	-	-	-	-	22
- Upland crops	-	15	-	-	-	-	15
II. With Project	680	300	400	500	1,000	1,000	3,880
- Spring rice	500	220	300	400	800	800	3,020
- Fall rice	560	220	300	400	800	800	3,080
- Soya bean	560	220	-	-	-	-	780
III. Increment							
- Spring rice	500	220	300	400	800	800	3,020
- Fall rice	560	220	300	400	800	800	3,080
- Soya bean	560	220	-	-	-	-	780
- Sugar cane	-310	-	-	-	-	-	-310
- Rainfed rice	-22	-	-	-	-	-	-22
- Upland crops	-	-15	-	-	-	-	-15

Table F-40 NET INCREMENTAL BENEFIT

(Unit: $J\$10^3$)

Description	Mineral Soil		Peat Soil				Total
	Holland	Hatfield	Styx River	Frenchman & Holliday Pen	Broad River Right	Broad River Left	
I. Annual Net Production Value							
1. Without Project	263	41	-	-	-	-	304
- Sugar cane	273	-	-	-	-	-	273
- Rainfed rice	-10	-	-	-	-	-	-10
- Upland crops	-	41	-	-	-	-	41
2. With Project	8,169	3,377	2,881	3,843	7,691	7,691	33,652
a) Small farm							
- Spring rice	2,216	1,354	1,001	1,382	2,860	2,860	11,673
- Fall rice	2,243	1,371	1,027	1,418	2,935	2,935	11,929
- Soya bean	1,066	652	-	-	-	-	1,718
Sub-total	5,525	3,377	2,028	2,800	5,795	5,795	25,320
b) Mother farm							
- Spring rice	849	-	421	515	936	936	3,657
- Fall rice	1,224	-	432	528	960	960	4,104
- Soya bean	571	-	-	-	-	-	571
Sub-total	2,644	-	853	1,043	1,896	1,896	8,332
II. Annual Net Incremental Benefit	7,906	3,336	2,881	3,843	7,691	7,691	33,348

Table F-41 SELECTION OF FARM SIZE

(Unit : J$)

Farm Size (ha)	1	2	3	4	5	6	7
I. Mineral Soil							
Unit Yield (ton/ha)							
Spring Rice	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Fall Rice	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Soya Bean	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Gross Income							
Rice	12,100	24,200	36,300	48,400	60,500	72,600	84,700
Soya Bean	3,250	6,500	9,750	13,000	16,250	19,500	22,750
Sub-total	15,350	30,700	46,050	61,400	76,750	92,100	107,450
Gross Outgo							
Farming expenses	4,914	9,828	14,742	19,656	24,570	29,484	34,398
Living expenses	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Sub-total	14,914	19,828	24,742	29,656	34,570	39,484	44,398
Net Reserve	436	10,872	21,308	31,744	42,180	52,616	63,052
II. Peat Soil							
Unit Yield (ton/ha)							
Spring Rice	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Fall Rice	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Gross Income							
Rice	9,900	19,800	29,700	39,600	49,500	59,400	69,300
Gross Outgo							
Farming expenses	2,823	5,646	8,469	11,292	14,115	16,938	19,761
Living expenses	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Sub-total	12,823	15,646	18,469	21,292	24,115	26,938	29,761
Net Reserve	-2,923	4,154	11,231	18,308	25,385	32,462	39,539

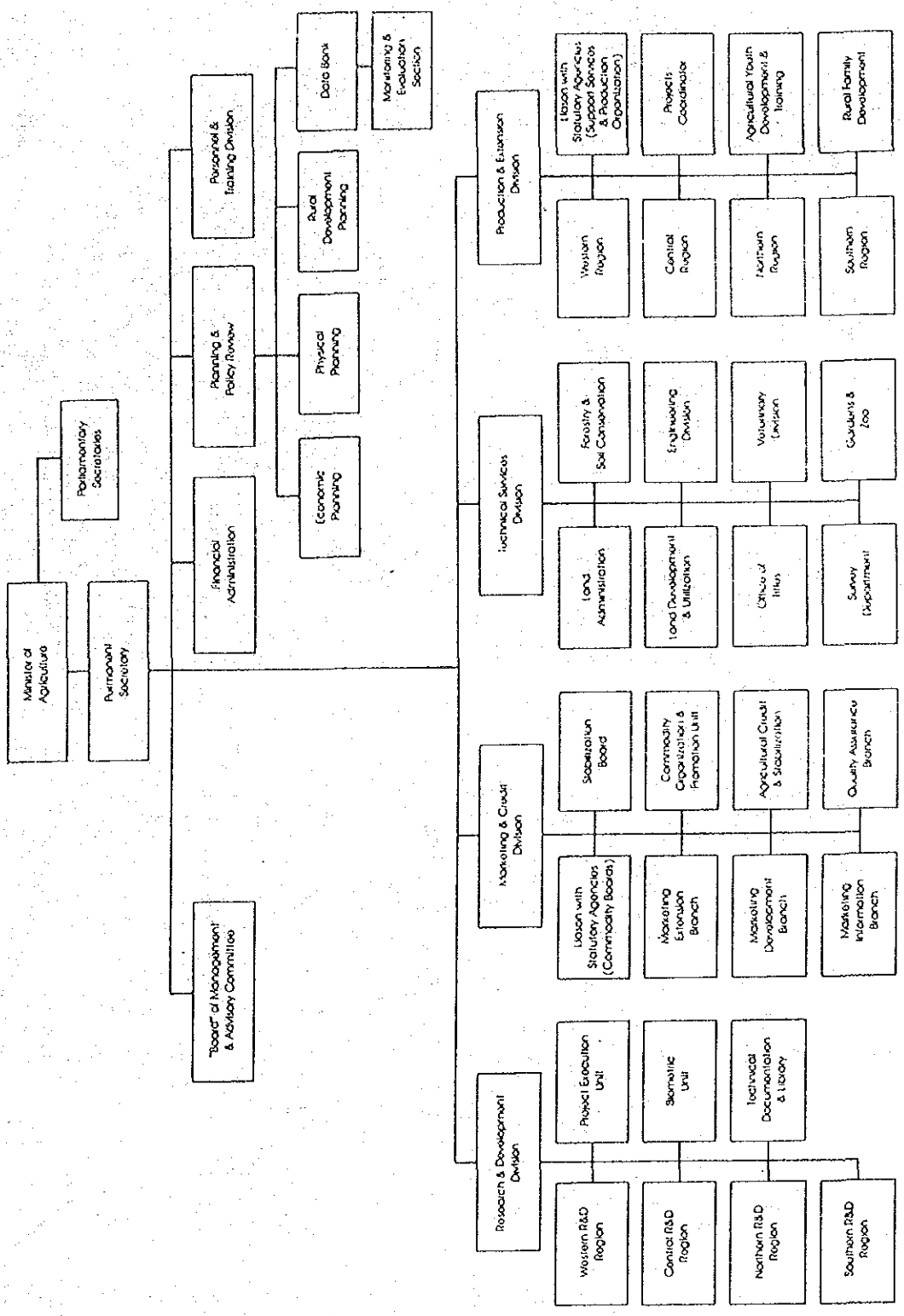
Table F-42 SMALL FARM BUDGET

(Unit : J$)

Year	1	2	3	4	5	6	7
I. Mineral Soil (3 ha)							
Unit Yield (ton/ha)							
Spring Rice	3.4	3.6	4.2	4.6	5.0	5.3	5.5
Fall Rice	3.4	3.6	4.2	4.6	5.0	5.3	5.5
Soya Bean	1.7	2.2	2.5	2.5	2.5	2.5	2.5
Gross Income							
Rice	22,440	23,760	27,720	30,360	33,000	34,980	36,300
Soya Bean	6,630	8,580	9,750	9,750	9,750	9,750	9,750
Sub-total	29,070	32,340	37,470	40,110	42,750	44,730	46,050
Gross Outgo							
Farming expenses	14,742	14,742	14,742	14,742	14,742	14,742	14,742
Living expenses	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Sub-total	24,742	24,742	24,742	24,742	24,742	24,742	24,742
Net Reserve	4,328	7,598	12,728	15,368	18,008	19,988	21,308
II. Peat Soil (5 ha)							
Unit Yield (ton/ha)							
Spring Rice	2.0	2.2	2.4	2.8	3.6	4.2	4.5
Fall Rice	2.0	2.2	2.4	2.8	3.6	4.2	4.5
Gross Income							
Rice	22,000	24,200	26,400	30,800	39,600	46,200	49,500
Gross Outgo							
Farming expenses	14,115	14,115	14,115	14,115	14,115	14,115	14,115
Living expenses	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Sub-total	24,115	24,115	24,115	24,115	24,115	24,115	24,115
Net Reserve	-2,115	85	2,285	6,685	15,485	22,085	25,385

Table F-43 ALLOCATION OF LAND IN AGRICULTURAL SETTLEMENT

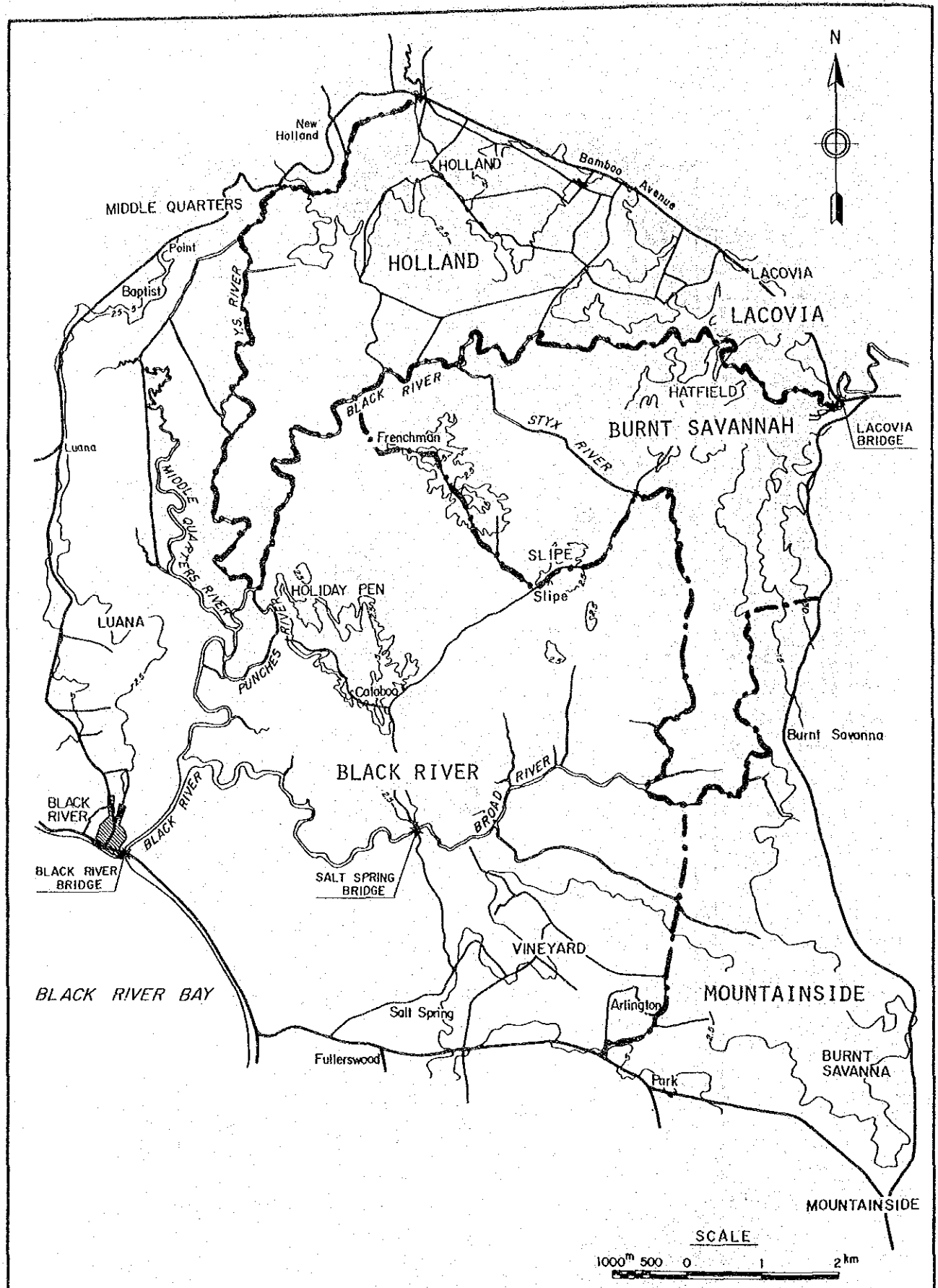
Agricultural Sections	Total Acreage	Mother Farm	Pilot	Balance of Settlement	No. of Farms for Settlement	Comments
1. Black River R.B	560 (1380 ac)	200	10	350	117	a) For simple calculation an average size on the mineral soil will be 3 ha and that on peat soil 5 ha because of levels of productivity and farm budget analysis.
2. Black River L.B (Hatfield, Styx, Frenchman-Holiday Pen)	920 (2270 ac)	200	20	700	169	b) In recruiting farmers for training it seems possible that the recruitment batches be as follows:
3. Broad River R.B	800 (1980 ac)	200	20	580	116	Black River R.B - 25 per batch
4. Broad River L.B	800 (1980 ac)	200	20	580	116	Black River L.B) Broad River R.B) Broad River L.B) - 50 per batch
Total	3080 (7610 ac)	800 (1980 ac)	70 (170 ac)	2210 (5460 ac)	518	



BLACK RIVER LOWER MORASS AGRICULTURAL DEVELOPMENT PROJECT

Fig. F-1 ORGANIZATION CHART OF THE MINISTRY OF AGRICULTURE

JAPAN INTERNATIONAL COOPERATION AGENCY



BLACK RIVER LOWER MORASS AGRICULTURAL DEVELOPMENT PROJECT

Fig. F-2 ADMINISTRATIVE BOUNDARIES

JAPAN INTERNATIONAL COOPERATION AGENCY

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ANNEX G

AGRICULTURE

ANNEX G

AGRICULTURE

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AGRICULTURE

1. PRESENT CONDITON IN AGRICULTURE

1.1 Present Land Use

1.1.1 Category description

Based on the existent feature of land use in the project area, following categories have been used for the present land use map as shown in Fig. G-1.

i) Sugar cane
ii) Grassland
iii) Forest/bush
iv) Trees (including fruit trees)/village/grassland
v) Upland crop field/grassland
vi) Paddy/swamp
vii) Swamp

Sugar cane category includes all cane fields in the Holland Sugar Estate and some farmers' fields, and represents 8% of the total project area. Grassland category which shows the grasslands with scattered trees and village represents about 24.1% of total area. Grasslands include cultivated pasture and uncultivated natural grassland, and are found mainly along the boundary of the project area and in the centrally located uplands. Forest/bush category includes upland forest/bush and swamp forests, and account for 14.5% of total area. Swamp forests are generally found on the border between the upland area and the swamp, and around the main rivers.

Trees/village/grassland category includes food, fruit and non-fruit trees planted around dwelling and in grassland, and account for 1.8% of total area. Upland crop field/grassland category represents many upland crop fields scattered in the grasslands. These pre-dominate in the eastern boundary and central upland and account for 5.9% of total area. Paddy/swamp category is located in the northern section where some drainage works have been carried out by the Holland Sugar Estate, and represents 1.1% of total area. The swamp category represents about 44.5% of total area, which is distinguished by inundated condition and marsh-type vegetation.

1.1.2 Land use within each category

i) Sugar cane category :

- Sugar cane field 100%

ii) Grassland category includes :

- Grassland (pasture and uncultivated) 90%
- Trees 5%
- Village 5%

iii) Forest/bush category includes :

- Upland forest 30%
- Swamp forest 70%

iv) Trees (including fruit trees)/village/grass-land category includes :

- Trees (including fruit trees) 55%
- Village 25%
- Grassland 20%

v) Upland crop field/grassland category includes :

- Upland crop field 8%
  intercropping of
  cassava (30%), gungo pea (25%),
  peanut (20%), yam (15%) and
  corn (10%)
- Grassland with scattered trees and bush 92%

vi) Paddy/swamp category includes:

- Paddy 20%
- Swamp 80%

vii) Swamp category:

- Swamp 100%

1.1.3 Description of the diversions within the project area

The project area has been broadly divided into four (4) divisions as follows (see Table G-1 and Fig. G-1):

i) Black River Right Bank
ii) Estuary and Middle Quarters
iii) Black River Left Bank
iv) Broad River Basin.

The Black River Right Bank area includes the Holland Sugar Estate; Lacovia/Tombstone; Cuffie Pen; and the Y.S. River Basin. This area covers about 2,500 ha including sugar cane area at the Estate, the dominant land use accounting for 36%. Throughout the Estate and adjacent swamp regions, untethered cattle of small farmers are frequently seen. Fish/shrimp 'pots' are laid among the many small paddy plots.

The Estuary and Middle Quarters area encompasses the Middle Quarters River left bank; Luana/Lower Works; the Black River estuary and Town; and the basin of the Broad River (west of the Salt Spring bridge). This area is approximately 2,680 ha. Main features are the swamp (58%) and the grasslands at Luana/Lower Works (24%). This grassland is mainly uncultivated supporting dairy cattle, the dominant commercial livestock enterprise. However, pockets of land are cultivated with improved grass species, mainly African Stargrass. Other animals reared include beef cattle, pigs, goats and poultry.

The Black River Left Bank area (2,320 ha) includes Hatfield; Styx River basin; Frenchman; Holiday Pen; and Slipe/Cataboo. Swamp (35%) and grassland (31%) dominate this area. This area constitutes a large proportion of total upland crop field/grassland category in the project area, and main upland crops are cassava, yam, corn and gungo pea.

Broad River Basin is the largest area including Cashew; Hope River; Burnt Savannah; Vineyard and environs; and the Broad River basin itself (east of Salt Spring bridge). It totals approximately 3,910 ha with the swamp occupying 51%. The main upland crop is peanut (occuring in 36% of all fields in this area and usually occupying 90% of the area of any field). However, cassava; yam; corn and gungo pea are frequently seen in mixed intercropped field.

1.2 Agricultural Production

1.2.1 Production in St. Elizabeth Parish and the project area

Over the years, agricultural production in Jamaica has been far below consumption levels. Importation of basic food items continue with some items on the increase (97% of rice consumed is imported). The Parish of St. Elizabeth is regarded as a producer of rice and a few other domestic crops, yet, there is scope for expansion and intensification of these crops (Table G-2).

In Table G-2, one of the dominant crops produced in this parish is found to be peanut which accounts for more than half of all island production. Tomatoes and onions produced reflect around one-third of all island and rice 27%. Carrot and pineapple are also important crops.

Cultivated area and yield of major crops in St. Elizabeth are also shown in Table G-2. As to production, peanut is again the dominant crop occupying 18% of total cultivated area in St. Elizabeth, while gungo pea, rice and corn which are some of the main crops of the project area each occupy 5%. Percentage of total area for other main crops (cassava and yam) is lower, ranging from 1 - 3% of total area. The table shows the average yield of each crop as somewhat higher than the ordinary yield of small farmers within the project area.

Table G-3 shows the comparative production of domestic crop by groups in St. Elizabeth for 2 years. Legume is dominant in cultivated area showing 36% of total cultivated area of this parish. These are peanut, red bean and gungo pea. Next are the vegetables (16.3%) and cereals (13.3%).

The crop with most increase in area and production from 1982 to 1983 is cereal which includes mainly rice and corn. This may have been due to shortages in supply experienced in 1982. On the contrary, vegetable crops and root/tuber crops decreased both in area and production during the year.

In general, total area cultivated has increased by 6.8%.

Production data for the project area is unknown as many farmers practise subsistence - type agriculture, that is, producing enough for home consumption and selling surplus to family needs.

1.2.2 Present farming practice within the project area

Within the project area, paddy and several upland crops are cultivated, also pasture and livestock (mainly cattle) at varying intensities.

1) Paddy

Paddy cultivation is concentrated in the Holland Sugar Estate property and is carried out by small farmers living near the Estate. Water control is virtually non-existent as the plots are scattered in the inundated lower reaches of the Estate. This condition is further aggravated whenever the drainage pump of the Estate suffers erratic break downs.

Variety and cropping pattern: The main varieties cultivated are Buffalo and Champion and, to a lesser extent CICA-8 which is obtained from BRUMDEC. The first two, require about 180 days to maturity whereas CICA-8 requires about 140 days. No fixed cropping pattern is adhered to. However, data from the Ministry of Agriculture infers the following:

	Planting	Reaping
Main season	April - May	November - January
Secondary season	August - October	February - July

Cultivation practices: The method used entails transplanting seedlings which are usually about 25 cm in height although well advanced seedlings of 60 cm or more in height are transplanted in some places. Transplanting is done into unploughed fields with the aid of a stick. The top of older seedlings are cut-off sometime before transplanting.

Weeding is a manual operation which is done at the farmers' will. Fertilization and pest control are not practised and consequently, average yields of 1,100 kg/ha are common with a range of 560 - 1,500 kg/ha according to farm economic survey. Manual harvesting is done piece-meal and grain is dried on an improvised barbecue[1/] and milled as required at the Middle Quarters mill.

Labour and input materials for rice: All operations are done manually at the farmer's discretion, however, the table below sets out the typical operation.

Labour Requirement	md/ha
Nursery work	5
Land clearing and making bunds	30
Transplanting	37.5
Weed control	5
Reaping	25
Threshing	25
Transportation to mill	3.5
Total	131.0
Materials	
Seeds (kg/ha)	28

1/: A barbecue is an open, flat drying area usually made of concrete.

For reference, a comparison between the rice production at BRUMDEC and Meylersfield, both Government projects, is set out below.

Item	BRUMDEC	Meylersfield
1. Variety	CICA-8 and 3 others	CICA-8 only
2. Cropping pattern	Rice - rice	Rice - rice - rice
3. Number of crops/yr.	2	2.5
4. Ave. yield (Spring '84) (mineral soil)	3,024 kg/ha 4,480 "	4,700 kg/ha
5. Ave. yield on peat soil 1983	2,016 "	2,240 kg/ha
6. Ave. of total labour requirement	30 md/ha	86 md/ha

2) Upland crops

In this context, the term upland crops is used to denote not so much the elevation of the land but rather unsubmerged annual and/or perennial crops such as legumes, vegetable and root crops. Sugarcane, although within this terminology, is considered separately.

As stated under "Present Land Use", these upland crops are found within the Black River Left Bank and Broad River Basin areas. The main crops grown are cassava, yam, corn, gungo pea and peanut. The table below gives the percentage of cropped area by location and crops withn the land use category: upland crops/grassland.

Percentage and area of crop field in grassland by location	(%)	(ha)
Hatfield	25	15
Frenchman/Slipe/Cataboo	7	16
West of Lacovia/Mt. side road	5	17
Lacovia	15	8
Weighted average/total	9	56

Average percentage 1/ of crops grown (all locations)	(%)
Cassava	30
Gungo pea	25
Peanut	20
Yam	15
Corn	10

1/: Calculated (Frequency x % area occupied)

From the table, Hatfield (gross area 58 ha) is the most densely cropped area with cassava, the most popular crop. Average farm size falls into two groups namely,

(i) those close to the villages, and

(ii) those scattered in the grassland.

The former is considerably smaller (0.06 ha) than the second group (0.2 ha).

Varieties and cropping pattern: Generally, improved crop varieties are scarcely adopted by small farmers in Jamaica. Mainly native varieties are grown. Their characteristics are shown in Table G-4.

The planting dates for these main crops hinge on the rainy seasons (see table below). The primary season is August - October and the secondary season is April - May.

Crop	Planting	Harvesting
Cassava	Apr. - May	Jan. - Apr.
Yam	Mar. - June	Jan. - Mar.
Corn	Mar./Aug. - Sept.	June/Nov. - Dec.
Gungo pea	May	Jan. - Mar.
Peanut	Apr. - May/Sept.	Aug. - Sept./Dec. - Jan.

Consequently farmers plant short-maturing varieties twice in the year and once for long-maturing varieties (Table G-4).

Depending on the farmers' main crop, a number of other crops (usually 4 - 5) are inter-cropped. Sometimes a mixed intercropping[1/] or a row intercropping[2/] method is used. Corn does not usually occupy a major portion of any field.

1/: An inter-cropping with no distinct row arrangement

2/: An inter-cropping where at leas one crop is planted in rows.

The main inter-cropping patterns[1/] are as follows:

1) Cassava + gungo pea + corn
   or Cassava + red peas + cow pea

2) Yam + red pea (or cow pea) + coco + corn
   or Yam + coco + sweet potato

3) Gungo pea + corn

4) Peanut + corn + gungo pea - peanut
   or peanut + corn - peanut + corn

Farmers who cultivate in the open grasslands usually practise shifting cultivation and observe a 3 - 5 year grassland fallow period. However, those cultivating within a restricted area usually only shift the planting holes and allow fallow after each season.

Labour and input materials: For the most part, farmers use traditional farming methods except in the case of peanut and corn where pest control is practised for both, and fertilization for peanut only (Table G-5). Despite these attempts, farmers use lower than the recommended rates of inputs.

Yields: Based on the level of farm inputs used, data on parish yields and discounted extraplated farmers' yields, a tabulated estimate of yield is given below for the main crops.

Crop	Yield (kg/ha)
Cassava	8,960
Yam	9,000
Corn	1,000
Gungo pea	840
Peanut	1,120

1/: Inter-cropping is denoted by a plus sign (+) between any two crops grown simultaneously and a hypen (-) used to indicate the crop sequence.

3) Sugar cane

Sugar cane fields are almost entirely within the Holland Sugar Estate that is, 99%, and so production and farming practices of the Estate are described here.

Over the decades, cultivated area in sugarcane steadily increased from about 560 ha to 1,000 ha. However, from 1980 to 1983 the area decreased and the factory ceased operations. Area in sugarcane (1984) is 910 ha (Table G-1) which reflects a 21% increase in area over last year. Presently, the cane produced is being milled at another Government owned sugar company Frome.

The table below shows the cropping pattern and average yields of replanted and ratooned cane.

Type	Planting Season	Time to Harvest	Harvesting Period	Average Yield (mt/ha)
Spring 1/	Jan. - July	9 - 15 months	Mar. - Apr.	34 - 79
Fall	Oct. - Dec.	15 "	Jan. - Mar.	79 - 90
Ratoon 2/	-	12 "	-	40 - 27

Note: 1/: Spring planting is the main season

2/: Ratoon repeated up to 7 times (normally 2 or 3 times)

Usually, 13% of cane cultivated is replanted in a given year with 87% being ratooned. A field is replanted whenever the previous year's yield falls to about 40 tons per hectare. There is a wide variation in yield/field/year even within re-planted fields (34 - 79 t/ha). Average yield is about 56 t/ha.

Table G-6 sets out the labour and input materials for replanted cane. The rate at which a labourer works varies depending on conditions of remuneration: that is, 'task-work labourers' are paid to do a specific job and usually work faster than 'hourly-paid workers'. The labour requirement for ratooned is 43.5 md/ha and 7 tractor/ha. The main weed throughout the Estate is paragrass (Panicum muticum).

4) Pasture

Within all the elevated lands of the project area, grasslands and pastures are found. However, pastures are concentrated in the Luana area. These pastures are managed at various levels of efficiency and therefore have various carrying capacities ranging from 1.25 head per ha to nearly 4 head per ha: Usually, 2.5 heads per ha are found.

Total extent of Luana/Lower Works is 380 ha of which pasture accounts for 54% (60% of grassland which occupies 90% of total area); and upland crops occupy 2% or 8 ha.

Different systems of husbandry are used namely, extensive, semi-intensive and feedlot systems are practised. However, the extensive system is prevalent (2.5 heads/ha).

For establishment of the pasture, ploughing and harrowing are done. Cutting are harrowed into the soil. Usually some amount of fertilizer is used. In the case of 2.5 heads per hectare, farmers growing either Pangola, African Stargrass or Bahamia grass apply 2 dressings of about 250 kg/application/year of sulphate of ammonia. Irrigation is not usually practised. However, sprinkler irrigation is seen on one farm where carrying capacity is 3 heads per hectare.

Weeding is not done on a regular basis but, in the event of many weeds, cutlassing or manual cutting is done. The following table gives an estimated yield and production of beef cattle per hectare.

Grass yield (per ha/yr)	36 tons
Carrying capacity	2.5 heads per ha
Liveweight gain (per ha/yr)	550 kg
Total production/ha (dressed wt)	280 kg

Presently, farms vary widely in size with about 15 ha on an average. Labour is one or two farm hands with up to six where other livestock are reared.

1.3 Processing and Storage Facilities

A number of processing plants ranging from cottage to large-scale industries have been set up across the parish mainly based on domestic food production. (Table G-7).

With the exception of Appleton Sugar Factory which is a privately-owned sugar,alcoholic drink and liquid carbon dioxide producer, raw materials for the efficient operation of the other factories are generally in demand. Reasons cited for this shortage of raw materials were most frequently: insufficient production at any given time, and seasonality of some inputs.

Factories particularly experiencing low operating efficiency due to lack of raw materials are the St. Elizabeth Cassava Products Limited; St. Elizabeth/Manchester Growers Coop., and Agro-Pak (the National Cassava Products factory has ceased operation for this same reason).

The cassava factory mentioned above contracts women (usually farmers' wives) to produce the 'bammie' - the finished product at their homes. Quality control is maintained by Home Economics Officers of the Ministry of Agriculture, then packaging is done collectively on one day per week for market outlets as far as Kingston. (The level of production does not warrant more than one day's packaging).

Although St. Elizabeth produces 61% of the island's peanuts, sufficient quantities are not available to operate a medium-sized processing facility within the parish.

The rice mill at Middle Quarters has served small and large producers of rice for many years. It operates a small mill (capacity 1.8 mt/day) which is adequate for the milling needs of the small farmers who usually harvest piece-meal.

In addition to processing peanuts, the St. Elizabeth/ Manchester Growers Cooperative provides farm input material for peanut cultivation and operates as a wholesale buyer. It is one of the Producer Marketing Organizations (PMO) of the Marketing and

Credit Division of the Ministry of Agriculture. This Division has plans to build 25 such units across the island. The Jamaica Soya Products Ltd. operates the only soya bean processing mill in the island. Its capacity is 45,000 mt annually. However, at present it is operating well below full capacity.

In general, limited raw materials for the processing facilities are available and increase acreage and/or intensification of present acreage is necessary.

Storage facilities for produce other than a warehouse in Black River for sugar, are non-existent.

2. AGRICULTURAL DEVELOPMENT PLAN

2.1 Proposed Land Use

The major thrust in the development of the Lower Morass is to develop such a large extent of un-utilized swamp lands. Rice has been chosen primarily on a physical basis of land capability and on the "self-sufficiency in grains" programme of Jamaica. Field surveys have determined that both mineral and peat soils could be used for rice cultivation.

At present, the elevated lands have a number of villages serving the area which would be difficult if not nearly impossible to propose a uniform agricultural development plan.

As for the Holland Sugar Estate, it is proposed that irrigable southern area at the west side of present main drainage canal (500 ha) and grassland at the east side of this canal (60 ha) will be for paddy with the remaining portion for sugar cane. As mentioned in later, triple cropping of two rice crops and one soya bean crop are possible on mineral soils in Holland and Hatfield, and double cropping of rice on peat soils in the other areas. Details are given below.

Soil Type	Location	Area of paddy	Spring rice	Fall rice	Soya bean
Mineral	.Holland	560 ha	500 ha	560 ha	560 ha
	.Hatfield	220	220	220	220
Peat	.Styx River	300	300	300	-
	.Frenchman, Holiday-Pen	400	400	400	-
	.Broad River Right Basin	800	800	800	-
	.Broad River Left Basin	800	800	800	-

2.2 Proposed Cropping Pattern

In making up this cropping pattern for the paddy field, the following conditions were taken into consideration:

- soil conditions
- seasonal climate
- period of irrigation
- maturity period of rice and other proposed crops
- capability of farm machinery
- farming practice

2.2.1 Soil conditions

For this project, large sections of swamp land and to a lesser extent of elevated lands will be developed into paddy fields where rice will be the dominant crop. Few problems are anticipated in rice culture on mineral soils of the elevated lands. However, it is known that there are many problems with respect to rice culture on peat soils of swamp land. Major problems in rice culture reported by BRUMDEC are as follws:

- subsidence of field level due to drainage,
- uneven drainage of water due to loose fibred type peat,
- seepage and breakage of levees and difficulty in maintaining the water level,
- severe outbreak of disease and lodging cause of lush plant growth due to high atmospheric nitrogen content,
- nutritional disorders,
- releasing of toxic substances to rice, and
- occurrence of sterility in rice

(the last four will be explained in detail under Farming Practice).

2.2.2 Climatic and irrigation conditions

According to rainfall data for this project area, there are two rainy seasons and two dry seasons each of which may be divided into the primary (1°) and secondary (2°) seasons depending on the monthly rainfall as given below.

	Primary (1°)	Secondary (2°)
Rainy season	Aug. - Oct. (240 - 280)	Apr. - May (170 - 260)
Dry season	Nov. - Mar. (60 - 80)	June - July (150 - 190)

Note: Figures in parentheses are range of rainfall (mm) per month

On the other hand, irrigation period for rice cultivation is restricted to range from mid-April to end of December depending on the flow of the Black and Y.S. Rivers. These conditions suggest that double cropping of rice seems to be possible for about 260 days of growing season including two rainy season.

With regard to temperature, those below 18°C are often found in the 1° dry season at BRUMDEC. Therefore, low temperature is the problem to be considered. There are many experimental reports on cold injury of Japonica type rice varieties. Influences of low temperature on rice plant are different in its growth stage; those are delaying of growth in vegetative growth stage and cold injury of partial young panicle in reproductive growth stage. Most drastic feature of cold injury is to induce sterility through low temperature at the young microspore stage after meiosis. Hayase et al (1969) reported that 50 - 95% of sterility occurred under cold treatment of 12°C for 4 or 6 days around the above sensitive stage, and about 20% of sterility under the same cold treatment at 24 days before heading (the young panicle initiation stage) and 5 days after heading (the anthesis stage). No sterility was found under 12°C for 2 days or 6 replications of 19°C by day and 15°C by night during the development of young panicles. However, 20% of spikelet number per panicle decreased under all above cold treatment.

The critical low temperature which induce sterility or decrease in spikelet number per panicle on Japonica rice was said to be below 15 - 16°C. Indica type rice varieties are known to be more sensitive to low temperature than Japonica, and the critical temperature may be below 18°C.

There are no temperature observations stations in the project area, but two stations near the project area, at BRUMDEC and Crawford, record temperature data. As Crawford is located near the coast, temperature

experienced may be closer to those of the project area than those at BRUMDEC. At Crawford, occurrence of minimum temperature below 18°C in November and December were few, and as these temperatures were usually higher than 17°C and not repeated for several days, those may have little influence on rice plant. However, those temperatures occurred frequently and repeated for 3 - 5 days in January and February, sometimes falling to 15 - 16°C. The table below shows the frequency of occurrence in minimum temperature below 18°C at Clawford. These low temperatures did not occur from April to October and were higher than 17°C in March.

Years	Jan.	Feb.	Mar.	Nov.	Dec.
1974	-	-	-	1	1
1975	11 (4)	21 (12)	9	-	-
1976	-	17 (2)	14	1	-
1977	5 (3)	4	4	-	-
1978	1	3 (3)	-	-	-

Note: Figures in parentheses show the number of days on which minimum temperature was below 16.5°C.

Depending on BRUMDEC data, when minimum temperatures were 15 - 16°C or 17 - 18°C, temperature below 18°C continued for 5 - 8 hours or 2 - 4 hours, respectively. Sterility would not be induced under such low temperature condition, but it is probably at least that spikelet number per panicle would be decreased. These continuous low temperature, therefore, should be avoided during the development of young panicle. Supposing that the continuity of the critical low temperature would occure since December 20th in the project area, anthesis of rice plant should have been over by then. In case of early maturing varieties having about 100 days of maturity period, as days to heading may be 65 - 70 days after planting, safety limit of planting date would be the end of September. Double cropping of rice is practical by using early maturing varieties during about 260 days of irrigation period.

2.2.3 Characteristics of rice varieties chosen

Rice varieties recently recommended by Agro 21 are Cica - 8, Labelle and Lebonnet. However, as Cica - 8 requires 130 - 140 days to maturity, and is not adaptable for double cropping. The other two varieties both require 100 days to maturity and are more suitable for peat soil, therefore, these were chosen for cultivation on peat soil. For mineral soils, three other promising varieties (Newbonnet, Lamont and Bond) were chosen from the recent results of research at BRUMDEC, all of which require less than 100 days to maturity. Characteristics of these varieties are shown in Table G-8.

In Table G-8 Newbonnet, Lamont and Bond on mineral soils achieve shorter plant height but have higher trial yield than Labelle and Lebonnet on peat soil. The latter two varieties when grown on mineral soils achieve lower plant height and yield than on peat soils, and not so high yield at present even on peat soils. However, these two varieties will give better yield by improvement of cultural method from the viewpoint of U.S.A. data, and as there is no variety other than those suitable for peat soils, those are recommended until a better yielding variety for peat soils can be found.

2.2.4 Possibility of triple cropping

For the double cropping of rice, there would be no crops grown on the paddy field during the dry season. On mineral soils however, it seems better to cultivate some other crops such as legumes under furrow irrigation, with the view to improve soil fertility and increase land productivity. As soya bean is now of second importance to rice in Jamaica, it may be introduced in a triple cropping pattern as a legume for the dry season.

There are many varieties of soya bean which are different in sensitivity to day length and in maturity period. Varieties suitable for this triple cropping should be insensitive to short day length in the dry season and require 80 - 90 days for maturity period. About ten years ago, 10 varieties were selected from a number of varieties within the University of West Indies collection by the Ministry of Agriculture in Jamaica. These varieties were tested for planting all the year round and showed the possibility of cultivation in the dry season, although planting from

December to January considerably decreased the maturity period and yield of soya bean. Within these varieties, U.W.I. code 30 is recommended as the variety which could be planted all year round and U.W.I. codes 60 and 27 from June 15th to January 21st.

Within recent varieties which were introduced from U.S.A., Duo-crop was recommended by the Agronomist at St. Jago and Spring Plain Farm in Clarendon. Characteristics of this variety is shown in Table G-8. However, further experimentation is necessary on those and other varieties to test adaptability to the paddy field of the project area in the dry season.

As mentioned above, it is desirable to cultivate soya bean on mineral paddy fields during the dry season after double cropping of rice. In the case of peat paddy fields, however, cultivation of upland crops during the dry season should be avoided, because radical oxidation due to drainage and tillage for cultivation under dry conditions will promote the decomposition of peat. As a result, many kinds of organic acids would be liberated, some of which are toxic to rice, and rapid decrease in peat depth resulting in sinkage of field surface. Therefore, double cropping of rice is chosen on peat soil and conversely, tripple cropping on mineral soils.

2.2.5 Duration of farm operations

As the duration of mechanized harvesting per sub-area is given as 40 days, under the required number for machinery in Tables G-22 and G-23, sowing duration may be known as 40 days. Based on these maturity period of rice and soya bean and commencement of irrigation, date of farm operations for each cropping are shown in Table G-9.

In double cropping, the period of harvesting for spring rice is followed by the period of land preparation for fall rice. However, under triple cropping the period of land preparation for subsequent crop partly overlaps with the period of harvesting of the former crop. This is because the total period of these farm operations and maturity period of each crop is over one year. These overlaps require an increase in operator for mechanical operations.

Fig. G-2 shows the proposed cropping pattern for triple cropping on mineral soil and for double cropping on peat soil, and is based on Table G-9.

2.3 Proposed Farming Practices

2.3.1 General

Proposed farming practices are made by the principles as follows.

1) Cultural practices for rice and soya bean are based on recommended methods by MOA or Agro 21, and are determined according to environmental conditions in Development area referring to procedure at BRUMDEC and Meylersfield, and experimental results in Jamaica and other countries.

2) Fertilizer applications are determined depending on methods at BURMDEC and Meylersfield, and nutrient contents of irrigation water and of the mineral or peat soils in Development area, taking the environmental preservation into consideration.

3) Application of chemicals for pest and weed control should be restricted on the view point of environmental pollution and mammalian toxicity. However, there is no prescription at present in Jamaica to regulate the application of agricultural chemicals. Considering the importance of environmental preservation especially in Development area, selection and application of chemicals are better to depend on Standard Safety Application of Agricultural Chemicals in Japan which was published officially according to Agricultural Chemicals Regulation Law and Food Hygiene Law. Details are given below.

i) Designation standard of mammalian toxicity (MT)

	Oral (toxicity) LD_{50}	Dermal (toxicity) LD_{50}	Inhalation LC_{50}
Poisonous substance (PS)	less 30 mg/kg	less 100 mg/kg	less 200 ppm (1 hr)
Deleterious substance (DS)	30 - 300 mg	100 - 1,000 mg	200 - 2,000 mg (1 hr)
Ordinary substance (OS)	Substance except PS, DS and special poisons		

ii) Standardard safety application concerning prevention of toxicity to aquatic animals (TAA)

A class No problem of toxicity under usual method of application
Carp (fish): over 10 ppm, Zoo-plankton: over 0.5 ppm

B class Less effect under usual method of application. Take special precaution in application on a wide scale at the same time. Carp: 10 - 0.5 ppm, Zoo-plankton; less 0.5 ppm take special care of B - s in B class.

C class Carp: less than 0.5 ppm
Where there is a possibility of applied chemicals scattering or flowing in rivers and lakes, do not use. And also in other places, do not use on a wide scale at the same time.

D class Donot use in prohibited area of application. Submit request for applying within a area of limited application.

As shown above, this Standard is divided into two portion, mammalian toxicity (MT) and toxicity to aquatic animals (TAA). Applicable chemicals are proposed to select and apply within the range of the Standard below.

Mammalian Toxicity (MT): Ordinary substances (OS)
Deleterious substances (DS)

Toxicity to Aquatic Animals (TAA): A or B class
(B - S is excluded)

Comprarison of toxicity and safety regulations in the use of pesticides between Japanese and international standards are given in SUPPLEMENT.

2.3.2 Cultural practices

1) Rice

Two cultural methods were recommended by Jamaica Development Bank (JDB) Reference Book for Agricultural Credit Officers. One is dry seed method and the other is wet sowing method.

Dry seed method is preparing land by harrowing, pulverizing and levelling under dry conditions, then broadcasting dry seed about 112 kg/ha and applying water. Wet sowing method is, after dry land preparation as in dry seed method above, flooding and levelling the land and then broadcasting pregerminated seeds about 112 kg/ha of dry seed before the mud has properly settled. Water is drained off 12 - 14 hours later. Thereafter, water is applied to prevent drying out and drained off to permit germination in both methods. After 2 - 3 weeks when seedlings are well established, allow water into the field to cover the land without submerging the rice plants. Water should be drained off 10 - 14 days before reaping.

Dry seed method may be suitable for the spring rice crop because land preparation and sowing can be done during the 2° rainy season. Wet sowing method may be adaptable to the fall rice planting in the 1° rainy season. However, if tillage for fall rice under dry condition cannot be done due to rainfall in the rainy season, puddling and levelling should be done under the water.

Experiments on tillage and water management at BRUMDEC showed that tillage under dry conditions followed by puddling/levelling under water, resulted in the best yield in comparison to tillage and levelling both under dry conditions or puddling and levelling both under water. However, the best germination resulted when tillage and levelling were both done under dry conditions.

Drill seeding method after dry land preparation is currently used on peat soils of U.S.A., and also practised partly at BRUMDEC. In this method, seeds are drilled in rows about 20 cm apart and 3 - 5 cm deep with seeding rates of 75 - 95 kg/ha. It may be achieved good result on light soils such as peat.

In this plan, the dry seed method was adopted for spring rice planting with broadcasting of seeds on mineral soils and drilling on peat soil, and wet sowing method after puddling/levelling under water was adopted for fall rice both on mineral and peat soils.

2) Soya bean

Soon after harvesting of fall rice, similar tillage as for spring rice is to be done. Moderate soil moisture content is preferred because soya bean seeds require moisture from soil for germination more than 100% of its dry weight. It is advisable to make ridges and to sow in the furrows in order to withstand more drought under dryland farming condition.

Seed rate is 56 kg per hectare, planting depth 2 - 3 cm and plant spacing 40 x 10 cm. It is necessary to inoculate the seeds of the first crop of soya with nitro-bacteria. When plant height is about 30 cm, a moulding and weeding operation is recommended.

Irrigation is necessary for cultivation during the dry season. Furrow irrigation would be at ten days interval with last irrigation 10 days before harvesting.

2.3.3 Fertilization

1) Rice

In estimating the rate of fertilizer application for rice, nutrient contents of soil and irrigation water were taken into account. Analytical results of river water samples which will be the main source of irrigation water for Development area are shown in Table G-10. Based on this data, nutrient content of water which is the irrigation requirement for one crop season is calculated and given in the same table as amount in kg/ha. The results have shown that 7.5 kg of NO_3 (1.6 kg of N), 0.4 kg of PO_4 (0.6 kg of P_2O_5) and 4.8 kg of K (11.6 kg of K_2O) are present in irrigation water supply per hectare. It is apparent that potassium is dominant and phosphate is minimum in three main nutrients. Calcium is supplied about 240 kg/ha during one crop season. In this table, nitrogen and C.O.D. shown to be less than critical level for rice cultivation. Therefore, precaution should be exercised only with respect to potassium fertilization.

Nutrient contents in the mineral soils are generally acceptable and there are no deficiencies of micro-nutrients in these soils. However, organic matter in these soils is low, therefore application of such is necessary. Consequently, rice straws after harvesting are applied to the paddy field twice a year in this plan.

On the peat, deficiency of P_2O_5 is evident and liberation of nitrogen brings about lush plant growth. Therefore, nitrogen fertilizer may not be needed, but phosphate application should be increased. However, it was reported by University of Florida that application of nitrogen at panicle initiation stage of rice on peat soils resulted in a yield increase over no nitrogen treatment.

Table G-11 shows the amount of active ingredients of the fertilizer applied at BRUMDEC and Meylersfield. On peat soil at Meylersfield, depth of peat is shallow, one third the rate of nitrogen used for mineral soil is applied and much more phosphate and potash are applied than on mineral soils.

Deficiency of micro-nutrients in peat soils depend on low content in the peat itself and rapid deactivation of metallines by lignin degradation compound. Even if there is enough copper in peat soil, deactivation of it at panicle formation stage causes sterility. At BRUMDEC, 9 kg/ha of copper sulphate is recommended to be applied with fertilizer. Microzit

which contains many kind of micro-nutrient is applied at Meylersfield at the rate of 0.14 kg/ha. Rice fertility studies in University of Florida revealed that application of silicone slag (calcium silicate slag) at rates of 10 - 20 metric tons/ha increased yield of rice significantly.

From above mentioned, fertilizer application on paddy field are determined as in Table G-12. On mineral soils, nitrogen and phosphate are applied at the regular rate, but the rate of potash is somewhat increased considering low level in old alluvial soils. Application of nitrogen fertilizer is divided into basal, tillering stage and panicle initiation stage. On peat soils, nitrogen fertilizer is not applied, but is necessary to examine the effect of application at panicle initiation stage. Rate of phosphate has increased and that of potash decreased according to levels in soils and irrigation water. Copper should be applied as same as BRUMDEC, and other micro-nutrient will be applied if necessary after trial. Application of calcium silicate at the rate of 10 metric tons/ha is recommended every three or four years.

2) Soya bean

In the field in which the nitrogen fixing bacteria (Rhizobium) had been introduced, nitrogen fertilizer is not necessary, but based application of it can be made for the first crop until the Rhizobium become active. Soya bean requires a relatively large amount of phosphorus. The seed and vegetative parts of a crop contains about 0.8% of phosphate. A yield of 1,000 kg contains 8 kg of phosphate. Crops get only 1.5 to 2% of phosphorus from fertilizer applied in the year. As phosphate content of irrigation water is very low, and of mineral soil is quite low, a considerable application of fertilizer will be necessary.

Soya bean also requires relatively large amounts of potassium. A crop of soya bean seeds removes 3.5% of potassium yielding 1,000 kg contains 35 kg of potash. However, potassium content of irrigation water and soils are relatively high, and so application of fertilizer may be somewhat decreased. Application of fertilizer for soya bean is given in Table G-12.

2.3.4 Pest and weed control

As mentioned above, chemicals for pest or weed control are selected and applied under Standard Safety Application of Agricultural Chemicals for the prevention of environmental pollution and mammalian toxicity. The class of mammalian or aquatic animals toxicity and rate of chemicals applied to rice and soya bean are given in Table G-13.

1) Weed control

Propanil is very commonly used in Jamaica as a herbicide in early stage of rice growth, because it is cheaper than any other rice herbicides available in Jamaica at present. However, propanil is known to be in effective to weeds as genus Cyperus which is seen usually in Development area, and sometimes gives severe injury to the rice plant. Bentiocarb is chosen instead of propanil in this plan. It is effective to Cyperus spp. and can safely be used as a herbicide in early stage of rice growth in submerged condition. Time of application is after 1.0 leaf stage of rice and before 2 leaf stage of weed. If broad leaf weeds become a problem, then spray between 35 - 55 days after planting with 2,4 D.

As soya bean is not a strong weed competitor in the early part of growth, control practices should be concentrated during that time. As a pre-germination herbicide, Diphenamid is used. As moulding is done for soya bean, mechanical control of weed is possible at the same time. After then broad-leafed weeds can be controlled with bentazon.

2) Pest control

Rice crops do not have many major pests or diseases in Jamaica. There are three major insects worth mentioning. They are the army worm (caterpillar), stink bug and grasshopper. Army worms usually attack 3 - 4 weeks after planting and damage the young leaves of the rice plant. It can be easily controlled by flooding the field. In case of severe infestation, trichlorphon (dipterex) should be applied. Grasshopper damage is usually noticed at heading stage. Trichlorophen or fenitrothion (Sumithion) should be applied. Sting bugs are also dominant at heading stage, and they damage the grains by sucking them. The control measure for stink bug is the same as for grasshoppers. On mineral soil, there are not many diseases except for helminthosporium (brown spot). On the peat,

helminthosporium is noticed at heading stage and blast around 6 weeks after planting, Mancozeb (Dithane) should be used.

The most important insect of the soya bean in Jamaica is the stink bug which attacks the soya bean late in the growing season. These insects suck the pod and damage the seeds, and if the pods are young, they will fall off. Monocrotophos (Nuvacron) is effective.

2.3.5 Labour requirement of rice and soya bean cultivation

As mentioned in "mechanization", land preparation and harvesting of paddy and soya bean are mechnized and operated by contract with the mechanical service station. The other operations such as sowing, fertilization, spraying chemicals and water management are made by the farmers. Labour requirements for these operations for rice and soya bean on mineral soils and for rice on peat soil are set up in the Tables G-14, G-15 and G-16, respectively. In these tables, herbicide or pesticide are applied with portable sprayers and soya bean or spring rice on peat soils are sown with manual seeders both of which are operated by the farmers. The other operations, broadcasting seeds, fertilization etc., are made by manpower of the farmers.

2.4 Anticipated Yield and Production

2.4.1 Rice

1) Present average rice yield of Parish

As mentioned above, average rice yields of small farmers are estimated at about 1,100 kg/ha with minimum of 560 kg/ha and maximum of 1,500 kg per hectare. Average yield in Parish shows 2,374 kg per hectare including the yield at BRUMDEC which is much more than maximum yield of the small farmer. Commercial production of rice at BRUMDEC is given below.

Year	Area Harvested	Production of Paddy	Average Yield	Location
1982	110 ha	248 ton	2,255 kg/ha	BRUMDEC
1983	232	633	2,729	BRUMDEC
1983	378	900	2,345	Parish

Note: Based on BRUMDEC's Annual Agricultural Report 1982 and 1983 and data from Parish Office.

Harvested area and production in 1983 at BRUMDEC was 232 ha (633 t) and for all areas in production in the Parish is 379 ha (900 t). BRUMDEC accounts for 61% of Parish in area and 70% in production in 1983. Consequently, it is obvious that the average yield level largely depends on the yield at BRUMDEC. Average yield of commercial production by mechanized rice cultivation at BRUMDEC is comparatively low. The main reasons of low yield are unlevelled land owing to lack of proper leveller resulting in unsuitable water level and insufficient weed control, and are low productivity of peat soils held in part of paddy fields. Average yield on peat soils was 2,000 kg/ha and on mineral soils was 2,600 kg/ha in 1983, but those are increased to 3,000 kg/ha on unlevelled mineral soils and 4,500 kg/ha on levelled mineral soils in spring rice crop of 1984.

2) Rice yield at Meylersfield

The yield of paddy field cultivated by farmers at Meylersfield are followed from 1982 through to 1984, as shown below. The first three crops were cultivated during the farmers' training period under supervision of a management team. The yield was very high in first crop, but decreased gradually year by year. Spring rice in 1983 yielded more than 4 tons/ha with 40% of farmers. On the other hand, spring rice in 1984 was the first experience of the farmers after settlement in April 1984 after two years of training, and half of farmers achieved more than 3 tons/ha or yield.

Crop Season	Paddy yield (tons/ha)								Total
	0.0 -2.0	2.0 -2.5	2.5 -3.0	3.0 -3.5	3.5 -4.0	4.0 -4.5	4.5 -5.0	5.0+	
Fall rice 1982/83	-	-	-	-	3	5	7	10	25
Spring rice 1983	-	-	7	4	4	6	3	1	25
Fall rice 1983/84	6	4	7	2	3	-	3	-	25
Spring rice	5	7	4	5	7	3	1	-	32

Note: Figures show the numbers of farmers at each class of yield.

3) Progress of anticipated rice yield after development

Yield data of main varieties tested in Jamaica and U.S.A. are shown in Table G-17. Newbonnet, Lamont and Bond on mineral soils yielded around 5 tons/ha in Jamaica and more than 6 tons/ha in Arkansas. Yields of Labelle and Lebonnet on peat soils are around 3 tons/ha in Jamainca, but over 6 tons/ha in Florida. Taking into consideration the improvement of field condition and cultural practices, introduction of better yielding varieties, upgrade of technical level in farmers and the facts mentioned above, target yield in seventh year after development may be anticipated as given in Table G-18.

During the first two years after development, peat soil field would be in an unstable condition, experiencing differential settlement of field surface and other problems, as described at "Proposed Cropping Pattern", owing to mainly the decomposition of peat. Therefore, even if rice would be cultivated under good management, initial high yields could not be expected, as shown in Table G-18. Peat field would still remain somewhat unstable with low yield up to 4th years, but after then, yield would increase owing to more stable field condition and improved cultural conditions suitable for peat soils.

Mineral soil field would be of uneven soil constitution in the irst two years owing to levelling of the field surface at the time of construction, and so normal yield would not be anticipated. However, in the 3rd years, the soil could recover almost stable conditions and yields would be upgraded considerably with the aid of improved cultural conditons, and after then, yields would gradually increase up to the 7th year.

Based on these assumptions annual increase in rice yields are anticipated as given in Table G-18. At the full development stage, total production of paddy would approximately attain to 28,950 mt.

2.4.2 Soya bean

Soya bean is cultivated only on mineral soils in the dry season under irrigation. The soils are suitable for soya bean and there is no lack of water. However, even if varieties insensitive to day length would be selected, maturity period (days from planting to maturity) would become shorter if seeds are planted in October to December than the other months and decrease yield as the research work shows in table below.

Variety Number	Planting Month	Maturity Period (day)	Yield kg/ha
30	July	104	1,900
	December	81	1,300
60	July	118	2,200
	December	95	1,500

Based on Technical Bulletin No.2 (1974) "Soya Bean".
Crops and Soils Dept. , MOA, Jamaica.

Table G-18 shows the anticipated yield of soya bean annually under assumption that more suitable varieties are chosen and improved cultural methods adopted for the dry season. Annual production of soya bean would attain to 1,950 mt at full development.

3. AGRICULTURAL MECHANIZATION

3.1 General

Agricultural mechanization plan is made based on two cropping patterns, one for triple cropping of two rice crops and one legume (soya bean) crop on the mineral soils and the other for double cropping of rice on the peat soil as shown in the "Proposed cropping pattern" (see Section 2.2 above).

In rice farming, land preparation and harvesting of paddy which require considerable manpower in case of manual operation, are fully mechanized; while sowing, weeding and fertilizer dressing, etc., are made manually. The reasons for adoption of mechanized operations are as follows:

- agricultural projects of estate or other types are mechanized, and farmers are experienced in operation of machinery,
- no farmer practises in farming by draft animal
- it is difficult to use draft animals in peat areas because of its low bearing capacity,
- wage of labour is relatively high, and cost of manual operations which require much manpower is higher than cost of mechanized operation

3.2 Soil and Field Operation

Dry land preparation may be desirable on the field of low bearing capacity. As for spring rice, land can be prepared under dry condition after several month of the dry season. However, as fall rice is sown in the 1° rainy season, it will be hard to get a chance to prepare dry land due to daily rainfall. Wet land preparation termed puddling, is therefore necessary on fields under water.

There may be a few problems concerning trafficability of machinery on mineral soils in a wet condition. However, as mineral soils in Development area are heavy clay, it will not be easy

to pulverize clod to a fine tilth in dry condition, therefore operating efficiency of tillage may be comparatively low.

As for the peat soils, bearing capacity may be so low, especially in wet land condition that trafficability of machinery will be a problem. In addition, uneven settlement of land will make it difficult to keep an even surface of field after land levelling for several years until settlement of peat paddy. It is proposed therefore that smaller scale machinery should be introduced especially for the smooth operation of land preparation in fall rice, and that tillage before sowing should be practised shallowly in order to prevent the decrease in bearing capacity of soil.

On the other hand, combine harvesting is performed 10 - 14 days after drainage. It is known that sinkage at travelling devices of machinery decrease under drained and somewhat dried paddy field even on peat soils. Really, the experiment by the member of this survey team revealed that drying increased in corn index of peat soils.

3.3 Selection of Farm Machinery

3.3.1 Tractors

Depending on the power of tractors, they can be classified as shown in the table below. Japanese classification shown for reference constitutes smaller Hp at the same class than Jamaican's. In this plan, Jamaican classification is applied.

Type	In Jamaica	In Japan
Garden	upto 12 Hp	upto 14 Hp/1
Small	upto 35 Hp	upto 20 Hp
Medium	35 to 60/70 Hp	20 to 45 Hp
Large	over 70 Hp	over 45 Hp

Note: /1 Walking type (Riding type; over 10 Hp)

Small type tractor as 30 Hp class would be compared with medium type tractor as 60 Hp class with regard to the trafficability on the paddy field of low bearing capacity. Weight of the medium tractor is about twice of the small one. These tractors should attach the adequate auxiliary running devices in place of the tire wheels in such a field condition. As larger tractor requires larger auxiliary running devices and attach larger implements, it becomes still heavier. Even if ground contact pressure of both tractors are same, whole load to ground in the medium tractor is larger than in the small one. The medium tractor would sink deeper, disturb the soil much more and may have difficulty in displaying its higher operating efficiency on such a field. Moreover, troubles are liable to occur such as falling into the weak point of soil layer which requires much man and mechanical powers to pull up. It is said that tractor scale suitable for the field of low bearing capacity may be less than 40 Hp, but tractors less than 30 HP are too low in power and operating efficiency.

Consequently, small type tractors of around 30 Hp class are proposed for this project. Durability of this class of tractor has been much improved recently and there may be a few problem with maintenance.

3.3.2 Combine harvester

Head-feeding type combine (Japanese combine) is compact and has high operating accuracy and efficiency, but is complicated in structure and there are some problems on durability and maintenance in other country. This combine has narrow adaptability to crop and field condition.

Conventional combine harvester (direct current type) with rice specification, however, has wider adaptability for field and crop conditions, has greater durability and fewer problems on maintenance of its simpler structure. It may be used for harvesting of soya bean. It is evident on the experimental data from the Report of Tropical Agricultural Research Center in Japan that this combine experience less sinkage at travelling device on the same soil of

low bearing capacity because of its specially wider track of crawler. In spite of its heavier weight it has better trafficability than the small head-feeding combine. Therefore, conventional combine with rice specification is thought to be more suitable for the condition of Development area, and smaller type of this combines (2.2 - 2.6 m of reaping width) are proposed to be introduced, considering the low bearing capacity of paddy field in the rainy season.

3.3.3 Machinery for land preparation and other operations

Tillage is usually divided into two operations, primary and secondary. Purposes of primary tillage are to break sods, to loosen the plough layer and to bury stubbles and weeds. Secondary tillage which follows primary tillage is mainly to crush and pulverize clods to a fine tilth to accomplish good soil condition for germination, seedling emergence and stand establishment. In dry land preparation, plough is well-adapted for the purpose of primary tillage, but results in uneven field surface which needs much levelling operation on paddy field. Moreover, deep tillage should be avoided on peat soils for the reason mentioned above. Disc harrow cuts the soil and bury those organic matters on the field surface. Agro 21 recommended three to four harrowing by disc until establishment of a fine tilth in dry land preparation, but harrowing only by disc can not get so fine tilth as ready to sow.

Rotavator is used for both primary and secondary tillage on dry and wet land condition, but not so effective to establish a fine tilth on clayey soil and also not efficient for its narrow operating width. Rotary harrow is more effective both in pulverizing and puddling to a fine tilth and have higher efficiency with its wider operation, and is also more adequate for the field of low bearing capacity because of its shallow tillage than rotavator. Consequently, disc harrow and rotary harrow are proposed to be used for land preparation both in dry and wet field conditions. Selected farm machines and their operating efficiency for triple and double cropping are shown in Table G-19 and G-20.

Other equipments such as seeder and sprayer for chemicals are better to be lent and operated by the farmers themselves to minimize the cost of mechanization. Tractor-mounted or self-propelled type are not suitable for this purpose. Knapsack type sprayer of power or manual are too low in efficiency. Portable type sprayer with boom or swath nozzle and long hose operated by 2 - 3 workers may be suitable in this case. Seeder is used for drilling of paddy mainly on dry peat soil and hill seeding of soya bean, and manual or hand seeder is suitable for the farmers to operate.

3.4 Required Number of Farm Machinery

3.4.1 Workable days and hours of mechanized operations

1) Rate of workable days

This may be restricted by rain, off days of operaters and periodical inspection of machinery. In land preparation, main restricting factors are rainy days. However, effects of rain are different in each mechanical operation and soil. Harrowing on dry field may be operated about 1 day after rainfall, but pulverizing on dry field required 2 or more days after rainfall, and puddling under water may be done immediately after rainfall.

In case of mechanized harvesting, the operations are only restricted by wet plants caused by rain and dew. Even if rain falls every day in the rainy season, its duration and after-effect are short, so it should be possible to operate every day except for the operator's day-off and maintenance checks. Based on these facts, rate of workable days are premised as set out in Table G-21.

2) Hours of duty

Hours of duty were assumed to depend on the daylength.

3) Rate of workable hours per day

There are some times during hours of duty, which one does not operate in the field. These including the following:

- transportation between machinery shed and field,
- preparation for mechanical operation,
- mounting, adjusting and dismounting implement,
- clearing and arranging machinery,
- going into and out of field,
- repairing mechanical problems,
- waiting time for operation (ex. transmission of grain to truck), and
- resting time

These times are different for various kind of machinery, and are usually expressed as a percentage of workable hours to hours of duty for each mechanical operation as below:

	Rate of workable hours (%)			
	2 Operators		1 Operator	
	M	L	M	L
tilling	81	78	69	66
pulverizing	83	80	71	68
levelling	83	80	71	68
puddling	78	75	66	63
harvesting (combine)	72	68	62	58

Note: M and L denote medium (M) or large (L) scattering extent of field. 2 Operators shorten the time of mounting and dismounting of implement, cleaning, adjusting and arranging.

In this plan, rate of workable hours for all operations of land preparation are assumed as 80% and rate of combine harvesting as 70%. However, during harvesting in the rainy season, rainfall duration (0.5-2.0 hours) and time lapse to workable time after rainfall (about 0.5 hours) should be subtracted from workable hours. Therefore, rate of workable hours is assumed as 55 - 65% for harvesting except in the 1° dry season.

3.4.2 Required number of machinery

Based on the duration of farm operation (Table G-9) and the workable days and hours (Table G-21), operable areas per each machine within the duration are calculated as shown in Table G-22 for the triple cropping

and Table G-23 for the double cropping. Depending on these tables, required numbers of machinery in each sub-area are calculated for each cultivated area and overlap of operation as shown in Table G-24. As duration of farm operation is same in any sub-area in spite of difference in area, larger sub-area requires more machines than small one.

3.5 Operation and Maintenance

3.5.1 Management of mechanical service station

Mechanical service station has two main roles. One is to manage the mechanical operation of the mother farm and the contract operation in farmers' field based on the cropping plan. The other is maintenance of machinery for farm and facilities of irrigation/drainage pump stations and of rice processing as a workshop. This station should be established in every sub-area. Each station is preferable to be situated at the center of the sub-area, so that transportation of machinery to the field will be minimized.

Among the stations, the station covering Broad River Right Basin play a role of the center station, and generalizes and supports the role of the other stations. Accordingly, the center station is required specially to hold office of general manager and agricultural (mechanical) engineers. Each station should employ operators for mechanical operation, and mechanics and store keepers for workshop. Required management staff at each station may consist of the following:

Management Stuff	Center	Mechanical Service Station				
	Broad R. Right B.	Holland	Hatfield Styx R.	Frenchman Holiday-pen	Broad R. Left B.	Total
General manager	1	-	-	-	-	1
Manager	-	1	1	1	1	4
Agricultural engineers	2	-	-	-	-	2
Assistant agricultural engineer	2	1	1	1	1	6
Operators (Drivers)	30	20	15	10	20	95
Mechanics	5	2	1	1	2	11
Store keepers	2	1	-	-	1	4
Clerks	3	1	1	1	1	7

3.5.2 Required facilities and equipment

1) Facilities

Each station should prepare shed for keeping required machinery and equipment as shown in Table G-24. Repairing shop and store room of spare parts and materials are necessary for the function of workshop. An office and operators' rooms are also necessary. Layout of required facilities is shown below.

Facilities	Center	Station				Total
	Broad R. Right B.	Holland	Hatfield Styx R.	Frenchman Holiday-pen	Broad R. Left B.	
	m^2	m^2	m^2	m^2	m^2	m^2
Manager's room	40	20	20	20	20	120
Office room	50	20	20	20	20	130
Parts store	100	50	20	20	50	240
Operators' room	60	40	30	20	40	190
(Sub-total)	(250)	(130)	(90)	(80)	(130)	(680)
Repairing shop	300	150	100	100	200	850
Machinery shed	700	400	400	300	600	2,400
Truck shed	200	130	130	80	160	700
(Sub-total)	(1,200)	(680)	(630)	(480)	(960)	(3,950)
Total	1,450	810	720	560	1,090	4,630

2) Tools and equipment in workshop

Workshop at center and other stations should reserve machine tools, equipment and other tools for repairing and adjustment of machinery as follows.

(1) Machine tool and others for center station

Lathe	1
Milling machine	1
Drilling machine	1
Oxy-Acetylene welding torch	1
Arc welder	1
Electric bench grinder	1
Cutting grinder	1
Power cutting saw	1
Crane	1
Chain block	1
Paint spray gun	1
Fork lift	1
Battery service equipment	1 (set)
Electric system repair equipment	1 (set)

(2) Main equipment and tools for each station including center

Generator (diesel)	5
Battery charger	5
Air compressor	5
Hand grinder	5
High pressure cleaner	5
Car washer	5
Mechanics' tools (large)	5 (set)
" (small)	5 (set)
Tractor tools (exclusive)	5 (set)
Measuring equipment	5 (set)
Work bench	6
Tool tray & cabinet	30
Air blow gun	6
Grease gun	6
Vice	6
Tube repair kit	5
Oil pan	6
Parts tray	60
Parts box (large)	600
" (small)	1,200
Parts cupboads	60
Tire gauge	6

4. POST HARVESTING

4.1 General

Rice processing operations after harvest involve mainly drying and milling. Harvesting by combine harvester produces much paddy rice at a given time which has a high moisture content and necessitates drying immediately, otherwise, moist paddy would soon decompose under high temperature. Sun drying on an "barbecue", as mentioned above, is commonly practised by small farmers, but needs wide space and many man power to dry a large quantity of moist paddy in a short time. Additionally, sun drying may be unsuitable for spring rice during frequent rainy days. Drying facility is therefore necessary for this project as same as BRUMDEC. Milling is not imperative immediately after drying, if storage facilities are available to receive and store the dried paddy. In fact, drying can be separated in period and location from milling in the presence of storage facilities.

Development area can be divided into five sub-areas and each sub-area should have the organization to manage the mechanical field work and to maintain the farm machinery and facilities. In this case, there are three ways to equip the rice processing facilities. The first way is full course of processing - drying, storage and milling - equipping at each sub-area. The second way is full course concentrated at one place, and the third way is separated course of processing; dryer and storage are equipped at each sub-area and mill is concentrated at one site. The first way is expensive for equipping many facilities, but transportation of paddy is easier. The second way is efficient and economical, but needs much time and trucking for the transportation of harvested paddy from the field to the facility. Additionally, if dryer happen to get trouble, harvested moist paddy would be soon decomposed and harvesting work would be stopped in all of the sub-area. In the third way, after paddy is dried at each sub-area, it may be kept in storage until the central mill receive the paddy. This way not requires concentrated transportation as the second way and incurs less costs for facilities than the first way. Consequently, the third way is chosen in this plan; i.e., dryer and storage are equipped at each sub-area and mill is concentrated at one site.

Parts of these facilities may be utilized in off-season of paddy reaping for drying and storage of soya bean harvested as raw materials for oil or other products.

4.2 Basic Conditions and Capacity

4.2.1 Dryer and storage

1) Basic conditions

In order to determine the required capacity of each facility, the following conditions were considered:

i) General condition

Total paddy field	3,080 ha (5 sub-areas)
Anticipated yield (Paddy base)	5.5 ton/ha (Mineral soils) 4.5 ton/ha (Peat soils)
Cropping pattern	2 crops per annum
Production per crop (Spring rice) (Fall rice)	 14,310 tons (5 sub-areas) 14,640 tons (5 sub-areas)
Total production per year	28,950 tons (5 sub-areas)
Means of harvesting	By combine harvester
Means of transportation	By truck

ii) Operative conditions

Duration of harvesting per crop	40 days
Harvesting days	34 days
Receiving and drying days	34 days
Receiving hours per day	8 hours
Drying hours per day (4 hours: For feeding and discharging)	20 hours

iii) Paddy conditions

Paddy density	0.56 tons/m^3
Moisture content of paddy harvested	Max. 24%
Moisture content of dried paddy	14% (Wet base)
Moisture reduction (24 - 14%)	10%
Moisture reduction per pass	2%
Required number of pass for complete drying (10% ÷ 2%)	5 passes

2) Capacity

On the premise of basic condition mentioned above and others, required capacity of facilities at each sub-area can be drawn as follows:

	Paddy Field (ha)	Paddy Yield (tons/ha)	Production per Crop (tons)	Max. Paddy Harvested per day (tons)	Capacity		
					Receiving (tons/hr)	Drying (tons/hr)	Storage (tons)
Holland	560	5.5	3,080	102	15.3	25.5	2,400
Hatfield & Styx R.	520	-	2,560	84	12.6	21.0	2,000
(Hatfield)	(220)	(5.5)	(1,210)	-	-	-	-
(Styx R.)	(300)	(4.5)	(1,350)	-	-	-	-
Frenchman & Holiday-Pen	400	4.5	1,800	61	9.2	15.3	1,400
Broad R. Right B.	800	4.5	3,600	110	16.5	27.5	2,800
Broad R. Left B.	800	4.5	3,600	110	16.5	27.5	2,800
Total	3,080	-	14,640	-	-	-	11,400

i) Receiving capacity (R)

$$R = M \div 8 \times 1.2$$

M: Maximum paddy harvested per day

8: Receiving hours per day

1.2: Considering superfluous capacity

ii) Drying capacity (D)

$$D = M \times 5 \text{ (pass)} \div 20 \text{ (hrs)}$$

iii) Storage capacity (S)

$$S = P \times (1 + 0.1 - 0.25)$$

P: Total production of paddy per crop at each sub-area

0.1: Considering superfluous capacity

0.25: Paddy milled during harvesting period and not requiring storage

4.2.2 Rice mill

1) Basic conditions

Paddy supply: Paddy is dried and stored in each sub-area and transported to the mill by truck according to the receiving capacity of mill.

Operating days:	150 days for one crop season
Operating hours per day:	16 hours (8 hours x 2 shifts)
Moisture content of milled rice:	12% or below
Finished rice density:	0.8 tons/m^3

(Other conditions are same as mentioned above)

2) Capacity

Daily processing capacity:	96 tons
Milling capacity per hours:	6 tons

4.3 Composition of the Facilities

4.3.1 Facilities at each sub-area

1) Receiving facilities

Truck scale (20 ton)	1 set
Receiving hopper	1 set
Paddy cleaner	1 set
Paddy weigher	1 set
Receiving bin	*
Control panel	1 set
Conveying equipment	1 lot
Other necessary equipment and materials	1 lot

2) Drying facilities

Dryer	1 set
Furnace	1 set
Tempering bin	*
Control panel	1 set
Conveying equipment	1 lot
Other necessary equipment and materials	1 lot

3) Storage facilities

Storage silo	*
Conveying equipment	1 lot
Control tank (20 ton)	1 lot
Other necessary equipment and materials	1 lot

4.3.2 Milling facilities

Mill day - bin (25 ton)	2 sets
Receiving hopper	1 set
Paddy cleaner	1 set
Stoner	2 sets
Paddy weigher	1 set
Paddy husker with aspirator	3 sets
Paddy separator	2 sets
Rice whitening machine (Abrasive type)	3 sets
Rice whitening machine (Friction type)	1 set
Rotary shifter	1 set
Length grader	2 sets
Scale shutter	1 set
Control panel	1 set
Conveying equipment	1 lot
Other necessary equipment and materials	1 lot

(Note) * Different in each sub-area as follows:

Sub-area	Receiving Bin	Tempering Bin	Storage Silo
Holland	$40^t \times 3$	$40^t \times 4$	$250^t \times 10$
Hatfield & Styx River	$30^t \times 3$	$30^t \times 4$	$250^t \times 8$
Frenchman & Holiday-Pen	$30^t \times 2$	$40^t \times 3$	$250^t \times 6$
Broad R. Right Basin	$40^t \times 3$	$40^t \times 4$	$300^t \times 10$
Broad R. Left Basin	$40^t \times 3$	$40^t \times 4$	$300^t \times 10$

4.3.3 Power source, fuel and building

All the machinery and equipment at all plant are driven individually by electric motors. Required electricity should be available at the site.

Receiving and tempering bins and storage silo are in the open-air, but machinery or equipments for receiving, drying and milling are covered in building. Required size of building, power and fuel are shown below:

Facilities & Sub-area	Power (KW)	Fuel (ℓ/hr)	Building (m^2)
Drying facilities			
- Holland	200	190	500
- Hatfield & Styx River	190	160	500
- Frenchman & Holiday-Pen	160	130	400
- Broad R. Right Basin	200	190	500
- Broad R. Left Basin	200	190	500
Milling facility	190	-	600

4.3.4 Operation staff

Each facility is required for operation staff as shown below. Operator drive the machinery or equipment of facility and can repair machine troubles, sometimes by the aid of mechanic at mechanical service station. Inspection and repair of electric system in facility may be done by electricians residing at the mechanical service center. As staff of rice mill work on two shifts, double personnel will be required.

	Manager	Operator	Assistant Operator	Laborer	Total
Holland	1	2	2	11	16
Hatfield & Styx River	1	2	2	9	14
Frenchman & Holiday-Pen	1	1	2	8	12
Broad R. Right Basin	1	2	2	11	16
Broad R. Left Basin	1	2	2	11	16
Rice Mill	1	2 × 2	2 × 2	10 × 2	29

4.4 Products and By-products

Based on the data of the rice mill at BRUMDEC, it may be assumed that the rate of husk, bran and broken rice per paddy by weight are 25%, 7% and 3%, respectively. Then, finished rice and by-products produced per annum in this project are estimated as follows:

Finished rice	18,820 ton
Broken rice	870
Bran	2,020
Husk	7,240

Broken rice may be used for food directly or after processing. Rice bran contains 15 ~ 20% of oil and bran or its residue after extracting oil can be used as feed. However, raw rice bran is easy to change in quality because of decomposition of oil by included enzyme, and therefore, rapid heating is necessary to stop the activity of the enzyme both for feed directly or for processing. Rice bran oil extracted contains considerably amount of free fatty acid and other impurities, and is not easy to refine. Refined oil is edible, but crude oil can be only used as a raw materials for industry.

There may be some ways to utilize a large amount of husk. One is using as fuel for dryer and the other is applying to paddy soil for improvement of physical property of clayey soil and for supplying organic matter and/or silicate.

4.5 Cost Estimate

Costs required for farm machinery and workshop are estimated to be J$30.9 million (US$7.7 million). Costs of rice processing facilities and storage are estimated at J$46.7 million (US$11.7 million). *The breakdown of the costs is given in Tables G-25 and G-26.*

Table G-1 PRESENT LAND USE

(Unit: ha)

Item	Category								Ratio to the Whole Area (%)
	Sugar Cane	Grass-land	Forest/ Bush	Trees/ Village/ Grassland	Upland Crop/ Grassland	Paddy/ Swamp	Swamp	Total	
I. Black River Right Bank									
1. Within Development area	310	100	-	-	-	100	170	680	6.0
- Holland Estate	310	100	-	-	-	100	170	680	6.0
2. Without Development area	600	290	300	10	50	30	580	1,860	16.2
- Holland Estate	600	100	-	-	-	10	310	1,020	8.9
- Other area	-	190	300	10	50	20	270	840	7.3
3. Sub-total	910	390	300	10	50	130	750	2,540	22.2
II. Estuary and Middle Quarters									
1. Within Development area	-	-	-	-	-	-	-	-	0.0
2. Without Development area	-	630	460	20	10	-	1,560	2,680	23.4
3. Sub-total	-	630	460	20	10	-	1,560	2,680	23.4
III. Black River Left Bank									
1. Within Development area	-	170	160	-	60	-	810	1,200	10.5
- Hatfield	-	170	60	-	60	-	10	300	2.6
- Styx River	-	-	-	-	-	-	400	400	3.5
- Frenchman & Holiday-Pen	-	-	100	-	-	-	400	500	4.4
2. Without Development area	-	560	200	90	260	-	-	1,110	9.7
3. Sub-total	-	730	360	90	320	-	810	2,310	20.2
IV. Broad River Basin									
1. Within Development area	-	20	-	-	-	-	1,980	2,000	17.4
- Broad River Right Bank	-	20	-	-	-	-	980	1,000	8.7
- Broad River Left Bank	-	-	-	-	-	-	1,000	1,000	8.7
2. Without Development area	10	990	540	80	300	-	-	1,920	16.8
3. Sub-total	10	1,010	540	80	300	-	1,980	3,920	34.2
V. Total									
1. Within Development area	310	290	160	-	60	100	2,960	3,880	33.9
2. Without Development area	610	470	1,500	200	620	30	2,140	7,570	66.1
3. Project area	920	2,760	1,660	200	680	130	5,100	11,450	100.0

Table G-2 AREA, YIELD AND PRODUCTION OF THE PARISH OF ST. ELIZABETH - 1983

Crop	Area (ha)	% of Total Area[1/]	Yield (mt/ha)	Production of St. Elizabeth (mt)	As % of All Island Production
Gungo pea	417	5	0.9	375	18
Red pea	638	8	1.0	660	18
Peanut	1,354	18	1.2	1,740	61
Carrot	168	2	12.4	3,740	24
Tomato	457	6	14.9	6,830	36
Pumpkin	211	3	12.3	2,574	8
Onion	65	1	9.2	600	33
Pineapple	118	2	11.2	1,310	21
Sweet potato	357	5	12.7	4,560	19
Renta yam	207	3	13.3	2,760	12
Yellow yam	208	3	15.1	3,150	7
Sweet cassava	76	1	11.7	730	10
Rice	379	5	2.4	900	27
Corn	386	5	1.2	460	13

Remarks: 1/: Total area cultivated in Parish is 7,711 ha.

Source: Compiled from data supplied by St. Elizabeth Parish Office and Rural Physical Planning Unit - Central Region.

Table G-3 COMPARATIVE ESTIMATE OF DOMESTIC CROP PRODUCTION BY PARISH 1983, 1982
ST. ELIZABETH

Crop	Production (mt)			Area (ha)		
	1983	1982	% Change	1983	1982	% Change
Legume	2,928	2,983	-2	2,780	2,555	9
Vegetable	14,378	15,188	-5	1,260	1,263	-0.2
Condiment	4,615	2,677	72	766	578	33
Fruit	5,139	6,692	-23	368	453	19
Cereal	2,978	1,534	94	1,027	738	39
Plantain	1,423	1,329	7	115	100	15
Potato	2,628	3,045	-14	249	263	-5
Yam	7,735	9,122	-15	614	631	-3
Other tuber	5,578	5,759	-3	510	617	-17
Sorrel	23	25	-7	21	22	-6
Total				7,711	7,219	6.8

Table G-4 CHARACTERISTICS OF THE MOST COMMONLY GROWN UPLAND CROPS IN THE PROJECT AREA

Crop Name			Planting Method	Population[1/]	Maturity[2/]	Main Products
Common	Variety/Strain	Scientific				
Cassava	Blue bud	Manihot esculenta	Hill[3/]	Low	Long	Roots
Yam	Renta	Dioscorea alata	Hill	Low	Long	Tubers
Corn	Local flint, MD II (Hybrid)	Zea mays	Spot seeding[4/]	Low	Very short	Cob and dried grain
Gungo pea	Native variety (un-named)	Cajanus cajan	Spot seeding	Medium	Long	Dried grain
Peanut	Native variety (Spanish type)	Arachis hypogaea	Spot seeding	High	Short	Dried grain

Remarks: 1/: Plants per hectare: low 100,000; medium 100,000 - 100,000; high 200,000

2/: Days from planting to harvest: very short 100; short 100 - 140; long 200

3/: Hill includes in the case of cassava, partially covering 'stick' and; in case of yam, burying of 'heads'

4/: Spot seeding denotes individual planting holes whether closely or scattered spacing. In case of peanut - close spacing.

Table G-5 LABOUR AND INPUT MATERIALS FOR MAIN CROPS

	Sweet Cassava	Yam	Corn	Gungo Pea	Peanut
Labour operation (md/ha)					
Land clearing	25	25	-	25	25
Forking (ploughing)	-	-	-	-	10
Making holes/hills and planting	45	52.5	20	12.5	10
Staking and tying	-	30	-	-	-
Weeding	20	37.5	-	25	-
Weeding and moulding	-	-	20	-	30
Twining	-	10	-	-	-
Fertilizer application	-	-	-	-	2.5
Pesticide application	-	-	2.5	-	2.5
Reaping	30	50	-	-	-
Reaping and threshing	-	-	30	30	-
Reaping and windrowing	-	-	-	-	12.5
Drying, picking pods, bagging	-	-	-	-	15
Transport	10	15	2.5	2.5	2.5
Total	130	220	75	95	110
Material					
Seed (kg/ha)	(9,250)	(15,000)	11.2	10	90
Stakes	-	3,750	-	-	-
Fertilizer 16-18-27 (kg/ha)	-	-	-	-	251
Chemicals Belmark (m//ha)	-	-	560	-	560
Dithane M45 (kg/ha)	-	-	-	-	2.2

Remarks: Numbers in ( ) parentheses are absolute amounts.

Table G-6 LABOUR AND INPUT MATERIAL FOR REPLANTED SUGAR CANE AT HOLLAND ESTATE

	Item	No. of Times	md/ha	Tractor Hours
A.	Labour Operations			
	Ploughing	3	-	9
	Harrowing	1	-	2
	Transport seed to field (tw) 1/	1	-	1
	Lay seed in furrow (md) 2/	1	2.5	1
	Planting (tw)	1	10	-
	Covering seed	1	-	1.5
	Molding (tw)	1	-	2
	Weeding (manual) (tw)	2	15	-
	Apply herbicide (md)	3	6	-
	Apply fertilizer (md)	1	4	-
	Supplying field (tw)	1	5	-
	Harvesting (tw)	1	15	-
	In-field haulage		-	1
	Transport from field to receiving station		-	4
	Total		57.5	30.5

	Materials		Quantity	
	Seed		6.75	mt
	Fertilizer	16 - 9 - 18 or 18 - 9 - 18	510	kg
	Herbicide	Gesapot or Paraquat	12.5	ℓ
		with Actril D	8.5	ℓ

Remarks: 1/: (tw) denotes task work

2/: (md) denotes man-day

Table G-7 PROCESSING FACILITIES IN ST. ELIZABETH

Name	Location	Raw Material	Operating 1/ Efficiency	Comment
Jamaica Food Processors Ltd.	Bull Savannah	Fruits and Vegetables	High	
National Cassava Products	Goshen	Cassava	N/A	Not in operation
St. Elizabeth Cassava Products Ltd.	Santa Cruz	Cassava	Low	Raw materials and product in demand
St. Elizabeth/Manchester Growers Coop.	Southfield	Peanut	Low	Raw material and product in demand
Thompsons Packaging	Braes River	Peanut Peppermint Kola nuts		
Agro-Pak	Santa Cruz	Spices	Low	Scarcity and seasonal supply of raw materials
Caribbean Exotic Foods Ltd.	Nain	Fruits	N/A	Building complete machinery being installed
Minotts' Pimento Oil Factory	Middle Quarters	Pimento Leaves	High	Newly established
Jamaica Farmers Ltd.	Peppers	Vegetables	-	-
Chambers Thatch Enterprise	Watchwell	Thatch palm		Limited market
Appleton Sugar Factory	Siloah	Sugarcane	High	

Remarks: 1/: High denotes over 50%, low less than 50% operating efficiency.

Table G-8 CHARACTERISTICS OF VARIETIES CHOSEN

Varieties	Soil Type	Maturity Period (days)	Plant Height (cm)	Days to Heading (days)	Experimental Yield (kg/ha)
(Rice)					
Newbonnet	Mineral	97	68	70	4,700
Lamont	Mineral	96	63	70	4,900
Bond	Mineral	87	74	60	4,600
Labelle	Peat	100	115	66	3,000
Lebonnet	Peat	100	85	-	2,700
(Soya Bean)					
Duo - Crop	Mineral	90	90	40 (55)*	2,800

Remarks: * Days to first flowering (pod formation) from sowing.
Rice data cited from Annual Agr. Report of BRUMDEC (1983).
Soya bean data depended on St. Jago and Spring Plain Farm.

Table G-9 DURATION OF FARM OPERATION FOR RICE AND SOYA BEAN

	Land Preparation	Sowing	Harvesting
I. Mineral Soil			
Spring Rice	Apr. 10 - May 19	Apr. 11 - May 20	July 19 - Aug. 27
Fall Rice	Aug. 11 - Sep. 19	Aug. 11 - Sep. 19	Nov. 18 - Dec. 27
Soya Bean	Dec. 2 - Jan. 10	Dec. 2 - Jan. 10	Feb. 29 - Apr. 8
II. Peat Soil			
Spring Rice	Mar. 20 - Apr. 28	Mar. 21 - Apr. 29	June 28 - Aug. 6
Fall Rice	Aug. 7 - Sep. 15	Aug. 7 - Sep. 15	Nov. 14 - Dec. 23

Table G-10 NUTRIENT CONTENT OF IRRIGATION WATER

(Unit: ppm)

	Y.S. River	Black River[1/]		Average	Amount[2/] (kg/ha)
		Sample(1)	Sample(2)		
Calcium (Ca)	42	72	58	57.3	
Magnesium (Mg)	6.3	5.3	8.4	6.7	
Sodium (Na)	3.1	4.3	6.1	4.5	
Potassium (K)	0.9	2.4	1.5	1.6	4.8
C.O.D.	7	12	5		
DO/B.O.D.	7.8/0.9	5.4/1.2	3.8/1.1		
Nitrates (NO_3)	2.3	2.7	2.1	2.4	7.2
Nitrites (NO_2)	0.03	0.06	0.06		
Sulphate (SO_4)	3.6	9.6	10		
Chloride (Cl)	10	12	16	12.7	
Phosphate Total (PO_4)	0.1	0.17	0.15	0.14	0.4

Remarks: 1/: Water samples were taken from 2 locations along Black River.

2/: Amount of each element in water which is irrigated per hectare in one crop season.

Table G-11 FERTILIZER APPLICATION AT BRUMDEC AND MAYLERSFIELD

(Unit: kg/ha)

	Active Ingredient			
	Mineral Soil		Peat Soil	
	M[1/]	B[2/]	M[1/]	B[2/]
Nitrogen	122	78	44	-
Phosphate	87	31	119	31
Potash	22	28	34	28

Remarks: 1/: Meylersfield

2/: BRUMDEC

Table G-12 PROPOSED FERTILIZER APPLICATON FOR RICE AND SOYA BEAN

(Unit: kg/ha)

Time of Application	Type of Fertilizer	Amount of Fertilizer	Active Ingradient N	P_2O_5	K_2O
RICE					
(Mineral Soil)					
Basal	12.24.12	200	24	48	24
Tillering stage	Diam. Phos[1/] (18.46.0)	70	13	32	-
	Urea (45%)	74	33	-	-
Panicle formation stage	Urea (45%)	67	30	0	0
	Murate of potash (60%)	60	-	-	36
Total			100	80	60
(Peat Soil)					
Basal	Triple super-phosphate (45%)	222	-	100	-
	Murate of potash (60%)	50	-	-	30
	Copper sulphate	9	-	-	-
Total				100	30
SOYA BEAN					
(Mineral Soil)					
Basal	Triple super-phosphate (45%)	249	-	112	-
	Murate of potash (60%)	112	-	-	67
Total				112	67

Remarks: 1/: Diammonia phosphate

Table G-13 CHEMICALS APPLIED TO RICE AND SOYA BEAN

Crop	Common Name	(Trade Name)	MT[1/]	TAA[2/]	Rate per Ha
	(Herbicide)				
Rice	bentiocarb	(Saturn)	OS	B	5.7 ℓ
	2,4-D	(2,4-D)	OS	A	2.9 ℓ
Soya bean	diphenamid	(Dymid)	OS	A	5.0 kg
	bentazon	(Basagran)	OS	A	2.5 kg
	(Pesticide)				
Rice	trichlorphon	(Dipterex)	DS	B	1.5 kg
	fenitrothion	(Sumithion)	OS	B	0.6 ℓ
	Mancozeb	(Dithane)	OS	A	1.7 kg
Soya bean	monocrotophos	(Nuvacron)	OS	A	10 ℓ

Remarks: 1/: MT: Mammalian Toxicity
OS: Ordinary substances
DS: Deleterious substances

2/: TAA: Toxicity to Aquatic Animals

Table G-14 LABOUR REQUIREMENT OF RICE ON MINERAL SOILS

Dates after Planting	Labour Operation	Spring Rice		Fall Rice	
		hrs/ha	MD/ha	hrs/ha	MD/ha
	Tillage (disc harrow)	(3.0) 1/	-	(3.0)	-
	Pulverizing or puddling (rotary harrow)	(3.0)	-	(3.0)	-
	Levelling (land leveller)	(2.0)	-	-	-
	Harvesting (combine)	(3.2)	-	(2.6)	-
	Basal fertilization	8.0	1.0	8.0	1.0
	Pre-germinating seed	-	-	4.0	0.5
	Planting (broadcasting)	8.0	1.0	8.0	1.0
1 week	Applying herbicide (1st)	4x3 2/	1.5	4x3	1.5
2 week	Supplementary transplanting	8.0	1.0	8.0	1.0
3 week	Second fertilization	8.0	1.0	8.0	1.0
5 week	Applying herbicide (2nd)	4x3	1.5	4x3	1.5
6 week	Applying pesticide (Dithane)	-	-	4x2	1.0
7 week	Third fertilization	8.0	1.0	8.0	1.0
10 week	Applying pesticide (Sumition, Dithane)	4x2	1.0	4x2	1.0
	Irrigation and drainage	40.0	5.0	44.0	5.5
	Transportation	(1.6)	-	(1.3)	-
	Total Manual (Mechanical)	112.0 hr (11.8 hr)	14.0 MD	128.0 hr (9.9 hr)	16.0 MD

Remarks: 1/: Figures in parentheses represent mechanical operation in hours.

2/: Operating hours x operating personnel required.