2.2.3 The analysis to determine the chemical properties of soils was performed using a soil test kit on specimens from 8 profiles and 15 horizons. The specimens were chiefly in the air dried condition. The analysis items were pH (KCl), $NH_4$-N, available $K_2O$, exchangeable Ca, exchangeable Mg and exchangeable Mn. The values obtained from the analysis were relative values for rough estimation rather than absolute values.

2.2.4 The samples prepared for mechanical analysis and chemical analysis on a consignment basis were collected as follows:

Gleysols : 2 profiles and 4 horizons
Histosols : 2 profiles and 4 horizons

The following were determined: coarse sand (%), fine sand (%), silt (%), and humus (%) for mechanical analysis, and pH (KCl and $H_2O$), organic carbon (%), total nitrogen (N%), cation exchange capacity (C.E.C., m.e. %), base saturation percentage (%), total sulphur ($SO_4$ %), specific conductivity (μ mhos/cm) and loss on ignition (%), 14 items in all.

## 3. Results Obtained

### 3.1 Main soil units of Pilot Project area

The Pilot Project area contains the "Paya Tanah Hitam" inland swamp and its surrounding hilly areas: The main soils in the area are peat and gley soils in the swamp area and reddish-yellow soil in the peripheral hill lands. The former two soils are chiefly depositions formed during the Quaternary Era and are gley soils formed above the alluvium of the Paka river and the woody peat that lies underneath the tropical swamp forest. The latter, which is presently covered with a tropical lowland forest, was formed either as a shale or sandstone during the Carboniferous Period (west and north sides) and the Jurassic-Triassic Period (east and north sides).

Table III-1 shows the three soils in terms of soil units incorporated in the "Soil Map of the World" (1974) published by FAO/UNESCO. The distribution of soils is: Histosols - about 1,500 ha or 53.0%; Gleysols - about 400 ha or 14.1%; and Acrisols - about 930 ha or 32.9%.

Fig. III-1 illustrates the decomposition condition of main soils in a topographic diagram and the topography of the swamp area stretching in the north-south direction which is the distribution area of Gleysols and Histosols. The figure shows the survey results of the inside of the swamp extending northward about 2.3 kilometers from base point '0' on the District Road about 500 meters away from the Paka river bank. It is widely known that swamp peat frequently forms a dome shape, and this tendency is partly shown in Fig. III-1.

The soil surface gradient is between 1/800 and 1/700 while the deposition layer of the peat thickness as it penetrates deep inside the swamp. Underneath the peat is a deposition of heavy clay which has been heavily subjected to reduction and corrosion and which has the peculiar Gleysols color. Further underneath was observed a deposition of sandy clay.

In Table III-2, the main features of the representative profiles of each main soil are shown. Compactness was measured by a Yamanaka Hardness Meter (mm), and the solid ratio was measured by the volumenometer mentioned previously.

Tables III-3 and 4 show the distribution range of physical and chemical properties of main soils. The physical properties of main soils were measured by a volumenometer, and the values were obtained while keeping the samples as far as possible in their wet condition. The values of chemical properties of main soils were derived from the results of Miss I. Jogeswary's analysis.

Table III-1 Main Soils in Pilot Project Area

| References / Sites in Swamp Area | Semi-Detailed Soil Survey of Bukit Bauk Area (1976) | Generalized Soil Map of West Malaysia (1970) | FAO/UNESCO, Definition of Soil Units for the Soil Map of the World (1968) | FAO/UNESCO, Soil Map of the World (1974) |
|---|---|---|---|---|
| Major Parts of Swamp, under Swamp Forest and Belukar (1,500 ha, 53.0%) | Peat | Organic Soils with Gley Soils | Histosols, Dystric Histosols | Histosols, Dystric Histosols |
| Southern Parts of Swamp, Flood Plains of Paka river (400 ha, 14.1%) | Riverine Alluvium | Alluvial Soils and Gley Soils on recent riverine alluvium | Gleysols, Fluvic or Humic Gleysols | Gleysols, Humic and Dystric Gleysols |
| Hilly Parts, Surround of Swamp (930 ha, 32.9%) | Bungor Series | Red Yellow Podzolic Soils on residual materials from Argillaceous and Mixed sediments | Acrisols, Helvic Acrisols | Acrisols, Orthic and Ferric Acrisols |

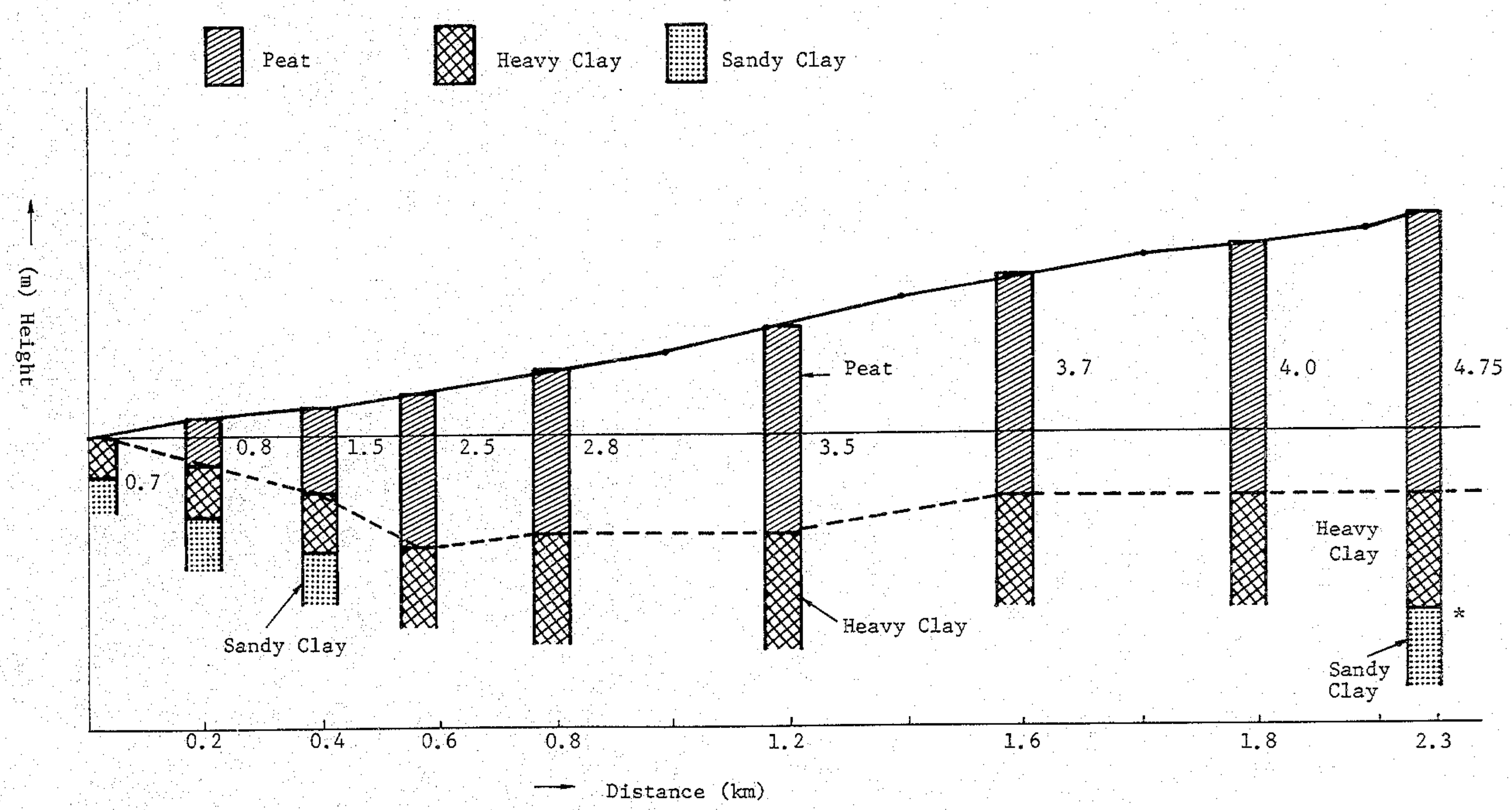


Fig. III - 1 Topographic Diagram of Inland Swamp "Paya Tanah Hitam"

Table III-2 Some Features of Main Soils

| Soils / Profiles / Horizons (cm) / Items | Gleysols | | | | | | | | | Histosols | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CI | | | EI | | | EIII | | | EII | |
| | 0 ∿ 16 | 16 ∿ 70 | 70 ∿ 80 | 0 ∿ 12 | 12 ∿ 40 | 40 ∿ 60 | 0 ∿ 16 | 16 ∿ 70 | 70 ∿ 100 | 0 ∿ 20 | 20 ∿ 35 |
| Colour | 7.5YR4/1 Brow.Gray | N 7/0 Gray.White | N 7/0 Gray.White | 7.5YR2/2 Brow.Black | 7.5YR5/1 Brow.Gray | N 7/0 Gray.White | 7.5YR4/4 Brown | 7.5YR7/1 L.Brow.Gray | 7.5YR8/1 L. Gray | 7.5YR2/2 Brow.Black | 10YR2/1 Black |
| Texture | HC Heavy Clay | HC Heavy Clay | SC Sandy Clay | HC Heavy Clay | HC Heavy Clay | HC Heavy Clay | SiC Silty Clay | LiC Light Clay | SC Sandy Clay | Peat Woody | Peat Woody |
| Compactness 1) mm | 7.4 | 11.6 | - | 15.0 | 14.0 | - | 12.8 | 18.3 | 16.4 | 5.0 | 5.6 |
| Solid ratio 2) % | 18 ∿ 28 | 45 ∿ 48 | - | 27 ∿ 40 | 38 ∿ 53 | - | 42 ∿ 50 | 64 ∿ 67 | - | 7.0 ∿ 10.0 | 9.2 ∿ 14.4 |
| Structure | Very Coarse Subangu. b | Very Coarse Subangu. b | Very Coarse Subangu. b | Very Coarse Subangu. b | Very Coarse Subang. b | Very Coarse Subangu. b | Coarse Subangu. b | Very Coarse Subangu. b | - | Undecomp. Peat | Undecomp. Peat |
| Rooting | many | a few | none | many | a few | few | many | a few | none | many | few |

| Soils / Profiles / Horizons (cm) / Items | Histosols | | | | Acrisols | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CIII | | | | WI | | | WII | | |
| | 35 ∿ 100 | 0 ∿ 225 | 225 ∿ 475 | 475 ∿ 675 | 0 ∿ 15 | 15 ∿ 80 | 80 ∿ 100 | 0 ∿ 20 | 20 ∿ 80 | 80 ∿ |
| Color | 7.5YR6/1 Gray.Brown | 10YR2/2 Brow.Black | 10YR3/3 Dark Brown | 5GY3/1 Dark Olive | 10YR3/3 Dark Brown | 10YR5/8 Yell.Brown | 2.5YR8/4 Pale Yellow | 7.5YR2/3 Brow.Black | 10YR5/6 Yell.Brown | 2.5Y8/6 Yellow |
| Texture | HC Heavy Clay | Peat Woody | Peat Woody | HC Heavy Clay | LiC Light Clay | LiC Light Clay | SC Sandy Clay | SCL Sandy Clay Loam | SL Sandy Loam | SL Sandy Loam |
| Compactness 1) mm | 7.0 | - | - | - | 16.4 | 20.6 | - | 18.4 | 21.4 | - |
| Solid ratio 2) % | 29 ∿ 36 | 6.2 ∿ 8.1 | 6.2 ∿ 8.1 | - | 48 ∿ 49 | 49 ∿ 55 | - | 34 ∿ 44 | 47 ∿ 49 | - |
| Structure | fine granular | fairly dec-omp. peat | fairly dec-omp. peat | fine granular | fine sub augu.b | fine sub augu.b | medium sub augu.b | fine sub augu.b | medium sub augu.b | medium sub augu.b |
| Rooting | none | many | none | none | many | a few | none | many | a few | none |

Note 1): Measured with Yamanaka's hardness meter
2): Measured with Misono's volumenometer
3): Samples were obtained from Geotechnique (Malaysia) SDN.BHD.

Table III-3 Physical Properties of Main Soils

| Properties \ Soils | Histosols | Gleysols | Acrisols |
|---|---|---|---|
| Textural Classes [1] | Woody Peat in various stages of decomposition | Fine textured | Fine ∿ Medium textured |
| Solids Ratio [1] Sv % | 2.3 ∿ 12.2 | 28.9 ∿ 46.4 | 39.0 ∿ 52.1 |
| Volume Weights [1] S gr | 3.5 ∿ 17.8 | 51.6 ∿ 116.5 | 103.0 ∿ 130.7 |
| True Density [1] d gr/cc | 1.46 ∿ 1.52 | 2.16 ∿ 2.57 | 2.47 ∿ 2.65 |
| Porosity [1] p % | 87.8 ∿ 97.7 | 53.6 ∿ 71.1 | 47.9 ∿ 61.0 |
| Soil Compactness [2] mm | 5.0 ∿ 5.6 (drained state) | 7.0 ∿ 16.8 | 16.4 ∿ 21.4 |
| Permeability [1] | Excess | Poor | Good |
| Dehydration % [1] | 75.3 ∿ 94.2 | 31.8 ∿ 43.0 | - |
| Shrinkage % [1] | 37.5 ∿ 75.6 | 14.1 ∿ 48.6 | |

1): Obtained with Misono's volumenometer

2): Obtained with Yamanaka's hardness meter

Table III-4 Chemical Properties of Main Soils

| Properties \ Soils | | | Histosols | Gleysols |
|---|---|---|---|---|
| pH 1) | $H_2O$ | 1) | | |
| | KCℓ | 1) | 3.8 ∿ 3.9 | 4.0 ∿ 4.7 |
| Organic Matter 1) | C | % 1) | 37.4 ∿ 53.0 | 1.52 ∿ 3.62 |
| | Humus | % 2) | 64.5 ∿ 91.4 | 2.64 ∿ 6.24 |
| Total | N | % 1) | 0.38 ∿ 1.87 | 0.37 ∿ 1.23 |
| C.E.C. | m.e. | % 1) | 17.5 ∿ 55.1 | 13.2 ∿ 24.4 |
| Exchangeable m.e. % | K | 1) | 0.16 ∿ 0.53 | 0.06 ∿ 0.12 |
| | Ca | 1) | 0.45 ∿ 1.23 | 0.58 ∿ 1.20 |
| | Mg | 1) | 0.62 ∿ 4.34 | 0.29 ∿ 0.50 |
| | Na | 1) | 0.18 ∿ 0.33 | 0.10 ∿ 0.12 |
| Base Saturation | | % 2) | 4.95 ∿ 29.5 | 7.82 ∿ 7.96 |
| Total | S<br>$SO_4$ | % 1) | 0.02 ∿ 0.73 | 0.16 ∿ 0.22 |
| Specific Conductivity μ mhos/cm | | 1) | 260 ∿ 1790 | 300 ∿ 400 |
| Loss on Ignition | | % 1) | 62.3 ∿ 94.2 | - |

1): Obtained from Miss I. Jogeswary

2): Calculated by the Japanese Survey Team

## 3.2 Physical properties of main soils

Table III-2 shows the distribution range of the physical properties of the main soils. It also clarifies the physical properties in each layer concerning the representative profile of each soil. Measurement was performed using a volumenometer.

Table III-5 shows the true density. As the humus content in the surface layer soil is large, the surface soil of Gleysols shows a smaller value than its lower layer.
This relationship between the surface layer soil and the lower layer soil holds in the same way with Acrisols. However, as the decomposition speed of the humus differs in the Acrisols, its influence appears differently.

The distribution range of true density in Gleysols is between 2.16 and 2.51; and Acrisols between 2.47 and 2.65, the former is small and the latter large. A marked difference was observed between the two.
This is judged to have been caused by the difference in heavy metals (Fe, Mn, etc.) contents, although chemical analysis was not conducted to confirm this.

The true density of Histosols being between 1.46 and 1.57 means that the soil is composed mainly of organic matters and few inorganic materials. Table III-6 shows the physical property of each soil layer measured with volumenometer.

The difference between the surface layer and the lower layer soil of Gleysols is due mainly to the differences in the contents of humus and structure. With regard to structure, while both are described as being 'very coarse subangular blocky structure', the space between each block in the surface layer is larger than in the lower soil layer. This shows that the physical properties of Gleysols require improvement and thus that it is necessary to add organic substances that are important to the improvement of the soil structure. However, when the solid ratio is extremely large as in the lower layer

Table III-5 True Density of Main Soils

| Soils | Gleysols | | | | | | Histosols | | | | Acrisols | | | | Fluvisols | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profiles | CI | | EI | | EIII | | EII | | CIII | | WI | | WII | | M | |
| Horizons(cm) Items | 0-16 | 16-70 | 0-12 | 12-40 | 0-16 | 16-70 | 0-20 | 20-35 | 20-100 | 20-100 | 0-15 | 15-80 | 0-20 | 20-80 | 0-17 | 17-70 |
| Total Weight W gr | 125.4 | 169.9 | 132.4 | 161.9 | 155.5 | 196.5 | 36.2 | 79.5 | 91.0 | 91.0 | 166.2 | 172.1 | 130.1 | 159.7 | 168.0 | 172.3 |
| Actual Volume V cc | 97.7 | 99.8 | 84.9 | 98.1 | 89.3 | 98.5 | 32.5 | 73.5 | 87.4 | 89.8 | 95.0 | 93.9 | 67.1 | 79.9 | 85.2 | 86.4 |
| Volume Weight S gr | 51.5 | 116.5 | 82.8 | 108.1 | 110.6 | 163.4 | 11.7 | 16.5 | 10.5 | 3.5 | 119.7 | 130.0 | 101.5 | 128.3 | 138.1 | 141.5 |
| Soil Water M gr | 73.9 | 53.4 | 49.6 | 53.8 | 44.9 | 33.1 | 24.5 | 63.0 | 80.5 | 87.5 | 46.5 | 42.1 | 28.6 | 31.4 | 29.9 | 30.8 |
| Solids Ratio Sv % | 23.8 | 46.4 | 35.3 | 44.3 | 44.4 | 65.4 | 8.0 | 10.5 | 6.9 | 2.3 | 48.5 | 51.8 | 38.5 | 48.5 | 55.3 | 55.6 |
| True Density d gr/cc | 2.16 | 2.51 | 2.35 | 2.44 | 2.49 | 2.50 | 1.46 | 1.57 | 1.52 | 1.52 | 2.47 | 2.51 | 2.64 | 2.65 | 2.50 | 2.54 |

Note: 1. Obtained with Misono's volumenometer

2. Samples of Histosols were examined under air dried (EIII) and drained (CIII) conditions.

Table III-6 Physical Properties of Main Soils

| Soils | Gleysols | | | | | | Histosols | | | | Acrisols | | | | Fluvisols | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profiles | CI | | EI | | EIII | | EII | | CIII | | WI | | WII | | M | |
| Horizons(cm) Items | 0-16 | 16-70 | 0-12 | 12-40 | 0-16 | 16-70 | 0-20 | 20-35 | 20-100 | 20-100 | 0-15 | 15-80 | 0-20 | 20-80 | 0-17 | 17-70 |
| Total Weight W gr | 125.4 | 169.9 | 132.4 | 161.9 | 155.5 | 196.5 | 36.2 | 79.5 | 91.0 | 91.0 | 166.2 | 172.1 | 130.1 | 159.7 | 168.0 | 172.3 |
| Actual Volume V cc | 97.7 | 99.8 | 84.9 | 98.1 | 89.3 | 98.5 | 30.6 | 75.8 | 89.8 | 87.4 | 95.0 | 93.5 | 66.1 | 78.9 | 85.2 | 86.4 |
| Air Ratio Av % | 2.3 | 0.2 | 15.1 | 1.9 | 10.7 | 1.5 | 69.4 | 24.2 | 10.2 | 12.6 | 5.0 | 6.5 | 33.9 | 20.1 | 14.8 | 13.6 |
| Water Ratio Mv % | 73.8 | 53.4 | 49.7 | 53.8 | 44.9 | 33.2 | 18.4 | 69.3 | 87.5 | 80.5 | 46.6 | 41.4 | 37.1 | 31.5 | 30.0 | 30.6 |
| Solids Ratio Sv % | 28.9 | 46.4 | 35.2 | 44.3 | 44.4 | 65.3 | 12.2 | 6.5 | 2.3 | 6.9 | 48.4 | 52.1 | 39.0 | 48.4 | 55.2 | 55.8 |
| Porosity P % | 76.1 | 53.6 | 64.8 | 55.7 | 55.6 | 34.7 | 87.8 | 93.5 | 97.7 | 93.1 | 51.6 | 47.9 | 61.0 | 51.6 | 44.8 | 44.2 |
| Volume Weight S gr | 51.6 | 116.5 | 82.7 | 108.2 | 110.6 | 163.3 | 17.8 | 10.2 | 3.5 | 10.5 | 119.6 | 130.7 | 103.0 | 128.2 | 138.0 | 141.7 |
| Saturation *percentage H % | 97.0 | 99.6 | 76.6 | 96.6 | 80.8 | 95.7 | 21.0 | 74.1 | 89.6 | 86.5 | 90.3 | 86.4 | 44.4 | 61.0 | 67.0 | 69.2 |
| Moisture *percentage Mo % | 143.0 | 45.8 | 60.1 | 49.8 | 40.6 | 20.3 | 103.4 | 697.4 | 2,500 | 766.6 | 39.0 | 31.7 | 26.1 | 24.6 | 21.7 | 21.6 |

Note: 1. Obtained with Misono's Volumenometer
2. Samples of Histosols were examined under air dried (EII) and drained (CIII) conditions.

soil of E III, top priority must be given to the work of improving both air and water permeability of the soil by crushing the compact layer.

To collect samples of Histosols (peat) in their original form was extremely difficult. This was true especially when extracting peat from underneath the swamp forest which was constantly under wet conditions. It is important to further improve the sampling method of peat to heighten accuracy of soil surveying in the future.

The E II profiles were from the cut-over land of the swamp forest where bush of 2 to 3 meters was growing, this being about 20 meters away from the drainage network site completed two years ago. The drainage effect expressed itself in the differentiation of peat layers in the profiles.

Acrisols generally are soils of high permeability. But as the W I profiles indicate, the air ratio was between 5.0 and 6.5%; and saturation percentage between 86.4 and 90.3 %, thus these were not in good condition. As the soil survey was conducted during the dry season, the results show that soil improvement is needed for crop cultivation. When developing farm lands in such an area, large machinery for deep plowing and pan breaking should be utilized before transferring the farm land to settlers.

## 3.3 Chemical properties of main soils

Table III-7 shows the measurement results of the chemical properties of main soils by employing Yagi's Soil Test Kit. Air dried samples were generally used. But wet samples were also used to measure the phosphate absorption coefficient of peat. Except for the pH (KCl) value, all other values obtained are relative values and not absolute. [E II] is a heavy clay found in layer No. 3 of the E II profiles belonging to Histosols. It is given this position because its chemical properties resemble those of the Gleysols.

Table III-7 Chemical Properties of Main Soils

| Soils | Gleysols | | | | | | Histosols | | | | | Acrisols | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profiles | EI | | CI | [EII] | WIII | | WIV | EII | | CIII | | WI | | WII | |
| Horizons (cm) Item | 0-12 | 12-40 | 16-70 | 35-100 | 0-20 | 20-60 | 7-70 | 0-20 | 20-35 | 20-100* | 20-100* | 0-15 | 15-80 | 0-20 | 20-80 |
| pH (KCℓ) | 4.3 | 4.2 | 4.0 | 4.0 | 4.2 | 4.1 | 4.1 | 3.8 | 3.9 | 3.8 | - | 4.1 | 4.4 | 4.2 | 4.2 |
| $NH_4$-N | 1 little | 1 | 0 no | 1 | 1.5 a little | 1 | 2 a little | 3 medium normal | 1 | 3 | - | 1 | 2 | 1 | 1 |
| Available $P_2O_5$ | 0.1> a little | 0.1> | 0.1> | 0.1> | 0.1> | 0.1> | 0.1> | 0.1> | 0.1> | 0.1> | - | 0.1> | 0.1> | 0.1> | 0.1> |
| Phosphate Absorption Coefficient | 1,000 medium normal | 1,000 | 850 common | 1,250 medium normal | 850 | 700 common | 2,000 strong | 500>* weak | 500>* | 1,500** strong | 500> | 1,500 | 2,000 | 1,250 | 2,000 |
| Available $K_2O$ | 2 a little | 2 | 1 no | 2 | 1 | 1 | 1 | 2 | 2 | 4 rich | - | 2 | 1 | 1 | 1 |
| Exchangeable Ca | 0.07> a little | 0.07> | 0.07> | 0.07> | 0.07> | 0.07> | 0.07> | 0.07> | 0.07> | 0.07> | - | 0.07> | 0.07> | 0.07> | 0.07> |
| Exchangeable Mg | 10 a little | 5 | 5 | 10 | 5 | 5 > little | 5> | 5 | 10 | 20 medium normal | - | 5> | 5> | 5 | 5> |
| Exchangeable Mn | 2 | 2 | 1 little | 2 | 2 | 1 | 0 | 1 | 1 | 4 rich | - | 3 medium normal | 2 | 1 | 2 |

Note: 1. Obtained with Yagi's Soil Test Kit

2. Air dried samples were used, but * and ** were measured on wet soils.

3. [EII] indicates Heavy Clay samples from Histosols profile EII.

The pH (KCℓ) of Gleysols is 4.1 - 4.3 and thus is 'extremely acidic'[1]. The $NH_4$-N, available $P_2O_5$ and available $K_2O$ contents are little and also exchangeable Ca, Mg and Mn were little. All these indicate that the fertility of this soil is extremely poor, and also indicate that the application of materials containing not only N, P, K, but for crop cultivation also micronutrients will be necessary. To improve acidity, liming must precede all work.

The pH (KCℓ) of Histosols is 3.8 - 3.9, and thus 'extremely acidic'. When compared with Gleysols, the $NH_4$-N and available $K_2O$ values are high while that of available $P_2O_5$ is equally low. Also exchangeable Mg and Mn values are high but exchangeable Ca value is equally low. All these indicate that drained peat had lost its available $K_2O$, exchangeable Mg and Mn although a part of the Histosols.

The pH (KCℓ) of Acrisols is 4.1 - 4.4, and thus is' extremely acidic' similar to the previous two cases. Except for the comparatively high exchangeable Mn value, the rest strongly resemble the trend observed in Gleysols. In other words, $NH_4$-N, available $P_2O_5$ and available $K_2O$ are little in content and also exchangeable Ca and Mg are little. All these testify to the fact that the fertility of the soil is poor.

Table III-8 shows the results of mechanical analysis and chemical analysis conducted on consignment on representative specimens of Gleysols and Histosols. The analysis was performed by Miss I. Jogeswary. Although in some cases a cross check analysis is desirable, they, are included in this table because the cross check analysis was not possible.

Total nitrogen is scarce both in Gleysols and Histosols. Also there is only a low exchangeable cations concentration - K, Ca, Mg, Na. All these show that the soils are poor in fertility.
Even in the case of Histosols, the maximum value of total nitrogen is only 1.87%. Base saturation percentage of Histosols C III peat is comparatively high at 26.2% - 29.5%. But that of E II peat, displaying the effect of drainage, is extremely low at 4.95 - 8.47%.

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1): Soil Survey Staff: Soil Survey Manual, USDA Handbook No.18. Washington, D.C. (1951).

Table III-8 Mechanical and Chemical Analysis of Main Soils

| | | | Mechanical analysis | | | | | | | | | Chemical analysis | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coarse Sand % | Fine Sand % | Silt % | Clay % | Humus * % | pH $H_2O$ | pH KCℓ | pH Wet | pH Dry | Organic C % | Total N % | Exchangeable K m.e.% | Exchangeable Ca m.e.% | Exchangeable Mg m.e.% | Na m.e.% | C.E.C. m.e.% | Base Saturation * % | $SO_4$ % | Specific Conductivity μmho/cm | Loss on Ignition % |
| Gleysols | EI | 0∿12 | 21.8 | 20.0 | 22.6 | 25.0 | 6.24 | 3.7 | 3.1 | 2.5 | 3.7 | 3.62 | 0.37 | 0.12 | 1.20 | 0.50 | 0.12 | 24.38 | 7.96 | 0.22 | 440 | - |
| | | 12∿40 | 26.9 | 15.6 | 21.0 | 28.3 | 2.64 | 3.7 | 2.5 | 5.3 | 3.7 | 1.53 | 1.23 | 0.06 | 0.58 | 0.29 | 0.10 | 13.17 | 7.82 | 0.16 | 300 | - |
| | EIII | 0∿16 | 23.5 | 23.3 | 19.1 | 22.7 | 3.26 | 4.3 | 3.5 | 5.1 | 4.3 | 1.89 | 1.50 | 0.16 | 0.40 | 0.29 | 0.09 | 10.68 | 8.79 | 0.02 | 90 | - |
| | | 16∿70 | 38.1 | 23.6 | 24.5 | 10.0 | 0.71 | 4.5 | 2.6 | 2.3 | 4.5 | 0.41 | 0.06 | 0.06 | 0.23 | 0.03 | 0.07 | 13.43 | 2.90 | 0.23 | 90 | - |
| Histosols | EII | 0∿20 | 10.2 | 3.9 | 4.5 | 7.2 | 66.2 | 3.1 | 2.9 | 3.4 | 3.1 | 38.4 | 1.87 | 0.73 | 0.45 | 0.62 | 0.18 | 40.02 | 4.95 | 0.26 | 740 | 69.7 |
| | | 20∿35 | 0 | 22.4 | 4.0 | 7.8 | 64.5 | 3.5 | 3.2 | 3.8 | 3.5 | 37.4 | 1.00 | 0.19 | 1.16 | 3.26 | 0.25 | 55.14 | 8.47 | 0.08 | 260 | 62.3 |
| | CIII | 20∿100 | 0 | 0 | 2.0 | 6.9 | 73.3 | 2.6 | 3.0 | 2.0 | 2.6 | 42.5 | 0.38 | 0.53 | 1.11 | 2.67 | 0.27 | 17.47 | 26.2 | 0.73 | 1790 | 91.4 |
| | | 20∿100 | 0 | 0 | 4.7 | 5.0 | 91.4 | 2.7 | 3.0 | 4.7 | 3.0 | 53.0 | 1.80 | 0.53 | 1.23 | 4.34 | 0.33 | 21.77 | 29.5 | 0.12 | 1690 | 94.2 |

Note: 1. Results are expressed for oven-dried samples.
2. Original data were obtained from Miss I. Jogeswary.
3. Items marked * were calculated by the Japanese Survey Team.

C III peat is kept in constant wet conditions underneath the swamp forest. When the area is to be developed into farm land in the future, the base saturation percentage will drop rapidly.

Base saturation percentage of Gleysols is also 'extremely low' with a maximum value of only 8.79%. It is considered that without soil improvement to boost the base saturation percentage, it will be impossible to heighten fertility.

Total sulphur in Gleysols is 0.02 - 0.23% in terms of $SO_4$ while in Histosols it is 0.08 - 0.73%, thus there is a comparatively wide range in each soil. In each case, the soils are not considered to be acid-sulphate soils.

## 3.4 Dehydration and shrinkage of heavy clay soils and peats

Fig. III-2 shows the dehydrating and shrinking curves of Heavy Clay (E $II_3$ horizon) taken from E II profile (Histosols). Molded samples of 10 cm x 4.5 cm x 4.5 cm (202.5 $cm^3$) were made of heavy clays collected under field moisture conditions, and were air dried in the laboratory. The dehydration and shrinkage curves were obtained by measuring the changes in total weight W and total volume Vt.

Fig. III-3 shows the dehydration and shrinkage curves of 100 cc samples collected as cylindrical shapes of E I profile (Gleysols) taken from E $I_2$ horizon after measurement of the changes in total weight W and total volume Vt by being kept in an air dried condition in the laboratory. The changes in total volume were calculated as follows:

Cross sectional diameter of cylindrical sample = D;
the height of cylindrical = H, thus $Vt = \pi/4.D^2H$.

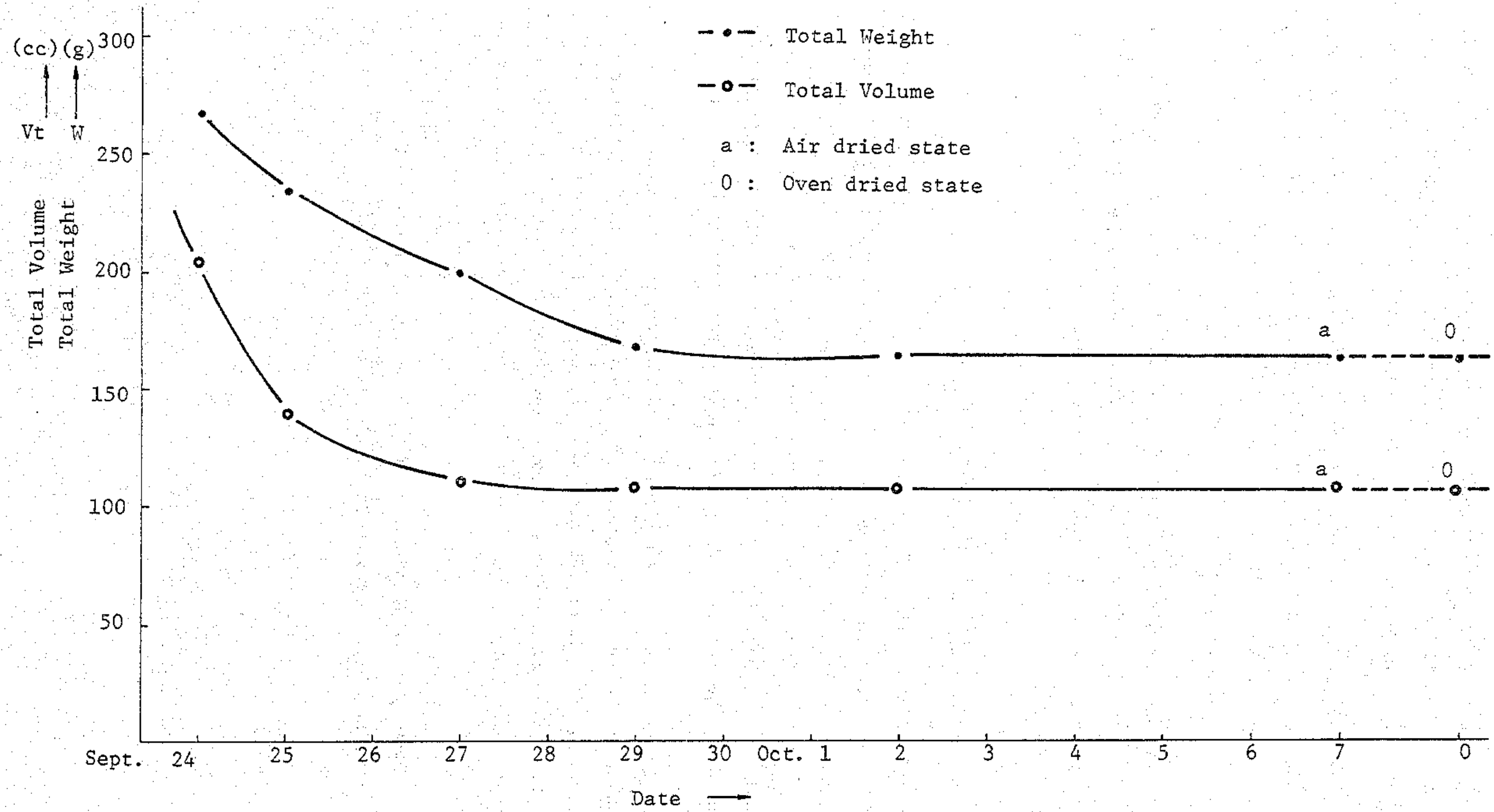



Fig. III - 2 Dehydration and Shrinkage of Heavy Clay Soil ($EII_3$)
(measured on molded sample (10 cm x 4.5 cm x 4.5 cm))

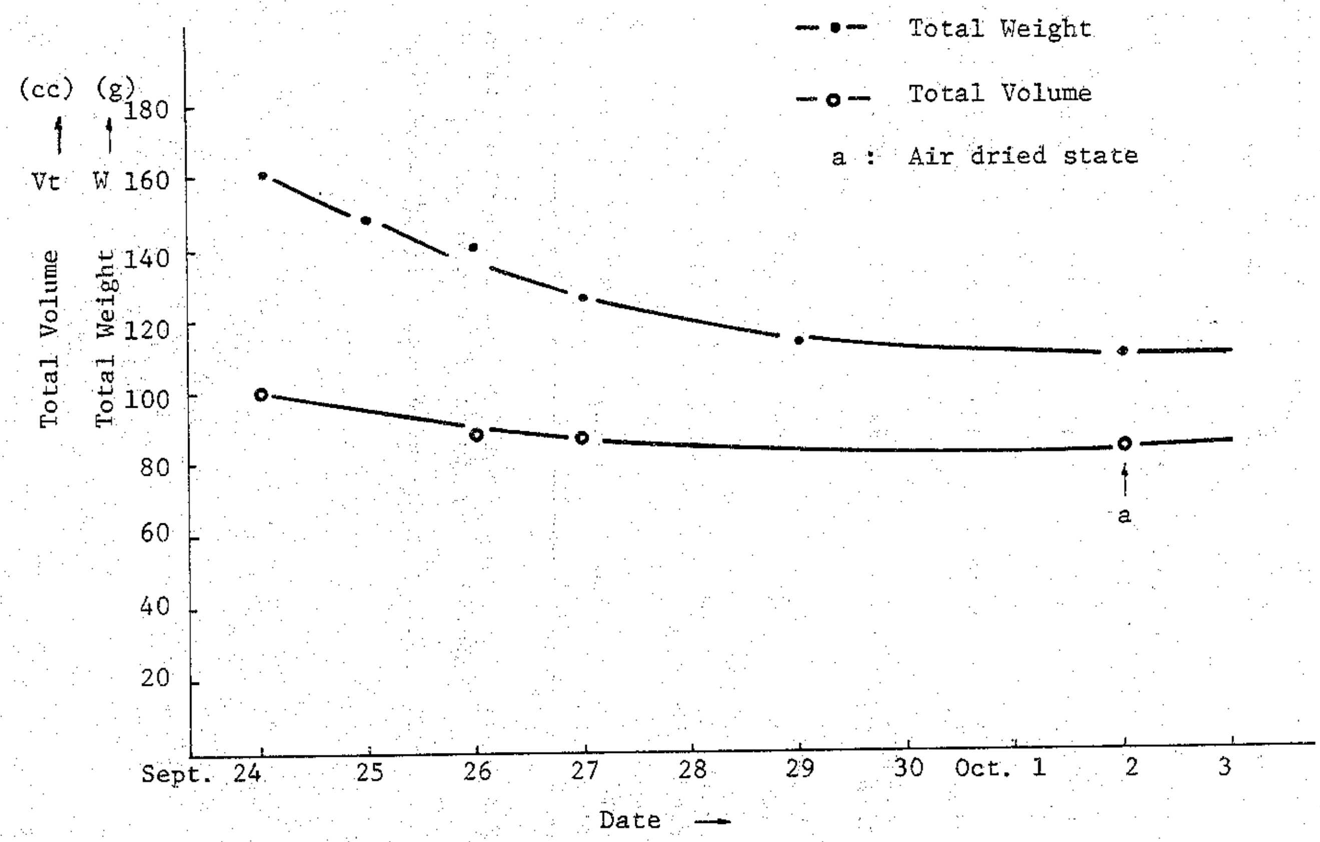



Fig. III - 3 Dehydration and Shrinkage of Heavy Clay Soil ($EI_2$)

(measured on 100 cc samples)

Table III-9 Dehydration and Shrinkage of Heavy Clay Soil

| Condition \ Soils | $EII_3$ Molded | $EII_3$ Air dried* | $EII_3$ Wet | $EI_2$ Wet | $EI_1$ Wet |
|---|---|---|---|---|---|
| Total Weight, Wet(g) WwV | 264.0 | 235.1 | 146.5 | 161.9 | 132.4 |
| Total Volume, Wet(cc) Vt,w | 202.5 | 147.3 | 100.0 | 100.0 | 100.0 |
| Total Weight, Air dried Wa | 161.0 | 139.1 | 83.5 | 110.4 | 85.4 |
| Total Volume, Air dried Vt,a | 104.0 | 100.0 | 66.2 | 84.3 | 85.9 |
| Total Weight, Oven dried Wo | 156.3 | 129.5 | 80.6 | 108.1 | 82.8 |
| Total Volume, Oven dried Vt,o | 63.5 | 48.3 | 32.7 | 44.3 | 35.3 |
| Dehydration %, Air dried Da | 39.0 | 40.8 | 43.0 | 31.8 | 35.4 |
| Shrinkage %, Air dried Sa | 48.6 | 32.1 | 33.8 | 15.7 | 14.1 |

Note: 1. EII profile belongs to the Histosols and EI profile belongs to the Gleysols.

2. Indicates air dried under field conditions.

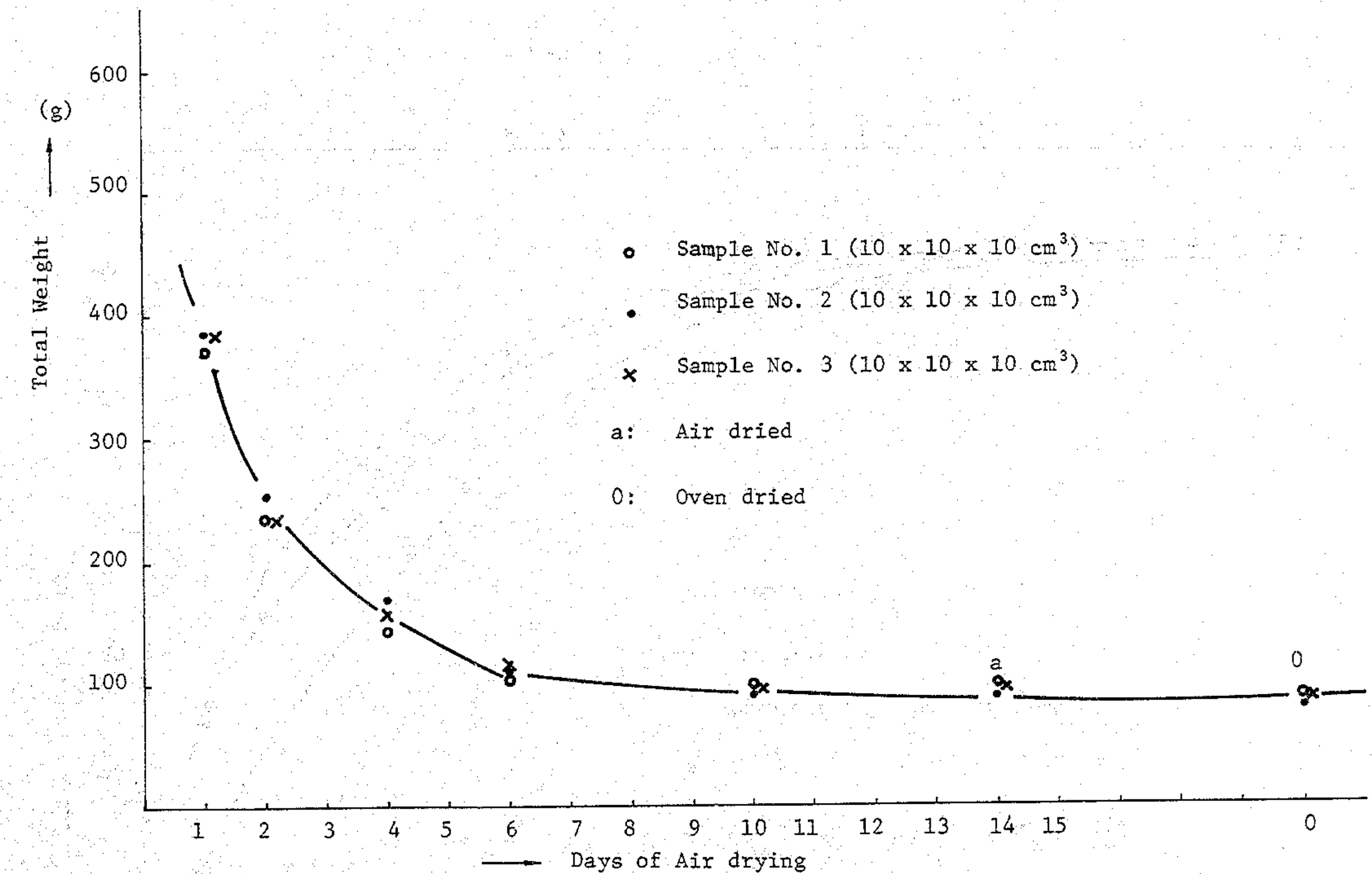



Fig. III - 4 Dehydration of Peat 1 (EII1)

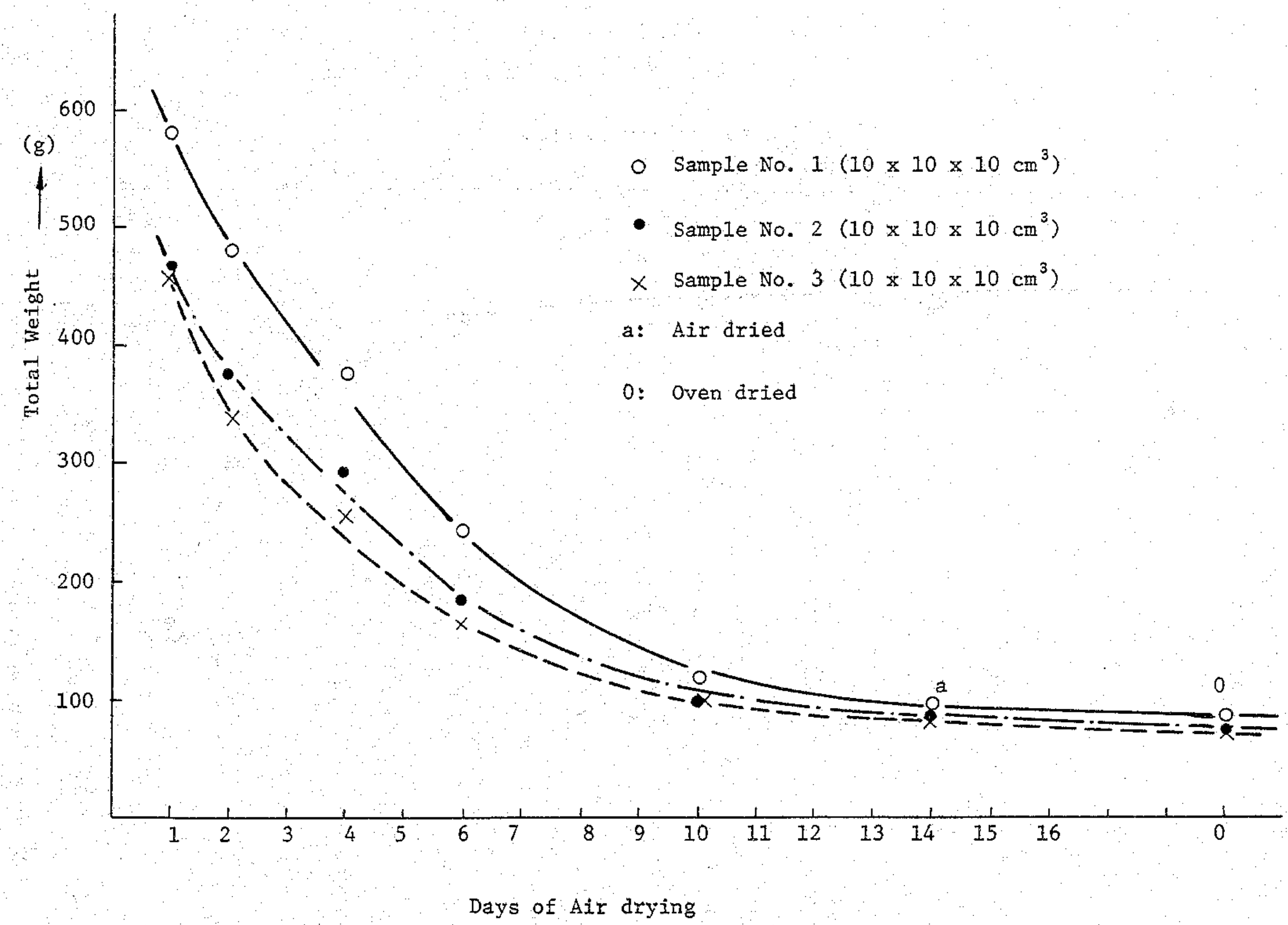



Fig. III - 5 Dehydration of Peat 2 (EII₂)

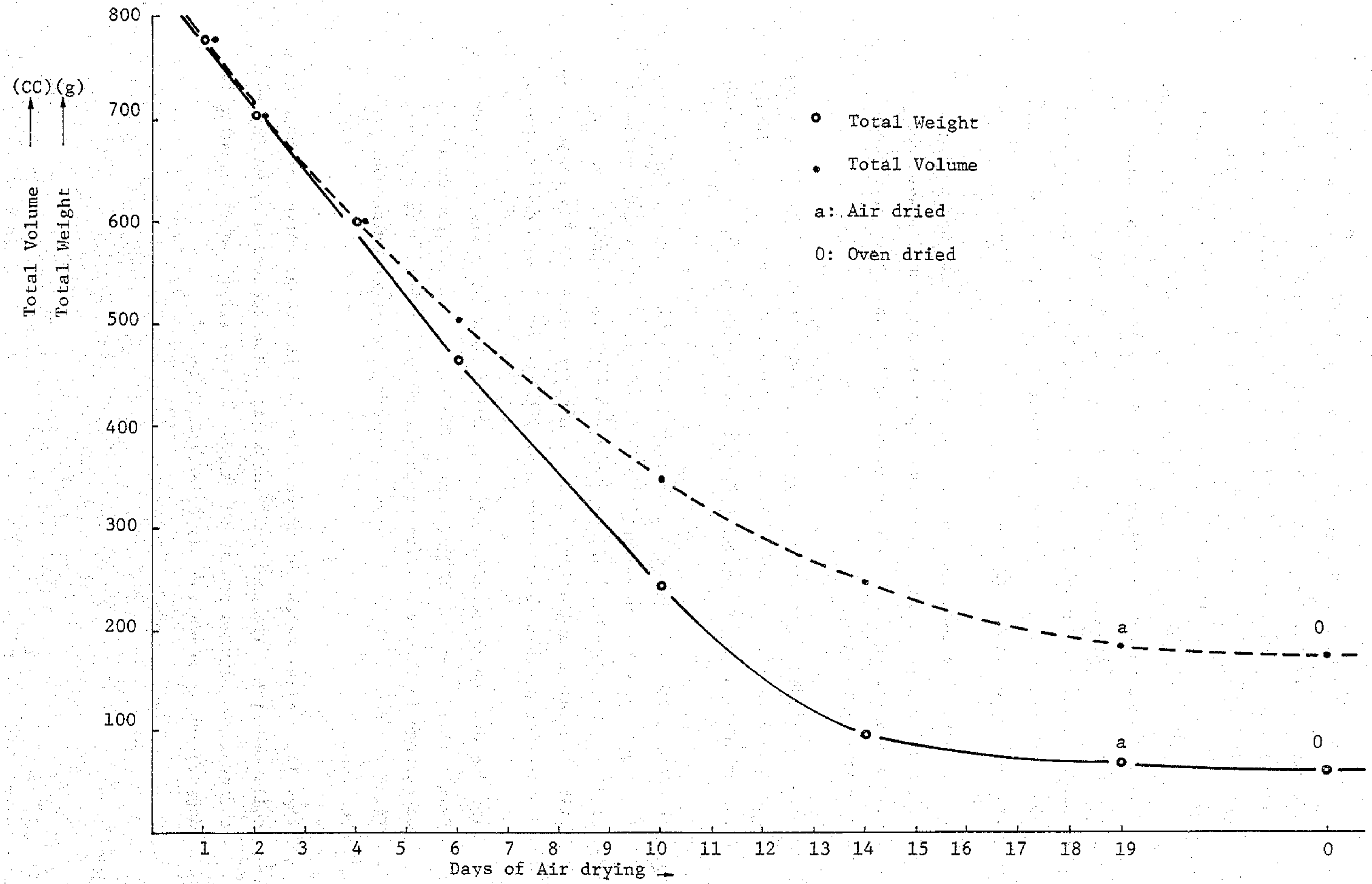



Fig. III - 6 Dehydration and Shrinkage of Peat 3 (C III drained)

Table III-9 shows the dehydration percentage Da (weight basis) and shrinkage percentage Sa (volume basis) of samples E $II_3$ air-dried (left for air drying in the field after drying out by construction of drainage canals), E $II_3$ wet (collected in 100 cc cylindrical containers from the E $II_3$ horizon of the E II profile) and E I-and E $I_2$ wet (collected in 100 cc cylindrical containers from the E I-and E $I_2$ horizons which are the surface and subsurface soils of the E I profile). The changes in total volume and total weight of the samples until they reached on the air-dried condition were measured. Also the total weight Wo and total volume Vt,o of all samples in the oven dried condition are shown.

E $II_3$ Heavy Clay that does not have a drainage record has a larger dehydration percentage and shrinkage percentage than E I soil does with a drainage record. The shrinkage percentage especially shows a marked difference.

Figs. III-4 and 5 show the dehydration curves of Peat I (E $II_1$ horizon) and Peat 2 (E $II_2$ horizon) taken from E II profile (Histosols) during the transition to an air-dried condition or oven dried state from the wet stage.

Three specimens of 10cm x 10cm x 10cm (=1,000 $cm^3$) were collected from the layers of each outdoor profile and were left in the laboratory to air-dry, then they were dried in an oven (80°C). Attempts made to track the volume and weight ratio were not successful. Therefore, the dehydrating process examined on a weight basis only is reported here.

The dehydration percentage under air dried conditions was 75.3% for Peat 1 (E $II_1$) and 82.3% for Peat 2 (E $II_2$). Also the dehydration percentage in the oven dried state was 77.5% for Peat 1 (E $II_1$) and 84.3% for Peat 2 (E $II_2$). Thus no marked difference exists between the two.

Fig. III-6 illustrates the dehydration and shrinkage curves of samples collected from C III profile (Histosols). The reduction of weight and shrinkage of samples proceeded rapidly in the first two weeks owing to dehydration to reach the air dried condition.

In the first four days, the dehydration volume (fall in weight) and shrinkage volume (reduction of volume) changed slowly and were equal. But thereafter, the dehydration volume change was greater than the shrinkage volume. In other words, the air ratio of the peat gradually increased.

The dehydration percentage in the air dried condition is 90.4% while the shrinkage percentage is 75.6%. The dehydration percentage in the oven dried state is 91.9% while the shrinkage percentage is 77.6%. As the results show, attention must be paid to the large dehydration percentage and shrinkage percentage of peat when executing development work.

## 4. Soil Improvement

### 4.1 General

As the swamp areas have extremely poor drainage and are submerged in many places, their utilization calls for the following three steps which need to be taken before any others for the purpose of soil improvement.

a. Completion of drainage facilities for drainage of all swamps

b. Addition of soil improvement materials such as precipitated carbonate, phosphate, etc. suitable for proposed crops.

c. Soil reversing and dressing of soil after draining and drying where necessary

The depth of drainage canals in peat soil areas should be determined with due consideration of the possible settlement of ground surfaces due to the soil shrinkage which could occur with the drainage, drying up and decomposition of organic substances. If mechanized farming is to be introduced, the bearing capacity of the ground surfaces should be examined carefully and stumps and other obstacles should be removed to permit smooth operation of farm machinery.

Countermeasures for soil improvement for the soil series classified in the Pilot Project area are given below. These countermeasures have been prepared on the basis of our field survey.

## 4.2 Gleysols

Soils of heavy clay (Gleysols) derived from recent alluvium have the characteristic that the values of both the solid ratio and the volume weight increase in parallel with drying by drainage through drainage networks. Therefore, softening and increasing the porosity of the soil must be attempted by reversing with organic substances. Lowering soil solids to a 35 - 40% ratio will be easier to achieve with such reversing. As one effective way utilization of farm machinery or plowing by buffaloes for grass cultivation is to be considered. These types of soils are severely leached, therefore plant nutrion elements including both N, P and K, and minor elements are lacking. The pH value (KCl) of the soil is 4.0 - 4.7, and both the exchangeable calcium and the available phosphate are scarce. Further, the phosphate absorption coefficient is normal to slightly high. In view of this situation, it is judged that soil improvement materials, in addition to calcium and phosphate materials, such as minor elements like Cu, Mg, Zn, Mo, B, etc. should be applied. After such improvement adequate conditions for upland crop cultivation will be achieved.

In areas where the layer of peat extends below 1.0 m, if the heavy clay of the lower layers is reversed with peat immediately after initial subsidence, and the soil improvement measures described above are effectively promoted, utilization of the land as upland will become possible.

## 4.3 Histosols

In areas where the layer of peat reaches 1.0 - 2.0 m below the ground surface, if deep plowing immediately after initial subsidence or within 1 - 2 years of the first deep plowing, in which the heavy clay taken from the deep layer in deep plowing during the early draining stage is reversed, and the soil improvement described in 4.2 above

are effectively conducted, the soil will become suitable for upland crop cultivation. However, for deep plowing large and medium types of farm machinery will be needed.
Even without deep plowing or reversing, peat soil might be useful for upland crop cultivation as an arable soil.
However, higher yields should not be expected.

In areas where the layer of peat is deeper than 2m, the effect obtainable from reversing with heavy clay, even immediately after the initial subsidence of peat will not be satisfactory. In this case, subsidence might reach 1 m per year. Dressing with mineral soils obtained from outside the Pilot Project area would be costly.
In constructing drainage canals and irrigation canals, a large amount of heavy clay soil would be excavated from the lower layers, however, this amount would not be sufficient for dressing the land.

In these areas, therefore the peat soils will be utilized as they are. The porosity value of the soil is very high at about 93%, its water holding capacity is also high. Even if a quantity equal to the gravitational water were drained, the soil would hold water equal to 12 - 15 times its weight. Since the speed of drainage from the peat layer is not so high in spite of the high porosity value, the spacing of open ditching should not be widened much. It is reported that a spacing of 30 - 40 m would be suitable.

According to our field chemical analysis, the pH value (KCl) of the soil is 3.8 under air-dried conditions, and that of the water collected in the field is around 4.0. Given these not-so-desirable analytical results for the soil, the application of calcium and phosphate materials including minor nutrition elements is needed.

P.M. Drissen (1977) says that soil improvement will be achieved by application of the following doses of materials.

Calcium materials

In the initial stage, ground magnesium limestone is to be applied at 8 - 10 tons/ha, followed by an annual application of 1 ton/ha.

Minor nutrition elements

15 kg each of copper sulphate, magnesium sulphate, and zinc sulphate, and 7 kg of manganese sulphate, 0.5 kg each of sodium molybdate and borax are to be applied per ha.

Regarding N, P and K, 50 - 130 kg of N, 30 - 70 kg of $P_2O_5$ and 60 - 100 kg of $K_2O$ and recommended as adjustable quantities.

## 4.4 Lime requirement

Analytical results for the buffer curves, by Miss I. Jogeswary are shown in Figs. III-7 and 8, giving the representative profiles E I and C III of each Gleysol and Histosol. From the buffer curves, the lime requirements can be derived as follows[1]:

$$q = 25\ M\ (kg,\ CaCO_3/ha)$$

This equation was obtained by setting the depth of soil to be improved at 15 - 17 cm and the soil volume (dried soil) at 2,500,000 kg. In this case, the value of the buffer curve on the absicissa corresponds to the attained pH (improvement target) after application of lime ($CaCO_3$) in M mg.

Accordingly, for mineral soils like Acrisols, the equation can be used without modification to give a close estimate. However, in the case of Humic Gleysols or Histosols, despite modifications, the equation gives considerable error.

For example, applying the values from Fig. III-7 and Table III-6 when attempting to improve the pH value of 15 cm of a surface layer of E I soil (Humic Gleysols to an intermediate pH value (6.0) between 'medium acidic' and 'slightly acidic':

$$q = 13.3 \times 50 = 665\ (kg.\ CaCO_3/ha)$$

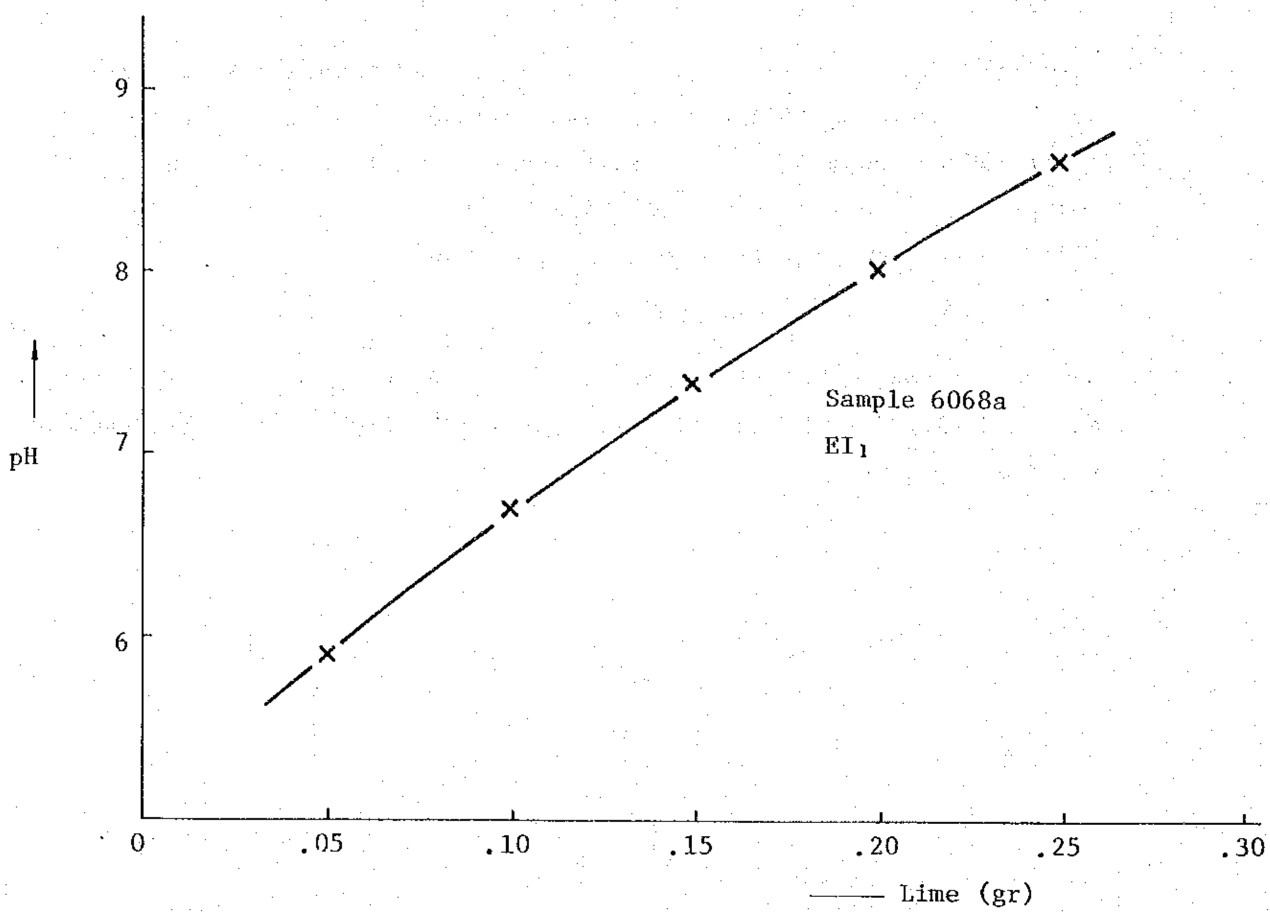
Where; M = 50 (between the E $I_1$ and E $I_2$ values) E $I_1$ horizon is 12 cm E $I_2$ horizon is 3 cm (= 15 - 12) the previous coefficient of 25 is replaced by 13.3.

1): FAO of the United Nations: Physical and Chemical Methods of Soil and Water Analysis, Soils Bull. No. 10, 172-173 (1970).

Similarly, in the case of Histosols C III, assuming that the volume weight of improved soil for farm land with an effective drainage of 12 gr/100 cc and thickness of soil layer to be improved is 20 cm, the volume of peat per 1 ha will be 240,000 kg.
The M value from Fig. III-8 will be 250, thus:

$$q = 2.4 \times 250 = 600 \text{ (kg. } CaCO_3\text{)}$$

Neutralization in the field is less effective than in the laboratory, and a "field factor" (usually 2 or 3) is normally used in calculating the field dressing.



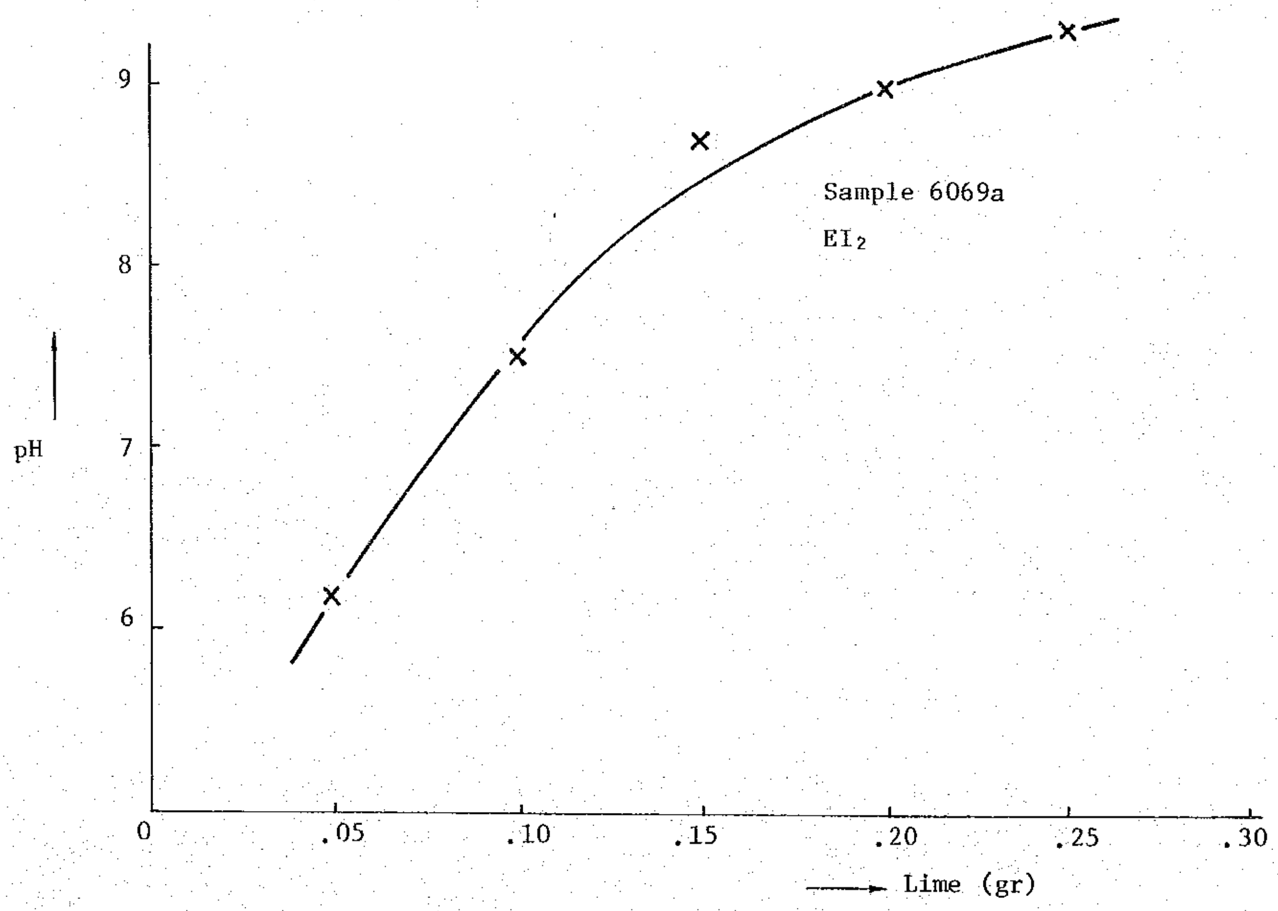




Fig. III - 7 Buffer Curves of EI Soils (Humic Gleysols)

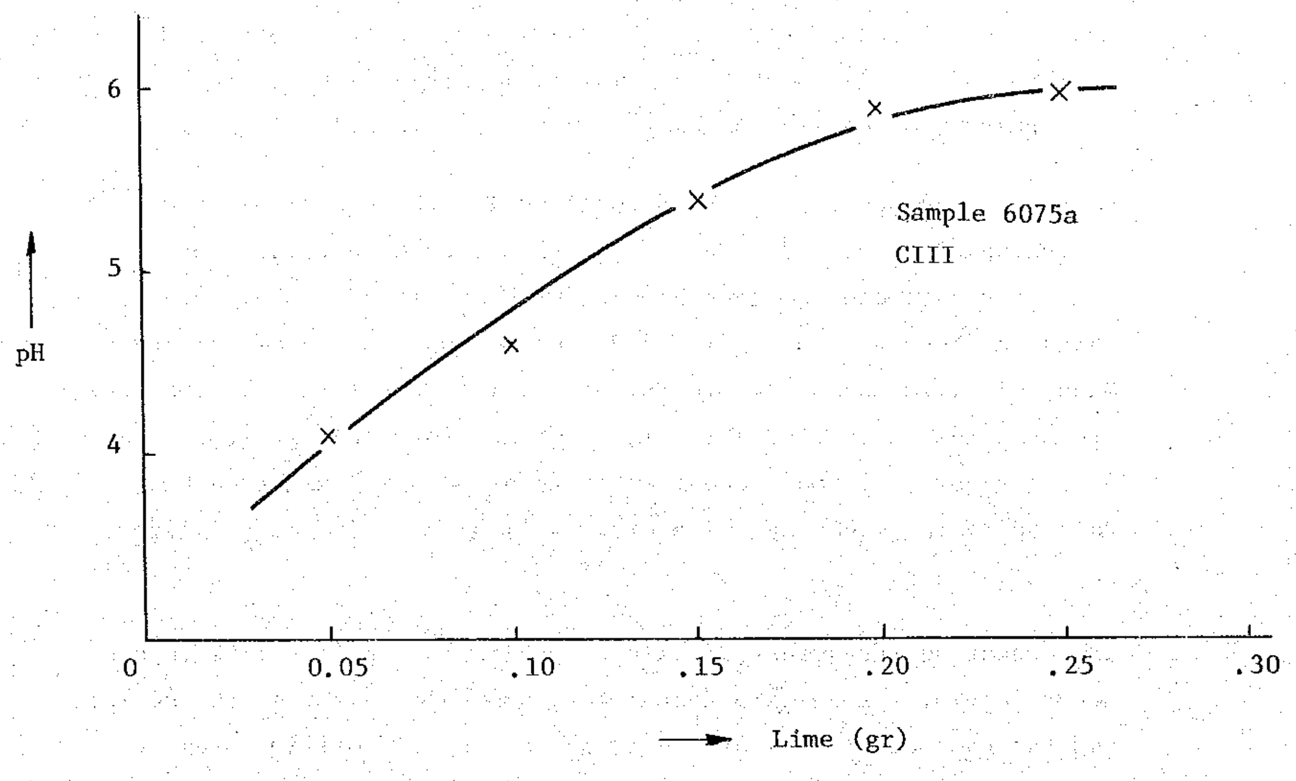



Fig. III - 8 Buffer Curve of CIII Peat (Dystric Histosols)

### 4.5 Acrisols

Soils belonging to Acrisols which occupy the western hilly area, and the eastern and northern area with a gentle slope are most naturally suitable for farm land. However, attention must be paid to the erosion which will result from the deforestation of the tropical forest. If facilities like drainage ditches are installed, and/or contour strip cultivation is used, even land with slops of 8° - 12°, and 12° - 15° can be effectively utilized as better grass land. Moreover in utilizing such land for fruit trees, rubber, or oil palm plantations, a covering grass crop like pasture will be necessary.

Land with a slope of 3° - 8° as well as land with a slope of 0° - 3° is suitable for upland. However, application of a great amount of organic substances and deep plowing will be needed. pH values of soils in these areas is 4.1 - 5.2 (KCl). Application of calcium materials like carbonate precipitate will be needed due to the lack of exchangeable calcium which is necessary for plant growth. A target for soil improvement in terms of pH value might be 6.0; this being the boundary value between 'medium acidic' and 'slightly acidic'.

The amount and frequency of calcium materials application should be determined by taking into acount the chemical quality of the soils and the characteristics of the proposed crops. Soil improvement must be conducted by continuous calcium materials application over 2 - 3 years in the initial stage rather than one application in the initial stage. It must be also noted that phosphate application is necessary for soil improvement due to the lack of effective phosphate and the high value of the phosphate absorption coefficient.

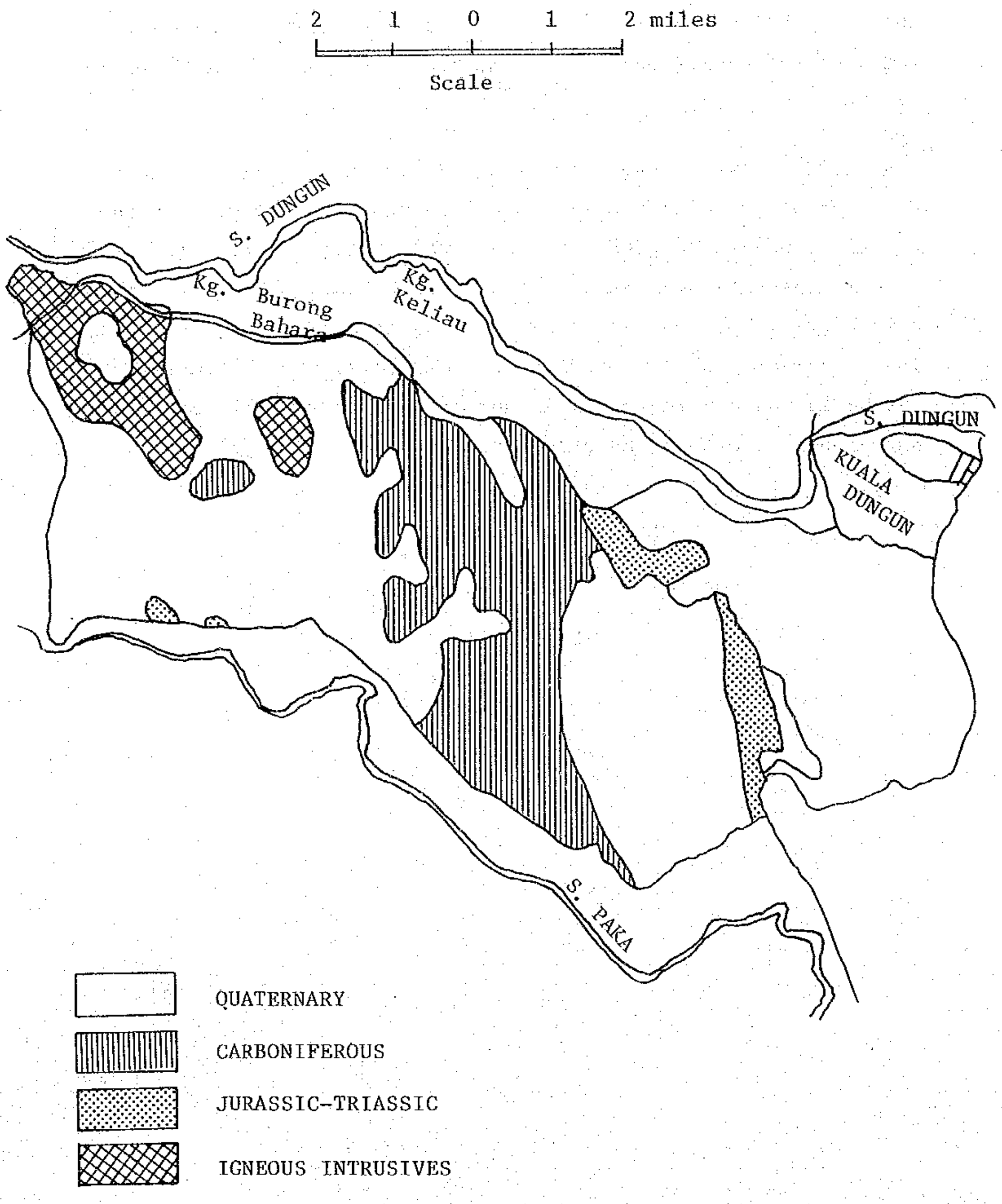
## B. Geology

A good portion of the Pilot Project area (2,830 ha) is covered with alluvial deposits (1,900 ha, 67.1%) which formed during the Quaternary Era. The alluvial deposits are composed mainly of Recent Riverine Alluvium (400 ha, 14.1%) and Woody Swamp Peat (1,500 ha, 53.0%). The thickest peat deposition measures about 5 meters.

The peripheral hilly area that surrounds the Inland Swamp of the Quaternary Era is 950 ha, accounting for 32.9 % of the total area. The geology of the hilly area on the west is composed of arenaceous rocks and argillaceous beds of the Carboniferous System, while the hilly area on the east and on the north is composed of sedimentary rocks (sandstone, silt stone, shale) of the Jurassic-Triassic System.

Fig. III-9 shows the geology of the Pilot Project area. The deposition of the Inland Swamp is considered to be composed mainly of the alluvium of the Paka river and Swamp Peat, and to some extent of efflorescence such as sandstone, silt stone, shale, etc. from the neighbouring hilly areas. The surrounding hilly area is comparatively low in height with low gradients. Therefore, the instructive from the hills was considered small and not enough to fill up the swamp but enough to prompt the growth of swamp peat.

Fig. III - 9 Geology of Bukit Bauk Area




Source; Semi-Detailed Soil Survey of Bukit Bauk Area; prepared by Ministry of Agriculture, Malaysia, June 1976

## C. Peat Soil in Tropical and Subtropical Zones

The sediments resulting from incompletely decomposed plant remains which make up an organic soil defined as peat containing plant organisms are widely distributed not only in the temperate zone but also in the tropical rain forests in Southeast Asia, America and Africa. It is only in recent years that the peat zone has begun to be converted into farmland in the southeastern Asian countries high in population density. The atmospheric temperature and the plants in the northern area of the temperate zone are quite different from those in the humid tropical zone, while both areas have peats of a character common to each other in many respects.

According to Dudal & Moormann, there is an organic soil layer as thick as 15 m at the east coast of Sumatra, although the organic soil layers in Southeast Asia are 1.5 to 5 m thick on an average. In addition to Sumatra in Indonesia, peat areas are distributed in the west and south coastal areas of Borneo, coastal areas of Sarawak to the north thereof, Brunei, Saba, the east and west coast of Malaysia, Sri Lanka, the southern part of Vietnam and northern parts of the Philippines.

In West Malaysia, the peat zone has an area of 460,000 ha and accounts for 3.5% of the total land of the country. All the large-scale peat areas are concentrated in the coastal lowlands.
According to Anderson, for example, it was about 5,400 years ago that the postglacial transgression reached the present sea level at the Sarawak-Brunei coasts. At that time, the sea covered up to the inland edge of the present peat zone. Subsequently, the bay was rapidly filled up, and the bay inlet was closed by spit or delta. As a result, the seawater in the area inside thereof was desalinized. The peat then began to be deposited about 4,000 years ago.

The age determination by $C^{14}$ of the 12m-peat layer in Sarawak shows that the specimen taken at the depth of 5 m is 2,255 $\pm$ 60 years old, the specimen taken from 10m deep is 3,850 $\pm$ 55 years old, and the specimen taken from 12 m deep is 4,270 $\pm$ 70 years old, and that the thickness of the deposits forward for 100 years is 22.2 cm for the upper part, 31.4 cm for the middle part, and 47.7 cm for the lower part.

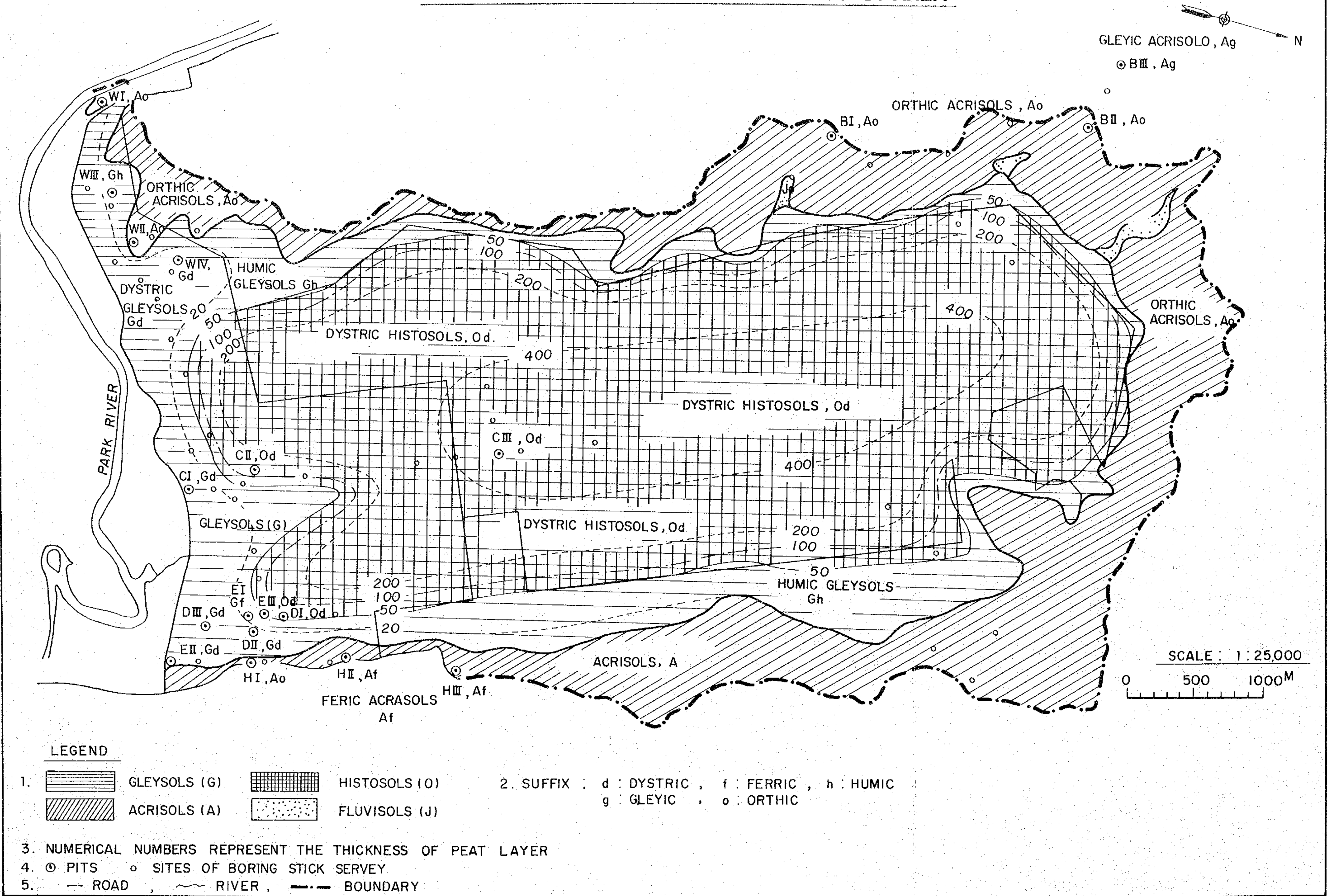
This has a reverse relation with the peat areas in temperate zones which were deposited at an average rate of 0.6 to 1 mm per year. This figure is very small due to compression of the lower part while it is comparatively larger for the upper part.
However, this fact does not completely account for the fact that the peat in the tropical zone grows more rapidly than that in the temperate zone, because many peat areas are only as deep as less than 5 m, and peat deeper than that, if any, is considered to have been carried in from other areas.

Making up the peat zone are the remains of plants and trees grown in freshwater swamps and these are quite different from those grown in the temperate zone. In the tropical zone, a great number of trees 30 to 50 cm in diameter lay one on another to make up a peat layer. It is dark inside the forests even in the daytime, and the forest floor is saturated with water. Water stays at some parts. Because of the great rainfall, the rainwater in the peat area is not discharged outside easily, and thus it provides a kind of means for holding rainwater, with the result that a peat area higher in level than the neighbouring waters is formed. The profile of the peat zone shows a formation worthy of the name "a raised bog".

If the water is drained and the land is cultivated, the trunks and leaves of trees suddenly lose their shape and are reduced to brown powdered soils. The comparatively shallow part of the Malaysian peat zone or the part thereof comparatively easy to drain water from has been utilized as a farmland for a considerably long time for growing such plants as pine-apple, coffee, oil palm, paddy rice and some kinds of vegetables, the most important of which is pineapple. Rubber trees, a major Malaysian agricultural product, are planted in every cultivable land area.

The rubber trees are not suitable for the peat zone, since they prefer well-drained conditions and if planted in wet ground, not only grow insufficiently but also fall before their roots penetrate deep into the soils. The pineapple, which may be planted also in mineral soils, is planted only in the peat zone as a national policy. Nevertheless, the pineapple grows well also in the peat zone. However, probably because of excessive nitrogen, the pineapple fruits in the peat zone grow too large in oval shape. If they are canned in sliced form, there is too much waste and therefore they are canned as cubes, which is disadvantageous in terms of the sales price.

# SOIL MAP OF THE BUKIT BAUK PILOT PROJECT AREA



# IV. AGRICULTURE

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CONTENTS

## A. Proposed Agriculture

### Basic Concept

Improvement of soil condition and its agricultural utilization in the Pilot Project area are described in detail in "6. Geology and Soil", A. Location and Natural Features, III. THE PROJECT AREA, and in "2. Soil Improvement", D. Land Reclamation, IV. THE PROJECT respectively. However, the basic concepts concerning the selection of crops to be cultivated and the methods of agricultural production will be described again in this section.

1) Rice: The production of paddy-field rice in the swamp area should be realized without toil when compared with other crops, and rice would serve as a self-sufficient staple food for the settlers. Surplus rice can become a cash crop. (Although the nation does not require additional rice production, if the swamp area can burden a part of the nation's rice production, paddy fields in other areas blessed with favorable farming conditions can produce other necessary crops. However, in this case, the paddy fields will have to be converted to upland fields. We consider this proposal worthy of consideration.)

2) Soybean, groundnut and tamato:
These are considered high earning cash crops when viewed from both natural and economic conditions. The cultivation of luguminous crops (Leguminosae) is especially expected effective as the soil fertility of newly developed agricultural land will be boosted by air nitrogen fixing bacteria.

3) Pepper: Pepper should be cultivated on the sandy clay soil of good soil condition forming the western hill area of the Pilot Project area as a long lasting cash product. When viewing from the standpoint of both land productivity and labor productivity, pepper is highly profitable than any other products.

4) Pasturage: Population increase and improved dietary life will inevitably boost demand for meat in the future. To cope with this situation, a part of the northeastern hilly area unfit for agricultural cultivation and a part of the swamp should be converted to pasture lands. The cattle will be put to graze to save labor, and they can also be expected to become an important source of organic fertilizer to realize rich farming.

Here are some points that require serious consideration prior to actual cultivation.

(1) As soil erosion at slopy area is terrible, measures to prevent further soil erosion is indispensible. This is especially true of hill areas to be converted to grass lands, and also of pepper plantation where contour cropping or cover cropping should be utilized.

(2) The heavy clay soil of the recent riverine alluvium forming the level area is increasing in soil solid ratio and volume weight by drying. Therefore, it is necessary to expand soil by applying organic matters. Also as leaching or micronutrients and fertilizers is large, replenishment is indispensible by administering organic fertilizers (compost, stable manure). (As there is a possibility of damage by reduction, verified items should be used.)

(3) It is widely known fact that agricultural chemicals afflict the human body. Therefore, it is necessary to have a thorough knowledge of all chemicals that cause harm to man. If possible, the use of agricultural chemicals should be limited to the minimum. Although there were mentioning of the use of agricultural chemicals, it is emphasized here that their use is not highly recommended.

B. Number of Farmers and Farm Income

The population of the State of Trengganu is almost 100% Malay. So by dividing the state population by the average number of persons per family Peninsular Malaysia Malay households (which is 5.3 persons), the number of families in 1970 would have been around 79,000 to 80,000. Then multiplying this figure by the growth rate for the 5 years up to 1975, the number of families is estimated to be 90,000 to 92,000.

The number of small farming households in 1970 was 40,258. If the proportion of small farming households out of the total farming households in Peninsular Malaysia is assumed to be much the same in the State of Trengganu as well, the total number of farming households (including fishing households) will be approximately 63,000. If this estimate is accurate, it means that some 80% of all families in the state are farming households. Then multiplying this total by the population growth rate for the 5 years to 1975, the total number of farming households in 1975 is estimated to have been about 72,000.

According to statistics for 1970, the proportion of low income Malays in Peninsular Malaysia is 82%, and 98% of these are small farming households. This means that practically all farming households, especially in the State of Trengganu, belong to the low income bracket. This tendency is even more noticeable among rice farmers.

In the Besut district of the State of Trengganu, there is an average of 5.3 persons per family in rice farming households, with 2.3 persons being engaged in farm work. The average amount of farm ground is 6.5 acres, consisting of 3.2 acres for paddy, 1.6 acres for rubber plantations, 0.9 acres for gardening, and 0.2 accres for coconut groves.

Annual income per household ranges from M$894 to M$1,373, averaging around M$1,030. This is some 20% lower than the mean monthly income of M$110 (M$1,320 per annum) in Peninsular Malaysia. This M$1,030 breaks down to M$513 (50%) as farming income, M$461 (45%) as non-farming income, and M$56 (5%) in the form of presents and gifts.

82% of all rice farming households earn an average of 45% per household by working as hired help. The income level of Trengganu farmers, particularly rice farmers, is one of the lowest in Peninsular Malaysia, and many depend on the "non-farming" income. However, chances of being hired are slim, resulting in quite a number of idle farmers.

C. Working Population

Although there was insufficient data for accurate estimates, figures based on the 1970 national statistics put the number of able bodied persons between the ages of 15 and 64 at 207,000 (102,000 males and 105,000 females). So by estimating the labor work force at about 70% of this, the number would be around 145,000 to 150,000 persons. However, the working population in 1970 was 137,000 persons, thereby indicating that the remaining 8,000 to 13,000 persons were apparently unemployed.

Approximately 49% of the working population was engaged in farm work, approximately 8% in fisheries, and approximately 1% in forestry. This means that some 68% were engaged in primary industry, a figure considerably higher than the national average of 54%. The income per person working in a primary industry, however, was lower than the national average for the same kind of work.

In 1969, the most common form of industry in the State of Trengganu was rice polishing. 155 persons were employed in 199 rice mills, the reason for the low number of employees being that many factories were completely run on a family basis. Other industries included lumber (with 29 saw mills employing 937 persons), textile knitting (knitting mills employing 300 persons), veneer board (3 factories employing 250 persons), and batik (40 factories employing 250 persons).

## D. General Living Standard

According to the Third Malaysia Plan, the number of persons per doctor in the State of Trengganu in 1975 was 10,063 (national average 4,344). The number of pupils per teacher was 32.1 (national average 30.8), the number of persons per hospital bed 694, while the number per village health center was 3,585. Although the figure for village health facilities is high in comparison to the national average, the number of doctors was low. The figures for vehicular ownership - 1.2 motor cars and 3.1 motor bikes per 100 persons - were the lowest of all states.

## E. Proposed Cultivation Method by Crop

### 1. Paddy

According to MARDI, improved Mashuri, Bahagia and SM-II are promoted as high-yielding varieties. Improved Mashuri yields 4 tons/ha on the average. Bahagia 5 tons/ha, and SM-II 3.8 to 4.5 tons/ha. Considering the tolerance to blast disease, these varieties are warrantable.

While the direct seeding on dry paddy fields may be reasonable from the viewpoint of labor economy, the transplantation still is a safe way and can dispense with the application of herbicides otherwise needed. If the double-cropping is to be carried out, the fallow period leaves little margin, and the transplantation, harvesting and land preparation should be mechanized.

With regard to preparations for plantation, and application of fertilizers, stubs, weeds and compost should be plowed in, and the clod breaking should be carried out as carefully as possible. The workmanship of puddling and leveling has a direct bearing on the quality of plantation. The surface of the field should be a little harder than in the case of manual planting, for the purpose of preventing the seedlings coming loose and afloat. To this end, it is recommended to keep the field submerged after puddling and leveling and then drain or carry out pubbling, 3 to 4 days before transplantation.

The fertiliser required will consist of N by 50 to 70 kg/ha, $P_2O_5$ by 30 to 50 kg/ha, and $K_2O$ by 10 to 30kg/ha.
In the mechanized transplanting, seedlings get rooted shallow, grow well putting forth tillers vigorously, and thus are liable to fall. For this reason, nitrogen-base fertilizer should not be used much. Of the fertilizer components referred to above, a half of N, four-fifth of $P_2O_5$ and four-fifths of $K_2O$ should be applied as a starter before transplantation, and the remainder as a top dressing or ear manuring in the reduct-division stage, that is, some ten days before the head sprouting period.

The fertilizer should be spread uniformly by hand. For the purpose of saving labor, collective seeding and nursery is recommended. The husbandry of seedlings for mechanized transplantation calls for some skill, and should be carried out under the guidance of extension workers.

In case seedlings with four to five leaves are to be nursed in a shallow perforated box measuring 60 cm by 30 cm, by 30 cm deep, 150 to 170 g of paddy for nursery will be needed per box. In this case, 24 to 30 boxes will be necessary per hectare of rice paddy. It is of great importance to rear up the seedlings to a uniform size and at a uniform density.

In the transplantation, the water depth should be limited to about 1 cm for the purpose of improving the working efficiency and obviating the drifting of seedlings. Twenty to twenty-five seedlings with four to five leaves each should be transplanted per $m^2$. Three to four seedlings should preferably be clumped as a group and planted as a depth of 3 to 4 cm.

The irrigation water should be husbanded to have a depth of about 3 cm immediately after transplantation. The water depth should then be increased little by little with the growth of the seedlings. The paddy field should be topped up to a depth of 5 to 10 cm until the latter phase of the productive tillering stage which will occur some 30 days after transplantation.

Then, during a period of about 12 days up until the yound panicle formation period, the mid-summer drainage should be carried out. This is to be followed by a submersion for something like 20 to 30 days until the end of the head sprouting period. Never run the water short. In the ripening period of some 20 days to come thereafter, intermittent irrigation is to be carried out. Then, the 10 to 15-day period just preceding the harvesting should be dried up.

Use of herbicides should be withheld, or limited to a minimum if unavoidable. Instead, a rotary weeder of 'keri' (Malaysian local tool) should be used for their proven working efficiency. If sufficient labor is not available for weeding, granular chemicals as represented by 2,4-D and PCP will be effective. Recommended pest control procedures are as follows:

To provide against blast disease, it will be effective to apply Kasumin Dust at a rate of 30 kg/ha when it is windless. In order to exterminate rice stem borers and blast disease simultaneously, an application of 40 kg of Kasuthion Dust per ha will tell.

For the rice crop, the harvesting and transplantation will be carried out mechanically as such jobs call for much labor. This is because the cows will be too inefficient to complete the jobs in time for the succeeding crop and also because hands necessary for the manual transplanting of all the paddy crops in about a month are hard to come by.

Proposed in the following is a farming calendar.

(1) Monsoon season paddy

| | |
|---|---|
| Land, preparations, seeding, and starter fertiliser application | End of August to Mid-October |
| Transplanting | End of September to end of October |
| Application of herbicides | Mid-October to Mid-November |
| Top dressing | Mid-November to Mid-December |
| Application of fungicides and insecticides | Mid-October to early January |
| Weeding | Mid-October to end of January |
| Harvesting | Mid-January to end of February |

(2) Off-season paddy

| | |
|---|---|
| Land preparation, sowing, and basic fertiliser application | Mid-February to end of March |
| Transplanting | Mid-March to end of April |
| Herbicides application | Mid-April to Mid-May |
| Top dressing application | Mid-May to mid-June |
| Fungicides and insecticides application | Beginning of April to beginning of July |
| Weeding | Mid-April to end of July |
| Harvesting | Mid-July to end of August |

2. Groundnut

Considering the peculiarity of swamp development, it goes without saying that repeated variety aptitude tests should be performed in the area to select the most appropriate cultivariety of groundnut. Varieties such as V-13, Matjam and Indonesia presently recommended by MARDI may be appropriate.

The proposed cropping calendar is as follows:

| | |
|---|---|
| Land preparation and basic fertilisation | Mid-January to late January |
| Sowing seed and herbicides application | Early February to early March |
| Tilling and weeding | Early March to early April |
| Fungicides and insecticides application | Early March to late May |
| Harvesting | Early June to early July |

Groundnut is a crop easily susceptible to excessive soil moisture. Therefore, extra care must be exerted to drainage while deep tillage at plowing time must be avoided. Plowing should be conducted immediately after the end of the monsoon season, and every effort should be made to facilitate drying of soil. When soil is thoroughly dried, lime should be applied to correct soil acidity. At least 0.4 - 0.5 tons/ha of magnesia lime should be necessary. The width of ridge should be between 60 and 70 cm, while seed furrows should be made shallow not to position the seeds too deep.

Concerning fertilizer application, basal application of all fertilizers should be conducted as follows: N: 40, $P_2O_5$: 30 - 50 and $K_2O$: 30 - 50 kg/ha. With regard to the application method, when the seed is positioned close to fertilizer application, the crop at germination time and at growing season is likely to be subjected to impediment. Therefore, an ample soil insulation must be taken. Also concerning compost, it should be broadcast applied to the total area prior to plowing of the preceding crop and then to be ploughed-in.

With regard to seeding, interraw spacing of at least 25 to 30 cm is considered necessary. Hand sowing should be generally applied. To prevent vacant hill, two seed sowing should be applied for safety sake. When a vacant hill occurs, either a seedling raised at another field should be readily transplanted or a compensation should be made.

Concerning the application of herbicides, either Rorox wettable powder or Aflon water-dispersable powder (1.2 - 1.5 kg) dissolved in 700 - 800 liters of water should be scattered uniformly over the soil during the period after sowing and before germination. In weeding, weedkiller should be mainly be applied if possible one or two times during the intertillage period from around the flowering stage to before the time when the foliage begins to cover the foothpaths.
Also with regard to intertillage, the weedkiller should be applied once or twice if possible before the gynophpre penetrates underground. In this instance, broadcast application of either 0.2 - 0.4 ton/ha of magnesia lime or slaked lime should be uniformly scattered over the whole area.

Pertaining to damage caused by insect and disease, as there are reports of outbreaks of leaf spot (Cercospora personate) and leaf spot (Cercospora arachiditola), the scattering of chemicals such as Benlate, CIBA-L671, etc. are considered effective.

With regard to damage caused by insects, as outbreaks of bean pyralid (Lamprorama), lima bean pod borer (Etiella zinckenella) and Stomopterix Subsericella are reported, an appropriate quantity of Dipterex, Malathion, Azodrin 60EC, etc. should be scattered.

Concerning harvesting, when digging out the hill, three of four stocks should be brought down together for drying. Expected harvest is estimated at 2 tons/ha.

3. Soybean

When compared with other crops, soybean excels in keeping within bounds the growth of weeds and also the consumption of soil fertility by facilitating the aggregate structure of soil. Therefore, it is considered an ideal crop rotating with paddy.

Considering the peculiarity of swamp development, it goes without saying that repeated variety tests should be conducted in the area to select the most appropriate cultivariety of soybeans.

From the viewpoint of disease resistance and high-yielding ability, varieties such as CES434, L-114, Improved Pelican and TK5 presently recommended by MARDI should be appropriate.

The proposed cropping calendar is as follows:

| Operation | Lowland | Upland |
|---|---|---|
| Land preparation, basic fertiliser application | Mid-March - Mid-April | Early January - Mid-January |
| Sowing; herbicides application | Mid-April - Mid-May | Late February - Early March |
| Tilling, weeding | Mid-May - Mid-June | Early March - Early April |
| Insecticides application | Late May - Mid-July | Mid-March - Late April |
| Harvesting | Late July - Late August | Early May - Early June |

Lack of soil moisture or excessive soil moisture badly influences the root and causes hampering of nutrient absorption. As the soil in this area is likely to become excessively moistured, thus deteriorating carbonhydrate metabolism, efforts must be exerted to hold down the groundwater level (50 - 80 cm) as possible. To realize this, building of drainage ditches and digging of field surface gutters can especially be considered in paddy fields. At places where drainage is bad, high ridge (width about 2 m and height 50 cm) cultivation can be employed by digging a gutter between the levees. Also prior to seed sowing, lime (broadcast application, 4 - 5 tons/ha) and phosphate (1 - 2 tons/ha) should be applied to control acidity.

Furthermore, to elevate soil fertility, compost application is also necessary. With regard to fertilizer application, total basal application should be conducted together with phosphate. Appropriate fertilizers for application are N 20 - 40, $P_2O_5$ 30 - 50, $K_2O$ 30 - 50 kg/ha. Also when there is no root nodule or when growth is poor, top-dressing of fertilizer should be applied.

With regard to the amount of seed sowing, it should be between 40 - 60 kg/ha, footpath width 60 - 75 cm and interraw spacing 15 - 20 cm as a standard. To prevent vacant hill, two-seed sowing is recommended. Also inoculation of root nodule becomes necessary prior to seeding of the first cropping. It is also effective to mix the soil of existing soybean nursery bed with seed when it is hard to obtain cultivated root nodule at seed sowing. It is desirable that the amount of nursery soil is about 10% of volume. Soil covering should be exerted to prevent birds from preying upon the sown seed. Extra care should be made at early morning time and sun-set time. In temperate zone, germination occurs about one week after sowing while it is shortened to 3 or 5 days in tropical zone. Therefore, in case of vacant hill, prompt complimentary planting or seeding should bedone.

Concerning the application of herbicides, either 7 - 10 kg/ha of PCP water solution (86%) or 5 - 15 kg/ha of CAT (Simazine solution 50%) should be applied, immediately after sowing. Intertillage and weeding should be conducted about three weeks after sowing, and when deemed necessary, they should be conducted twice.

However, they should be avoided during flowering time.

With regard to damage caused by insects, application of Rogor (Dematoate), Bidrim and Sevin 85 are considered effective insecticides against leefeeder and pod boror that are found in rampant. Especially, to prevent 'insect bitten beans' by pod boror, it is ideal to apply the solution two or three times every other week from about two weeks after flowering. In this case, chemicals such as Sumithion, Disiston, etc. of 15 - 20 kg/ha or mixed in a 1-and-1000 emulsion of 700 liters/ha should be used for application.

The harvest season should come as earliest as possible as the delay in harvest season would invite shredding. Roguing reaping should be the main harvesting methods followed by 3 or 4 days of air drying in the field. The expected harvest is estimated at 2 tons/ha.

## 4. Chillies

Chillie, also called red pepper, is an important condiment crop, grown for its pungent fruits, which are used both green and ripe (the latter in the dried form), to impart pungency to food. It is also used medicinally and in pickles. The pungency is due to active principle Capsicin contained in the skin and septa of the fruit.

The crop is grown from almost sea level to an altitude of 5,000 feet in tropical and sub-tropical conditions with an annual rainfall of 25 to 50 inches. Very heavy rainfall during crop growth is definitely harmful. In low rainfall tracts or when grown in the hot weather, it is cultivated as an irrigated crop.

The rainfed crop does well on deep, fertile, well-drained black soils and somewhat heavy clayey loams. In ill-drained soil, plants shed leaves and turn sickly even with temporary water-logging. Under irrigation and good manuring, excellent crops can be raised on sandy and light alluvial loams as well as red loamy soils.

Under rainfed conditions, the crop is rotated with groundnut and others. As an irrigated crop, it is grown in rotation with maize or any of the vegetables. Because of the pests and diseases common to them, it is not deemed advisable to include potatoes in the rotation. Irrigated chillies are sometimes grown mixed with millets, groundnut or vegetables.

The land is ploughed and harrowed three or four times to obtain a fine tilth, and 20 to 40 cartloads of farmyard manure per acre worked in at the last ploughing. For the irrigated crop in many areas, a basal application of about 600 lb. of groundnut cake per acre is given in addition. Sometimes, sheep or cattle penning is practised. The land for irrigated chillies is laid out into beds six to eight feet square, or thrown into ridges 18 to 36 inches apart.

The irrigated crop is weeded and hand hoed three or four times by manual labor. In some places, it also receives a top dressing of ammonium sulphate at 250 lb. per acre in slit doses. Irrigation is given once in seven to ten days depending on season and crop growth. As a typical garden crop, it responds well to good cultivation, irrigation and manuring. The rainfed crop is given two or three bullock hoeings and sometime earthed up to help free flow of surplus rain water.

The average yield of rainfed crop is about 500 lb. of dry chillies per acre and that of the irrigated crop 1,200 to 1,500 lb. Dry chillies is 25 to 30% of the fresh weight.

F. Paddy Distribution Policy

The income from rubber and rice produced by small holder had been exploited by merchants of Chinese origin until the distribution mechanism was reviewed as a result of advocation of the principle of equal employment opportunity as one of the most important policies. Since October, 1949, the government applied the minimum guaranteed price system to unhulled rice. It was initially set at 15 Malaysian Dollars per picul. Since then, the price was changed in the range of 12 to 17 Malaysian Dollars per picul in certain years.

On the other hand, the government tried positive intervention to the distribution mechanism governed so far by merchants of Chinese origin. The Federal Agricultural Marketing Authority (FAMA) was established in 1965 as the organization to handle distribution problems. Further in 1967, the Paddy and Rice Marketing Board (PRMB) was established in the FAMA for stabilization of farm household economy through control of unhulled rice and rice distribution, and the minimum price of unhulled rice to be purchased by the PRMB and distributors was decided to be publicized. Only those approved by the PRMB were allowed to purchase, transport, store, and sell unhulled rice and rice. Commission, payment terms, and other conditions were specified in the conditions for approval. The PRMB itself was allowed to purchase and transport rice, and also handled loans to approved distributors. These jobs were handed over to the National Paddy and Rice Authority (NPRA) as of January 1, 1972.

Although situation differs from region to region, farm households generally sell rice to retailers. Brokers are nest to retailers, and direct sales to rice mills and the government is rare. About 50% of the total rice-selling farm households sell, the rice crop at one time. The remaining 50% sell 70% at the time of harvest, and another 30% as required.

Almost all farm households sell rice in double-cropping areas as against only 15% of farm households in single cropping areas. Since rice cultivating farm households are generally poor, it is not rare that they sell unhulled rice before drying to obtain cash as early as possible. In such a case, the price of unhulled rice is kept as a low level. The above said minimum guaranteed price is shown as the price to rice mills for one picul of unhulled rice with the water content of 13%. The price of insufficiently dried unhulled rice, therefore, may be kept lower, but various social problems arise from this type of transaction. Introduction of unhulled rice drying and selection techniques as well as arrangement of necessary farm implements in farm households will be needed as one of the methods to increase cash income of farm households.

G. Income of Farm Household

The annual income in 1970 of an average paddy growing household in West Malaysia was M$110. This includes both agricultural income and non-agricultural income. The ratio between agricultural income and income of farm household differed according to single cropping or double cropping. In single cropping areas, farm households depended nearly half of their total income on rice crop, while double cropping households 70%. A poverty household is defined as a household with a monthly per capita income of less than M$25 or an annual family income of less than M$1,600. As mentioned above, 88% of the paddy growing households belong to this category.

On the other hand, 70 % of individual farm households engaged in double cropping were considered poor while 84% of sharecropping farm households engaged in double cropping were indigent. With regard to single cropping farm households, 94% were branded destitute.

However, various irrigation improvement schemes coupled with the recent rises in rice price have increased the income of paddy growing households which in turn decreased the number of poor farmers. In 1975, the figure of poor farm families dropped to 77% of the total farm households. Based on the data obtained at the MUDA Irrigation Project area, the average rice crop income in 1974 per acre in single cropping was M$300 for a sharecropper, M$340 for an owner tenant and M$370 for an owner. On the other, non-agriculture income had a tendency of dropping with the introduction of double-cropping.

The cultivated area per household in Trans Peark Stage area was 5.2 acres of which rice production was 2.9 acres.
The annual average income per household in 1974 in this area was M$1,608 (M$134 per month). Agricultural income accounted for 2/3 of the income, while the remaining M$544 was non-agricultural income. However, nearly half of the total households had a yearly income of less than M$1,500.

On the other hand, in the single cropping Kelantan area, the average yearly income of a paddy growing household was M$714 of which 84% was agricultural income and the remaining 16% non-agricultural income. And nearly 1/3 of the total farm households recorded an annual income of less than M$500.

In short, 60% of the paddy growing households in double-cropping areas had an average monthly earnings of M$150, while their counterparts in single cropping areas had an average income of only M$100. The smallness in scale of farm management of paddy growing households can be quoted as the main reason for their low income and also the low employment opportunity in these farming areas. Even in double-cropping areas, 33% of the population have lost their jobs during the year. The day laborers eraned their income by engaging in rice-transplanting, harvesting and planting preparation work.

## H. FELDA's Land Development Procedure

FELDA's land development is preceded by a land suitability survey. The findings are examined by technical research and technical planning committees organized in the FELDA, and the minister makes the final decision. Existence of deforcer is investigated in selecting the land. If it is approved as necessary, the state government acquires the land, removes concerned parties, and pays the compensation. On the other hand, the soil division of the state department of agriculture makes the soil map. The geological survey division manager and the chief mining surveyor issue an approval certificate for removal of minerals while the forestry department issues an approval certificate for removal of trees. To minimize the development cost, construction of main and secondary roads at the optimal distances is determined. The construction work is proceeded by the public work department (PWD).

After the development area selection, the development is executed in four stages. In the first stage, a village is constructed at the center of the selected 1,300 acres of agricultural development area. The position is finalized with consideration of road and soil conditions. Then forest cutting and burning are effected by contract. Two or three blocks of houses (120-180 houses per block) are constructed in the village area. At the center of the village area, FELDA's office, market, movie theater, young farmers club house, community center, shopping center, clinic, repair shop, post office, filling station, library, school, police station, Mosque, and other public facilities are built.

Reclamation of the land for agricultural use had initially been carried out by settlers themselves until 1958 when it was determined that a contractor was to carry out the basic work and the settlers the appurtenant works because of such troubles as the failure to complete the work within the planned period. In 1960 it was further changed to make a contractor do the appurtenant works, too. Because of such criticism as "Contradiction to the initial aim of self-help efforts by settlers" and "giving unreasonable profit to Malaysians of Chinese origin", the ways of contract have been examined repeatedly.

As a consequence, a contractor now employs settlers for at least 50% of the total manpower requirement and the works after reclamation are done by contracts with settlers.

The number of applicants for settlers in the period from June, 1962 to June, 1963 was 6,011, out of which 1,462 was approved. In other words, only one fourth of the total applicants were approved to become settlers. The qualification is as follows:

> A married male citizen of the confederation or a state with the age between 21 and 50 who owns no land or a land smaller than 5 acres with the farming experience and willingness to work and is capable of observing conditions, rules, and orders for settlement. 20% of the total settlers are reserved for ex-staff of Security Forces and a considerable part is reserved for the regional inhabitants. So the general applicants compete for the remained portion.

General applicants submit applications to respective District Officer (DO). The applications are then sent to the state government and forwarded to the FELDA. The settler selection committee consisting of FELDA staff and state government representatives interview the applicants for selection. The selection is based on point system as follows:

| | |
|---|---|
| Age (35-36, male) ............................ | 10 points |
| Number of family members (5 or more) .......... | 10 points |
| Farming experience ............................ | 5 points |
| Others | |

Settlement starts when house construction is completed. Settlers cultivate vegetables and perennial crops in 1/4 acre in their building lots, and perform controlled joint operation in the common rubber plantation. Formerly, combined cropping of rubber (6 acres), fruits trees (2 acres), and paddy (2 acres) was tried. Recently, the management is unified to monoculture.

Initially, M$50-70 was paid to a settler each month before starting production of main crops. From October 10, 1962, payment has been according to actual labor of each settler and his family to make them work effectively. Daily wages for a male settler, wife, a child with the age between 14 and 18, and a child with the age below 14 are M$2.90, 2.40, 1.80, and 1.00, respectively. The paid daily wages are entered in a block as loan account.

For several years after settlement, settlers are divided into 15 to 20 groups for joint operation in blocks of 120-200 acres of main crop cultivation area. This joint operation system allows unified control of plant growing and land management, easy technical guidance of settlers by the FELDA staff, and enhancement of settlers' spirits for social responsibility and joint activities. After this period, each block is split into lots which are assigned to individual settlers by drawings for independent cultivation.

Nursery stocks of rubber trees and oil palms for the FELDA scheme are cultivated if the FELDA itself. Generally speaking, a rubber tree is transplanted to the main plantation after it has grown for 0.5-1 year in the nursery. Latex collection starts from the 4-6th year after transplanting. Latex collection volume reaches the maximum level in the period of 12th to 15th years, and the economic age of a rubber tree is said to be 35 years. An oil palm germinates in about 3-10 months. When two or three leaves develop, seedlings are transplanted to the nursery bed. After they spend 8 to 12 months there, the nursery stocks are transplanted to the main plantation. They reach the yield age in about 3 years, and the yield reaches the peak in the period of 11th to 30th years.

The maintenance expenses per acre of the developed rubber plantation in 6 years after the first transplanting is M$1,195, and the same of the oil palm plantation in 4 years is M$1,060. House construction cost is M$1,400. The total development cost for the settler household having about 10 acres of land is about M$18,000. M$14,000-15,000 out of the total cost plus the interest (7%) shall be paid back to the FELDA. The repayment of the loan is effected by deducting two thirds of the portion of the monthly rubber or oil palm sales in excess of M$100.

The FELDA has constructed four rubber processing plants and four palm oil refineries by the end of 1968. Rubber and oil palms produced under the FELDA scheme are prohibited to be sold to other parties than the FELDA. The FELDA pays for the purchase amount of these products less loan repayments to settlers.

Average monthly income of the FELDA settlers is about M$350, and the net monthly income of a settler after deduction of loan repayment is about M$180.

I. Swamp Area Development

260,000 acres out of 3,200,000 acres of Trengganu State are swamps. There are 47,000 acres of swamps in Trengganu Tengah Area alone virtually underdeveloped due to insufficient water control. The swamps are left intact because of lack of flood control and drainage despite being situated in the lower reaches of rivers, near the shorelines, having favourable social and economic conditions and covering a wide range of area.

Of the swamps, there is the tidal swamp receiving sea water where mangrove and nipah grow in profusion but is difficult for agricultural utilization. Tidal swamp occupies very little acreage of the total. However, when considering the fact that this tidal swamp and the height of the tide in the eastern coast of Trengganu State shows a difference of a maximum 2.1 meters, there leaves a room for possibility of some kinds of developments in the future.

Swamp not affected by the tide is referred to as a 'fresh water swamp' and is widely distributed in Trengganu State leaving great potentials for development. Except for pineapple growing in Johor State after conducting drainage of 10 - 20 feet in the peat area in the southern tip of Peninsular Malaysia, swamp development in Malaysia is virtually non existence. The Ministry of Land and Regional Development of Malaysia places great hope in swamp development in Peninsular Malaysia instead of limiting the development area only to Trengganu Tengah Area which was surveyed by the Japanese Mission.

On the other hand, although at a slow pace, development of the peripheral areas of the swamps is undertaken by individual farmers. Although, in general, swamps and forests belong to the nation, it is possible for farmers to bring the waste land under cultivation except for those areas designated as forest reserve. When a sound farm management is maintained for three years reclaiming land, the government is to issue an official permission to the farmer for use of land. Paddy fields brought under cultivation by this system around the swamps were merely developed by cutting open the jungles and burning up the areas.

Measures for irrigation and drainage were non-existence. Therefore, these paddy fields are easily subjected to the drainage condition of the swamps and thus are unstable. As the soil is poor, the farmers are forced to conduct shifting cultivation.

Besides farm lands for shifting cultivation and jungles that make up the peripheral areas of swamps there are Belklars, or patches of land where jungles were once cut open and are in the process of being revived. Belklar includes lands where cultivation was abandoned, illegal cultivation was suspended and denudation is left intact. The swamps are generally not utilized due to difficulty in the method of carrying out cut-trees except for small areas of standing trees being felled. In this way, excluding the very limited number of peripheral areas, the swamps are virtually left unused, and their center parts totally untouched. Also in Malaysia, as schemes for embankment construction for water and flood control are not envisaged, the utilization of the flood plain is extremely difficult.

The swamps having the sole merit of a flood control function today, may be exposed to a much deteriorated condition in the future. Today, the hilly areas and low land areas in the upper reaches of rivers and streams are rapidly being developed in Trengganu Tengah. As oil palm production is boosted by cutting open jungles, the outflow of rainfalls can cause trouble. As development of land progresses it will accelerate the velocity of flood. As the flood peak becomes larger, the flood control function of the swamps located in the lower reaches will shoulder extra burden. Not only that, the rapid population increase in the up-stream areas will inevitably contaminate water in the near future.

Swamp development means water control. And water control is too heavy a burden for individual farmers. To include swamp development as a part of its scheme to effectively utilize available lands by the Government of Malaysia is indeed timely and appropriate.

J. Agriculture in Dungun District

Dungun District has a total area of 675,840 acres and a total population of about 56,000 (as of 1977). The total area of the cultivated lands is 33,300 acres, or only about 5% of the total area of the district. The farming households amount to 2,668 and the farming population is about 14,000. Although no data about the demography of farmers was available to the survey team, it is surmised that the farming population is on a slight decline. This is because the population is draining from the farming communities towards the cities.

The dedicated and side-work farming households are estimated to account for 25% and 75% of the total, respectively. Small operating scale, low productivity and a large difference in labor demand between the rainy and dry seasons characterize the farming in the district, and may have sent up the ratio of side-work farming households. The farmers in the coastal zone are engaged in fishing as a principal side job. On the other hand, the inland farmers usually work out at their nearby plantations in FELDA, FELCRA and RISDA in the off-season.

Of the major crops, rice is a staple food, and rubber and oil palm are made much of as realizable produce. In the district, double-cropping of paddy is rarely practised. Most of other crops are cultivated by small holders. The agricultural operations in the district are classified into the following three types.

a. Small-scale diversified producers (small holders) who husband paddy, vegetables, fruits and several domestic animals for self-sustenance;

b. Capital-intensive large-scale farmers (FELDA, FELCRA and RISDA) who mainly are engaged in the production of rubber and oil palm; and

c. Tenants (estate farm labor) who work estates of non-residential landowners for earnings.

Small holders account for 80 to 90% of the total, and usually operate paddy cultivation of 1 to 2 acres and dry fields of 0.5 to 1 acre. Small holders and estate farm laborer earn M$200 to 300 a month and the planter in FELDA, etc. earns M$300 to 400 a month (rubber) or M$500 to 600 a month (oil palm). The agriculture in the district is characterized in that modern and traditional ways of farming are found in a mix, and that the productivity is largely different between them. This difference in productivity takes shape as a difference in income between the farmers.

K. Present Staffing of the Department of Agriculture

| Unit | SAO | AO | AA | AT | Clerks; store-keepers | Typists | Others | Total |
|---|---|---|---|---|---|---|---|---|
| State Head Office | 1 | 2 | 5 | 4 | 11 | 5 | 3 | 31 |
| Federal Crop Production | 0 | 3 | 2 | 10 | 0 | 0 | 15 | 32 |
| Federal Plant Protection | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 5 |
| Federal Soils | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 4 |
| Workshop Tractor Service Operator Training | 0 | 0 | 0 | 5 | 3 | 0 | 18 | 26 |
| District Staff | | | | | | | | |
| Kuala Trengganu | 0 | 0 | 7 | 23 | 0 | 0 | 0 | 30 |
| Ulu Trengganu | 0 | 0 | 2 | 13 | 0 | 0 | 27 | 42 |
| Merang | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 7 |
| Dungun | 0 | 0 | 1 | 4 | 1 | 0 | 5 | 11 |
| Kemaman | 0 | 0 | 1 | 5 | 1 | 0 | 2 | 9 |
| Besut | 0 | 0 | 2 | 16 | 0 | 0 | 0 | 18 |
| Total | 1 | 7 | 22 | 90 | 16 | 5 | 74 | 215 |
| Extension Personnel | 0 | 0 | 16 | 66 | 0 | 0 | 0 | 82 |

Remark:

SAO = Senior Agricultural Officer - graduate
AO = Agricultural Officer - graduate
AA = Agricultural Assistant - Diploma of Agriculture
AT = Agricultural Technician - Certificate of Agriculture

Source: The State Department of Agriculture
(Arranged based on reference materials)

## L. Varieties and Characteristics of Paddy Grown in Peninsular Malaysia

According to the data and information obtained from MARDI and other governmental departments, varieties and characteristics of paddy grown in Peninsular Malaysia as follows:

| | | Improved Variety | | | |
|---|---|---|---|---|---|
| Item | Local Variety | Malinja | Mahsuri | Bahagia | Ria(IR-8) |
| Irrigation Conditions | Rainfed irrigation | | | | Complete irrigation |
| Stem Length (cm) | More than 110 | 100∿110 | 100 | 80∿90 | 70 |
| Lodging characteristies | Extremely susceptible | Slightly susceptible | Medium | Resistant | Resistant |
| Dosage of Nitrogen Application (kg/ha) | 0 30 | 30∿40 | 40∿60 | 60∿90 | More than 90 |
| Planting Density (cm) | 35x35 | 35x35 | 30x30 | 30x30 | 20x20 |
| Yield (ton/ha) | 1.5∿2.9 | 3.0 | 4.0 | 4.0 | More than 5 |
| Growing period (day) | 150∿250 | 130∿135 | 130∿133 | 132∿142 | 128 |

Source: MARDI

M. Credit

The major source of agricultural credit in Malaysia is the Bank Pertanian Malaysia. In Kuala Trengganu there are also the Bank Rakyat and six commercial banks. However, the bank is said to play for Farmers Organizations and Independent Tobacco Producers to function as local credit centers rathan than for small holders to provide production credit.

According to the socio-economic survey, usually crop production loans are granted for a six months term at an interest rate equivalent to 8.5% per annum. For late payment a penalty charge of 1% per month is required.

As shown in the table below, the loans disbursed by the Bank Pertanian Malaysia in Trengganu State amounted to about M$10.68 million as of June, 1976.

Loans Disbursed by Bank Pertanian Malaysia as of June, 1976

| Type of Loan | $M\$10^3$ | % |
|---|---|---|
| Crop production | | |
| Paddy | - | - |
| Tobacco | 6,165.7 | 57.7 |
| Groundnut | 52.5 | 0.5 |
| Ginger and fruits | 28.0 | 0.2 |
| Poultry | 2.0 | |
| Tractors | 415.8 | 3.9 |
| Vehicles/Lorries | 46.3 | 0.4 |
| Agricultural equipment | 2.7 | |
| Mills | | |
| Coconut | 126.0 | 1.2 |
| Rice | 17.0 | 0.2 |
| Factories | | |
| Ice | 180.0 | 1.7 |
| Laminated materials | 565.0 | 5.3 |
| Land purchase and development | 97.2 | 0.9 |
| Contractor finance | 2,986.5 | 28.0 |
| Total | 10,684.7 | 100.0 |

Source: Bank Pertanian Malaysia

## N. Production Cost and Income by Crop

(Per acre)

Unit: M$

| Crop | Number of Working Days | Production Cost | | | Gross Income | | Net Profit | Income | Income per Working Day |
|---|---|---|---|---|---|---|---|---|---|
| | | Labour Cost | Materials Cost | Total | Yield | Sales Value | | | |
| Paddy (Kelantan) | 31.5 | 136.40 | 82.65 | 219.05 | 400 | 333.40 | 114.35 | 250.75 | 8.0 |
| Paddy (Kelantan) | 33.5 | 145.07 | 87.40 | 232.47 | 600 | 500.00 | 267.53 | 412.60 | 12.3 |
| Paddy (Kelantan) | 35.5 | 153.72 | 59.30 | 213.02 | 560 | 423.45 | 210.43 | 364.15 | 10.9 |
| Chilly | 240.0 | 104.00 | 27.00 | 131.00 | 60 | 240.00 | 109.00 | 213.00 | 8.9 |
| Maize | 24.0 | 104.00 | 240.28 | 344.28 | 3000 | 360.00 | 15.72 | 119.72 | 5.0 |
| Sorghum | 27.5 | 119.07 | 139.01 | 258.08 | 400 | 400.00 | 141.22 | 260.29 | 9.5 |
| Peas | 255.0 | 1105.00 | 353.00 | 1458.00 | 88 | 1355.00 | 103.00 | 1002.00 | 3.9 |
| Groundnuts | 40.0 | 173.20 | 260.90 | 434.10 | 30 | 1050.00 | 615.90 | 789.10 | 19.7 |
| Leaf Mustard | 151.0 | 655.00 | 205.00 | 205.00 | 120 | 1176.00 | 316.00 | 971.00 | 6.4 |
| Komatsuna (a kind of Chinese cabbage) | 165.0 | 714.00 | 167.00 | 881.00 | 96 | 960.00 | 79.00 | 793.00 | 4.8 |
| Chinese cabbage | 124.0 | 537.00 | 189.00 | 726.00 | 100 | 900.00 | 174.00 | 711.00 | 5.7 |
| Tomato | 121.0 | 523.93 | 1057.00 | 1580.93 | 120 | 3000.00 | 1479.07 | 2003.00 | 16.6 |
| Sawi Hijau | 220.0 | 952.00 | 322.00 | 1274.00 | 76 | 1915.00 | 641.00 | 1593.00 | 7.2 |
| Cassava | 33.0 | 142.86 | 325.15 | 468.04 | 330 | 1105.50 | 619.46 | 762.35 | 23.1 |
| Tobacco | 147.0 | 636.00 | 262.24 | 898.24 | 10934 | 2020.00 | 1121.76 | 1757.76 | 12.0 |
| Banana (P. Embun) | 47.0 | 203.51 | 86.00 | 289.51 | 106 | 636.00 | 346.49 | 550.00 | 11.7 |
| Coconut (12th and subsequent years) | 18.0 | 77.64 | 66.00 | 143.94 | 6 | 312.00 | 168.06 | 246.00 | 13.7 |
| Markisa (3rd year) | 60.0 | 259.80 | 114.00 | 373.80 | 15000 | 1125.00 | 751.20 | 1011.00 | 16.9 |
| Cashew (7th and subsequent years) | 15.0 | 64.95 | 33.00 | 97.95 | 1800 | 630.00 | 532.00 | 597.00 | 40.0 |
| Citoron (5th and subsequent years) | 20.0 | 86.60 | 126.00 | 212.60 | 80 | 432.00 | 219.40 | 306.00 | 15.3 |
| Cocoa (8th and subsequent years) | 27.0 | 116.61 | 137.40 | 254.31 | 1620 | 599.40 | 345.09 | 462.00 | 17.1 |
| Pepper (3rd year) | 172.0 | 744.75 | 537.72 | 1282.47 | 27 | 7101.00 | 5818.53 | 6563.28 | 38.2 |
| Coffee (3rd and subsequent years) | 94.0 | 407.02 | 128.78 | 535.80 | 35 | 385.00 | 150.80 | 256.22 | 2.7 |
| Pineapple | 48.5 | 209.99 | 534.68 | 744.67 | 16000 | 800.00 | 55.33 | 265.32 | 5.5 |
| Oil palm (11th and subsequent years) | 20.5 | 88.77 | 217.00 | 305.77 | 106 | 1038.80 | 733.03 | 821.80 | 40.1 |

Source: MARDI

O. Production Cost

Production costs of major crops for the financial analysis were estimated taking into account the following tables which are prepared on the basis of data and information on production costs studied by MARDI, FAMA and DOA, Malaysia.

Chillies

(Per acre per crop)

| Item | Description | Cost (M$) |
|---|---|---|
| 1. Land cost | | 220 |
| 2. Ploughing | By contract | 70 |
| 3. Making beds | 3-mandays | 21 |
| 4. Making nursery and related work | 0.5-manday | 4 |
| 5. Transplanting | 3-mandays | 21 |
| 6. Adding soil | 30-mandays | 210 |
| 7. Spraying insecticide and fungicide | 20-mandays(@M$12) | 240 |
| 8. Manuring | 4-mandays | 28 |
| 9. Weeding | 6-mandays | 42 |
| 10. Harvesting | 65-mandays | 455 |
| 11. Seeds | 2 katis | 4 |
| 12. Fertilizer: | | |
| Chicken dung | a lorry load (@M$250) | 250 |
| NPK green | 20 bags (@M$36) | 720 |
| 13. Insecticide: Lannate | 9 lbs. (@M$37) | 333 |
| 14. Fungicide: Manet | 22 lbs. (@M$4) | 88 |
| Total | | 2,706 |

(Estimated yield: 9 tons/acre)

Tomato (Lowland)

(Per acre per crop)

| Item | | Description | Cost (M$) |
|---|---|---|---|
| 1. | Ploughing | By contract | 70 |
| 2. | Making beds | 10-mandays | 84 |
| 3. | Making nursery and related work | 0.5-manday | 4 |
| 4. | Transplanting | 1.5-mandays | 11 |
| 5. | Putting up sticks and wire | 2-mandays | 14 |
| 6. | Tying plastic string | 8-mandays | 56 |
| 7. | Spraying insecticide and fungicide | 12-mandays | 144 |
| 8. | Manuring | 12-mandays | 120 |
| 9. | Watering | 1-manday | 7 |
| 10. | Weeding | 3-manday | 21 |
| 11. | Harvesting | 23-mandays | 161 |
| 12. | Seeds | | 20 |
| 13. | Fertilizer: | | |
| | Chicken dung | 4 lorry loads (@M$230) | 920 |
| | NPK green | 15 bags (@M$42) | 630 |
| 14. | Insecticide: Lannate | 10 lbs. (@M$41) | 410 |
| | Thamaron | 5 bottles (@M$28) | 140 |
| 15. | Fungicide: Bolinomg | 50 lbs. (@M$3) | 150 |
| 16. | Sticks | | 100 |
| 17. | Wire | | 44 |
| 18. | Plastic string | | 56 |
| 19. | Basket | | 105 |
| 20. | Fuel and oil (for powder sprayer) | 16 gal. (@M$3.50) | 56 |
| 21. | Repair to powered equi equipment | | 10 |
| 22. | Transport: (Farm to collecting point) | 150 baskets | 90 |
| | Total | | 3,333 |

(Estimated yield: 9 tons/acre)

Watermelon (Black Boy)

(Per acre per crop)

| Item | Description | Cost (M$) |
|---|---|---|
| 1. Land clearing | By contract | 250 |
| 2. Land preparation | By contract | 90 |
| 3. Planting material: 10 seeds/hole | M$1/per packet for 100 holes | 7 |
| 4. Holing, lining and planting 700 holes | 40 holes per manday 18-mandays | 126 |
| 5. Initial fertilizer: Nitrophoska green | 2 ox./hole for 700 holes | 35 |
| 6. Normal fertilizer: | 2 lbs./hole for 700 holes | 550 |
| 7. Insecticide | 2 bottles (@M$3.50) | 7 |
| 8. Total labor forces | 80-mandays | 560 |
| 9. Harvest | 8-mandays | 56 |
| Total | | 1,681 |

(Estimated yield: 7 tons/acre)

Lady's Finger

(Per acre per crop)

| Item | | Description | Cost (M$) |
|---|---|---|---|
| 1. | Ploughing | By contract | 110 |
| 2. | Making beds | 6-mandays | 42 |
| 3. | Planting | 2.5-mandays | 18 |
| 4. | Discarding extra plants | 0.5-manday | 4 |
| 5. | Spraying insecticide and fungicide | 16-mandays | 192 |
| 6. | Manuring | 40mandays | 28 |
| 7. | Watering | 3-mandays | 21 |
| 8. | Weeding | 10-mandays | 70 |
| 9. | Harvest | 35-mandays | 245 |
| 10. | Seed | 4 kati (@M$5) | 20 |
| 11. | Fertilizer: Cowdung | 2 bullock cart-full | 8 |
| | Urea | 15 kati (@M$0.40) | 6 |
| | NPK green | 15 kati (@M$0.40) | 6 |
| 12. | Insecticide 'Sword brand' | 6 bottles (@M$8) | 48 |
| 13. | Fuel and oil | 4 gallon | 14 |
| | Total | | 832 |

(Estimated yield: 5 tons/acre)

Paddy (Improved) (Per acre per crop)

| Item | Description | Cost |
|---|---|---|
| 1. Land tax | | 1 |
| 2. Water charge | | 4 |
| 3. Fertilizer: | | |
| NPK basal mixture | 2.2 bags (44 lbs./bag) | 22 |
| Urea | 2.8 bats (44 lbs./bag) | 28 |
| Others | | 3 |
| 4. Insecticide: | | |
| Camma BHC/Thiodan | 10 lgs. | 8 |
| Others | | 3 |
| 5. Seed | 4 gantangs/acre | 4 |
| 6. Land preparation | By contract | 35 |
| 7. Nursery preparation | 1.5-mandays | 10 |
| 8. Raking, levelling and bend repair | 5-mandays | 35 |
| 9. Transplanting | 6-mandays | 42 |
| 10. Fertilizer and insecticide application | 1.5-mandays | 10 |
| 11. Weeding | 2-mandays | 14 |
| 12. Harvest (cutting) | 6-mandays | 42 |
| 13. Threshing | 5-mandays | 35 |
| 14. Field transport | 3-mandays | 21 |
| 15. Winnowing and drying | 3-mandays | 21 |
| Total | | 338 |

(Estimated yield: 1.65 tons/acre)

Pineapple

| Item | | Description | 1st Year | 2nd Year | 3rd-tenth Year |
|---|---|---|---|---|---|
| 1. | Land cost | | 100 | | |
| 2. | Cutting, burning and clearing of roots | | 250 | | |
| 3. | Planting materia (@M$0.012) | | 180 | | |
| 4. | Transport of planting material to farm | | 24 | | |
| 5. | Planting | 8-mandays | 56 | | |
| 6. | Fertilizer: | | | | |
| | Material | | 175 | 150 | 160 |
| | Labor | | 56 | 42 | 56 |
| 7. | Weeding: | | | | |
| | Material | | 70 | | |
| | Labor | | 105 | 35 | 35 |
| 8. | Pesticide | | 10 | 10 | 10 |
| 9. | Hormone application: | | | | |
| | Material | | | 7 | 7 |
| | Labor | | | 35 | 35 |
| 10. | Removal of ruwanted sukers | | | 35 | 35 |
| 11. | Harvest | By contract | | 150 | 150 |
| 12. | Carriage to road side and loading onto lorry | By contract | | 75 | 75 |
| 13. | Transport to cannery | | | 90 | 90 |
| 14. | Contribution to association | | | 32 | 32 |
| 15. | Miscellaneous | | 50 | 50 | 50 |
| | Total | | 1,076 | 711 | 735 |

(Estimated yield: 15 tons/acre of acceptable quality/harvest)

## P. Possibility of Paddy Cultivation in Peat Soil Areas

1. In most of the proposed paddy fields the soil is Gleysols with a thin layer of peat. Even in the area where Histosols is contained, only a thin layer of peat exists. Therefore, it is possible to develop a mixture with the underlying mineral soil.

2. When the irrigation and drainage systems are improved with an adequate amount of better irrigation water for keeping dryer conditions of paddy fields, paddy is cultivated in a more desirable oxidized environment.

3. Paddy is one of the most important products to secure the rice consumed by settlers themselves and promote stability and establishment of their farm management.

4. It is both necessary and rational for the regional development to maintain the better water use condition by using the functions to hold groundwater and control flood.

5. In shallow peat soil area paddy is cultivated by existing paddy farmers. This is one of the reasons why paddy is planned to introduce in the Bukit Bauk Pilot Project area.

6. Regardless of whether the reason why the tropical forest peat is not suitable for paddy cultivation is "the formation of organic acids on flooding" as claimed by K. Kanapathy (1975) or "ligunin-derived polyphenolic compounds and the consequences of copper inavailability" as maintained by P. M. Driessen (1976), paddy cultivation is considered to be stabilized year by year if proper fertilization is conducted under the conditions mentioned in Paragraphs 1 and 2 above.