LAND SUITABILITY EVALUATION AND LAND USE STUDY OF THE MATARA DISTRICT

AGRARIAN RESEARCH AND TRAINING INSTITUTE
Colombo, Sri Lanka

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ARTI/Wageningen Project on
Agricultural Planning

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PART I

LAND SUITABILITY EVALUATION

F O R E W O R D

In September 1979, the ARTI and the Agricultural University of Wageningen started a Joint Research Project on Agricultural Planning with the objective of improving the processes of planning for agricultural development in Sri Lanka.

The first planning exercise undertaken by the Research Project was the agricultural sector plan of the Matara District Integrated Rural Development Plan.

Upon inventorizing available data on Matara District, it was found that there was no complete, systematic and quantified information on landuse potentials. The present study therefore was conducted by Mr S Dimantha at the request of the Research Project to fill this gap. As it took only three months to compile this information it shows that land suitability data, detailed enough for planning purposes, can be generated within a short period. Undertaking similar studies on an islandwide scale immediately would help the preparation of agricultural plans for other districts as well.

The first question that has been answered by this exercise is: suitability for what? Eighteen Land Utilixation Types (LUT) have been taken into consideration, covering the main existing and potential crops that can be grown under practical farming conditions according to current agronomic knowledge. For each crop system both an advanced and a low technical level of cultivation has been defined.

The next step was to describe land in relation to suitability for crops. For this purpose, twelve land qualities were determined each representing a complex of interacting land characteristics. Land characteristics as such do not affect landuse, landqualities however are supposed to influence the possibilities of landuse directly and independantly of each other.

What landqualities do the different crops require, assuming a high and a low technical level of cultivation was the third question that this study endeavoured to answer.

This last assessment combined with the foregoing sets of data permit the description of the suitability of different land units for different land utilization types.

The analysis is however more complex. Land qualities are not unchangeable. They can be improved to a certain extent by human efforts such as soil conservation measures and improvement of the structure and the fertility of the soil. Therefore, the study also taken into account the possibility of upgrading landqualities.

Land suitability in this study is described in qualitative terms using a scale of different suitability ratings. Areas of land units are quantified. Agronomic interpretation of the suitability ratings in terms of yields per acre would permit an assessment of potential physical production and hence of the technical carrying capacity of the land. The latter is to be considered as an upper limit to agricultural production which one cannot expect to be realised in practice. Technical suitability does not necessarily imply social or economic feasibility. Socio-economic analysis of farmers' behaviour patterns, price structure, distribution of land, etc., reduce technical potentials to realistic proportions. This report shows how one can make use of land suitability data in socio-economic planning.

It is hoped that together with the landuse mapping this report will be a useful tool in general policy making and in systematic identification and localisation of projects.

My thanks are due to the Research Team and Messrs. Dimantha and Jinadasa of the Land Use Division of the Irrigation Department for making this study and publication possible.

T B Subasinghe
Director - Agrarian Research & Training Institute

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A massive amount of field work and office work could be done within a short period due to the facilities provided by this Project. The authors wish to express their sincere appreciation for this support.

Valuable advice on the field work and the evaluation was available from Dr.K.A.de Alwis. His work on the land suitability evaluation for tea was a solid foundation for this work. Dr.N.S.Jayawardena, and K.A.D.K. Perera supplied a lot of field information from their work in the Nilwala Ganga Scheme. Drs. Alwis, Jayawardena and C.R.Panabokke critically read the report and gave their comments. Mr.K.S.Fernando did the cartography work. Mr.W.Gunesekara did most of laboratory work required for the job. All this assistance is gratefully acknowledged.

A word of thanks to Miss. Anne Fernando for preparing the final script for publication.

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An integrated rural development plan is being proposed for the Matara District. The Dutch team which is in Sri Lanka to advise the Government on rural development planning commissioned this land suitability study of the Matara District as being a prerequisite to rural development planning.

1. ENVIRONMENT

1.1. Location

The Matara District is located in the Southern Province of Sri Lanka (fig.1), and lies between 6° and 7° N latitude and 80° and 81° longitude.

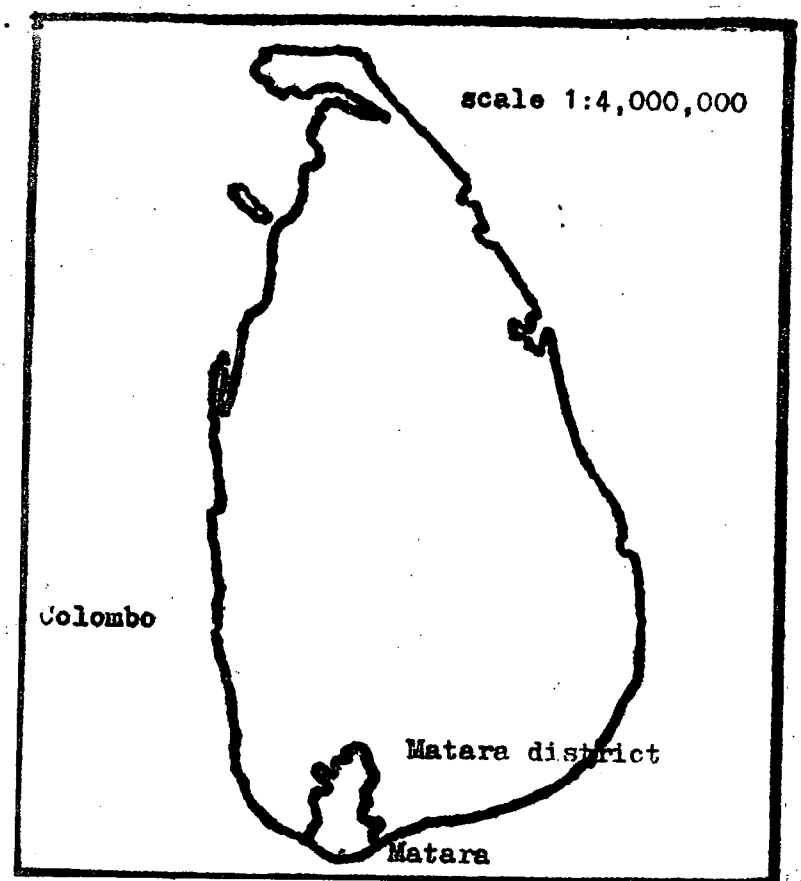

Fig. 1 Map of Sri Lanka showing the location of Matara District.

1.2. Climate

Most of the Matara District lies within the Wet Zone of Sri Lanka and gets the benefit of 2 monsoonal rains and 2 intermonsoonal rains. The temperature, relative humidity, wind speed and cloudiness data were analysed by the Blaney Criddle and Radiation methods (Doorenbos & Pruitt, 1977) to obtain monthly reference crop evapotranspiration estimates and are presented in table 1.

Table 1. Reference crop evapotranspiration calculated by the radiation - and Blaney Criddle methods for Galle (the nearest suitable station to Matara district with required data)

	Reference crop evapotranspiration mm/day											
Method	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Radiation	4	4	4.5	4	4	4	4	4	4	4	3.5	3.5
Slaney Criddle	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4	4	4

5 agro-ecological regions run through the Matara District (Land and Water Use Division, 1976). The rainfall in these regions is further analysed with regard to the availability of moisture for crops etc., and the results are presented in chapter 4.

1.3. Geology

The residual Landscape is on Pre-cambrian formations (Hapuarachchi & Herath, 1969). These consist mainly of garnet silimanite granulites associated with quartz felspar granulites in places and also charnocites. Recent alluvium occurs in the flood plain.

1.4. Physiography

The lands in the district were separated into 5 physiographic regions. The

coastal plain occurs adjacent the sea. Next is the mantle plain with undulating to rolling topography and elevation upto about 50 to 60 meter. The mountainous region occurs at the northern part of the district starting at an elevation of about 300 meter and going upto about 1000 m. Between the mantle plain and the mountainous region, the highland plain occurs with an elevation range of 50 to 300 m. The flood plain occurs in proximity to the major river Nilwala, and around some minor streams.

1.5 Hydrology

1.5.1 Hydrology of the flood plain

The hydrology of the flood plain is governed by the flow of the river. The river is in spate during heavy rainfall periods and the flood plain is subject to high groundwater tables and flooding. It is mentioned by the local people that in the recent years that the Nilwala Ganga floods have been more frequent. This has been attributed to the wanton clearing of lands in the upper catchment of the river and the resultant high runoff from these lands. This idea will have to be kept in mind when designing an overall flood control plan.

1.5.2 Hydrology of the valleys

The valleys of the mantle plain and the highland plain receive runoff water during rainfall periods and sometimes flash floods occur. Subsequent to the rainy periods a slow seepage of water (interflow) occurs from the hills. This seepage flow is some times seen to ooze out of bank cuts in the hillsides. This water is charged with a lot of metallic ions notably ferrousions which on reaching paddy fields are supposed to cause nutritional imbalances in rice plants (Moorman and Brinkman, 1980, Moorman, 1978.)

2. METHODS

2.1 Soil survey and Land classification

1:25,000 air photos of 1973,74 & 75 were used as base maps and also for the air photo interpretation during the survey.

As mentioned in section 1.4 five physiographic regions were identified mainly by analyses of the 1:63560 topographic sheets and the air photos. Sample areas were selected in the different regions and detailed soil studies were made in order to find correllations between the terrain features and air photo details and soil types. On the basis of this study the air photos were analysed to make a land classification map and traverses were taken across the district to check the air photo interpretation.

The soils were observed in the field either by examining bank cuts, soil pits or by augering (with a 1.2 Edelman augar in the dry lands and with a auger made out of a pointed iron in the wet paddy fields). 500 soil observations in the Nilwala basin and 900 observations in the rest of the district were carried out for the survey.

2.2 Land evaluation procedure

The land evaluation procedure used is as proposed by Beek and Bennema (1972) and by F.A.O. (1976). The land use proposals are described as land utilization types (LUTS) and land quality requirement ratings are done for the considered LUTS. Finally a physical land suitability evaluation is done on the basis of the grading of the land qualities.

3. SOILS

The soil groups which occur in the various units of the land classification map are listed in table 2. Brief descriptions of the constitutent soils in each group are given below.

3.1 Red Yellow Podsolic Soils

The red yellow soils occupy most of the residual landscapte in the district. The soils in the high hillocks in the mantle plain and the more gentler slopes of the highland plain are the more typical of the red yellow podsolic soils. The soils in the low hillocks of the mantle plain have a ironstone gravel pavement. The red yellow podsolic soils of the more sloping lands are not very deep and contain a fair amount of decomposing rock.

The red yellow podsolic soils are vary deep (more than 2 m deep), well drained soils with a dark yellowish brown to brown medium textured top soil underlain by a brown to yellowish brown and sometimes reddish brown moderately fine textured subsoil (Moorman and Panabokke, 1961, Alwis and Panabokke, 1972).

The reaction of the soils are strongly acid (PH range 4 to 5). The base saturation is less than 35% i.e. the soils are extensively leached and poor in natural fertility. The cation exchange capacity of the subsoil ranges from 10 to 15 meg/100 gm soil. The soils respond well to good fertilizer management.

The moisture holding capacity of the soil is about 8 to 10%. Given a average evapotranspiration demand of about 4 to 5 mm per day a 1.2 m deep soil could supply moisture for 20 - 30 days.

Table 2. List of soil groups present in the map units

SOIL GROUPS	CODE
Complex of well drained red yellow podsolic soils with a ironstone gravel layer with or without plinthite in the subsoil and red yellow podsolic modal soils.	1
Complex of well drained red yellow podsolic modal soils with red yellow podsolic soil either mottled or with plinthite in the deep subsoil	2
Imperfectly drained red yellow podsolic soil sometimes with a cover of alluvial or regosolic material	3
Well drained red yellow podosolic soil with more than 15% decomposing rock fragments irregularly distributed in the profile.	4
Complex of very poorly drained bog and half bog soils	5
Complex of poorly drained humic colluvial gley soils and half bog soils	6
Complex of poorly drained humic alluvial gley soils and half bog soils	7
Poorly drained low humic alluvial gley soil	8
Well to moderately well drained levee alluvial soil	9
Imperfectly drained levee alluvial soil	10
Well to moderately well drained regosols	11
Imperfectly drained regosols	12
Imperfectly drained shallow regosols overlying coral stone	13
Complex of very poorly drained bog and half bog soils with a fair amount of sulphides.	14

The erodibility factor is estimated to be 0.22 (Joshua, 1977) which makes the red yellow podsolic soils the most stable soil in Sri Lanka. Given the climatic conditions existing in the Wet Zone of Sri Lanka with high rainfall of high intensities, very good soil conservation measures have to be taken to conserve the soil.

In the Soil Taxonomy (USDA staff, 1975) this soil is classified as a Paleudult at the great group level.

The red yellow podsolic soils with a ironstone gravel pavement has around 30% gravel in a layer 30-60 cm thick. This layer exhibits low moisture holding capacity of 4-6%. Soils having this gravel layer supply moisture optimally only for about 15-25 days. The gravel layer also would impede root growth especially in the seedling stage of crop plants.

These soils are classified as Paleudults in the Soil Taxonomy.

The red yellow podsolic soils with plinthite has dark reddish brown mottles in reticulate patterns in a continuous phase within 125 cm of the surface. The soil material in this horizon would harden on exposure and alternate drying and wetting.

These soils are classified as Plinthudults.

The soils with mottled subsoil have dark reddish brown individual mottles which are not present in a reticulate pattern. These soils are also classified as Paleudults.

The imperfectly drained red yellow podsolic soils occur in the lower positions of the residual landscape and are most commonly seen in the mantle plain. They have greyish yellow brown to brown moderately coarse textured to medium textured top soil overlying moderately fine textured brownish grey mottled subsoil. Sometimes plinthite is present in the sub-soil. At some locations a thin gravel pavement is present.

3.2 Bog Soils

Bog soils occur in depressed sites such as backswamps of flood plains, in narrow valleys and in sites adjoining lagoons.

The bog soils have more than 30% organic matter and consists of black to brownish black muck, mucky peat or peat (Dimantha, 1977). These are very poorly drained soils and have a low bulk density which varies with the moisture content. Due to the low density, the soil materials tend to float at times of high water levels. The bearing capacity of these soils is low and cannot support men, animals or machinery at most field moisture contents. This property constitutes the major limitation of the soil and causes difficulties in applying intensive management techniques for paddy cultivation.

The reaction of the soil in the field state with high moisture content is strongly acid (pH 4.5-5.5). The electrical conductivity (EC) depends on whether the soil is subject to salinity or not. The electrical conductivity of the soils not subject to salinity is less than 0.1 mmho/cm. These soils have low base saturation and are low in natural fertility.

Bog soils occuring close to the coastal plain adjoining lagoons etc., have a fair amount of sulphides in the wet anaerobic condition. If these soils are drained too much and get aerated sulphates would form and the soils will be extremly acidic.

Bog soils are classified as Saprists and Hemists at the suborder level in the Soil Taxonomy.

3.3 Half Bog Soils

The half bog soils contain between 15-30% organic matter. The bearing capacity of these soils are much better than of bog soils and can support men and animals at most field moisture status. Therefore these soils are easier to manage. The pH is around 4.5 to 5.5 and the electrical conductivity of soils not subject to tidal intrusion is low. The classification according to the Soil Taxonomy is Tropaquents.

3.4 Humic Alluvial and Humic Colluvial Gley Soils

These soils occur in the poorly drained valleys and flood plains. These soils have brownish grey to brownish black surface horizone containing 5-15% organic matter overlying mottled brownish grey to grey fine textured subsoils. In the colluvial soils there are few pockets of coarser textured material and gravel in the profile.

These soils have good bearing capacity and light tractors too could be operated on these soils. The reaction is strongly acid and the base saturation is low. These soils are classified as Tropaquents in the Soil Taxonomy.

3.5 Low Humic Alluvial Gley Soils

These soils have less than 5% organic matter in the surface horizone. The soils have mottled brownish grey to grey fine textured soil material. Most properties of these soils are similar to that of soils described in section 3.4 except for low organic matter. These soils have very low moisture holding capacity and tend to dry out very rapidly. These soils are also classified as Tropaquents according to the Soil Taxonomy.

3.6 Levee Alluvial Soils

These soils occur in a narrow bank alongside the main Nilwala river and its main branches in the upstream reaches.

These soils are generally fine textured containing a high amount of silt and are generally brown in colour in the well drained soils and grey to brownish grey and mottled in the imperfectly drained soils. These soils are classified as Tropofluvents.

3.7 Regosols

These soils occur in the coastal plain. They are coarse textured and are moderately well drained to well drained soils, and grey to brownish

grey and mottled in the imperfectly drained soils.

These soils are associated with coral beds and sea shells. Therefore, there is a certain amount of calcium available in the subsoil.

Groundwater tables are present at relatively shallow depths of around 1-3 meter in the well drained locations and 0.5-2 m in the imperfectly drained locations. Most perennial plants like coconuts are able to utilize this water.

4. LAND UTILIZATION TYPES

The land utilization types taken for the study are shown in table 3. Different levels of management for tea, rubber, coconut are considered to show the potential loss in return due to poor management. The table is for the most part self explanatory.

Citronella cultivation which was widely prevalent in the district over 2 decades ago was seen to contribute to a lot of soil degradation due to heavy erosion. When citronella is harvested the soil is exposed to the beating action of rain and a lot of erosion resulted. Citronella is not cultivated very much now due to low prices obtained for citronella oil. In the event citronella becomes economic again, it is considered as a LUT but with a high technological level of management. This includes well designed soil conservation works combined with contour growing of citronella and harvesting in alternate strips to minimize erosion.

A new LUT sedges cultivation(Dimantha, 1977, Jayaweera, 1980) for the lands unsuitable for paddy is proposed. The cultivation of sedges entails much less risks than paddy cultivation and would be a new proposal for establishing a cottage industry in the integrated rural development plan.

In limited areas farmers are cultivating annual crops like cowpea, okra, brinjals on broad bunds in paddy fields. The suitability of lands for this LUT too is evaluated so that extension to other areas may be considered.

Intercropping is proposed by the Coconut Research Institute for coconut lands to maximize returns from these lands. To evaluate the suitability of lands for intercropping with coconut, the suitability of the lands for annual crops or minor export crops should be referred to.

Table 3. Land Utilization Types

No.	Product	Capital		Farm Power	Farm Size	Technical knowhow	Type of Technology
		Development	Recurrent				
1	Tea	high	high	high labour	medium to large	high	using new clones and TRI fertilizer recommendations
2	Tea	medium(subsidy available)	low	low labour	small to large	low	using new clones and fertilizer in early stages only
3	Rubber	high	high	labour	small to large	high	using new clones and RRI fertilizer doses, disease control, tapping through wintering period
4	Rubber	medium(subsidy available)	low	labour	small to medium	low	using new clones and fertilizing in early stages only
5	Coconut	high	medium	labour	small to large	high	mostly existing old plantations some with new hybrid varieties using CRI fertilizer doses
6	Coconut	medium(subsidy available	low	labour	small to large	medium	existing plantations, low fertilize applications
7	Paddy (irrigated	medium	high	machinery for LP	small to medium	medium/ high	improved varieties, transplanted, weedicide, pesticide, fertilizer applications
8	Paddy (rainfed)	medium	low	manual, animals or machinery for LP	small to medium	medium	village varieties, basal and urea fertilizing

TRI Tea Research Institute, RRI Rubber Research Institute, CRI Coconut Research Institute
Land preparation.

Table 3 Continued. Land Utilization Types

No.	Produce	Capital		Farm Power	Farm Size	Technical knowhow	Type of Technology
		Development	Recurrent				
9.	Pasture	high	high	labour	medium	high	mainly improved fodder grasses, strip harvesting
10.	Pasture	low	low	labour	small to medium	low	local grasses, uncontrolled grazing
11.	Minor export crops-cinnamon, nutmeg, cloves	high	medium	labour	medium to large	medium	existing and new plantations good soil conservation works.
12.	minor export crops as above	low	low	labour	small to medium	low	existing plantations with poor or absent conservation measures.
13.	Annual crops	medium	high	labour	small	high	using high fertilizer, pesticides
14.	Annual crops	medium	low	labour	small	medium	low fertilizer and pesticide use government operated
15.	Forestry	low to high	low		large	high	government operated
16.	Citronella	high	high	labour	small to large	high	contour planting and strip harvesting
17.	Sedges	medium	low	labour	small	medium	
18.	Annual crops in paddy field	medium	low	labour	small	medium	crops grown on extra wide bunds on paddy fields.

5. LAND QUALITIES

Some of the individual characteristics of the lands are shown in table 4. These characteristics do not affect lands use directly. The term Land Quality is proposed by Beek & Bennema (1972) as being a complex attribute of land which has a direct bearing on a basic requirement of land use and is expected to influence land use independantly of any other land quality. The grading of the land quality is determined by one or more interacting land characteristics.

12 land qualities are proposed as being relevant for the different LUT in this study and their gradings are shown in tables 5 to 16.

5.1 Soil Moisture Availability

The land quality soil moisture availability is discussed for perennial crops. Tea seems to be the crop of all the perennial crops considered which shows early symptoms of drought effect. The effect of drought was seen at one month of occurrence when buds were scanty. This observation is confirmed by Chenery (1966) who says that tea bushes can grow optimally for one month without any rainfall contribution. After about 2 months of drought tea bushes are seen to be predisposed to termits attack and the bushes would start dying off.

The agroecological zones WM_1 and WL_1 (Land and Water Use Division,1976) are expected to experience a $1\frac{1}{2}$ month period of drought in more than 75% of the years. The zones WL_2 and WL_4 experience 2 & $2\frac{1}{2}$ month drought periods in 75% of the years. This data was used to assess the land quality soil moisture availability and the gradings are shown in table 5a.

Analysis of the rainfall pattern at Denagama which is supposed to be in the intermediate zone failed to show any difference in the rainfall pattern from a station in the WL_4 region. Also in this region the soils were Red Yellow Podsolic soils and not Reddish Brown Earths and Immature Brown Loams as shown in the Agro-ecological map. Therefore for the purpose of this study it is taken that the intermediate zone boundary falls outside the Matara District.

Table 4. Land Characteristic Classes

Soil Depth	Code
Deep 1.2 m	1
Variable	2

Slope class %	Code
0-2	1
2-6	2
0-10	3
10-25	4
25-40	5
40-50	6
50-70	7
70	8

Soil Drainage	Code
Well drained	1
Moderately well drained	2
Imperfectly drained	3
Poorly drained	4
Very poorly drained	5

Soil Texture	Code
Medium	1
Fine	2
Coarse	3
Organic materials	4

Land Use/Vegetation	Code
Forest	1
Well managed land	2
Poorly managed land	3
Homestead gardens	4
Annual crops	5
Paddy	6

Cation exchange capacity	Code
10 meq/100 gm soil	1
5-10 meq/100 gm soil	2
5 meq/100 gm soil	3

Soil pH	Code
4-5	1
5	2

Groundwater depth	Code
1.5 m	1
1.5 m	2

Gravel %	Code
< 10% in upper 90 cm	1
> 10% in upper 90 cm	2
< 25% in a 30 cm layer (restricting layer)	2

Natural fertility	Code
medium	1
low	2
very low	3

Rockiness %	Code	Symbol
0 - 10	1	no symbol
10 - 20	2	X
20 - 30	3	XX
30	4	XXX

Physiographic unit	Code
Coastal plain	1
Mantle plain	2
Highland plain	3
Mountainous region	4
Flood plain	5

The moisture availability for rice was analysed by using daily rainfall data of stations within the different agro-ecological zones for 30 years. Simulations of paddy cultivations were done making the following assumptions. Optimum data for Yala season sowing is March 15-30th; and for Maha Sept. 15-30th. About 12 to 15 cm of rainfall should fall within 2 weeks to enable adequate land preparation. If the land is prepared in time the farmer uses a 4½ month variety which comes in for harvest around August 1-15th for Yala and February 1-15th for Maha, which seems to be the most optimum time for harvest in all agroecological regions. If the land preparation is delayed the farmer uses a 3½ month variety.

During the growing season it is assumed that the potential evapotranspiration is equal to 1:1.2 times the reference crop evapotranspiration shown in table 1. It is also assumed that there is about 5-7 cm of standing water in a paddy field and the paddy crop could stand about 14 days without rainfall while the standing water and soil moisture storage is utilized for evapotranspiration. Beyond 14 days growth or reproductive processes are affected and optimum yields are not obtained.

To evaluate the land quality soil moisture availability for rainfed paddy simulations of the cultivation of paddy was made to estimate in how many of the seasons there was successful sowing and successful growing periods.

To classify the land with grade 1 soil moisture availability there should be more than 80% successful sowing at the correct period and more than 80% seasons without shortages of water during the growing season. In grade II lands there is more than 50% successful sowings and more than 50% of the seasons without shortages of water. Grade III lands will have less than 50% successful sowing and less than 50% successful seasons. The land quality ratings are shown in table 5b.

Table 5a. Moisture Availability for Perennial Crops (m).

Grade	Ag.Ec. zone	Soil type	Depth	Gravel	Rock	Texture	Water table	Drainage
I	WM_1	2,4	1,2	1,2	1,2	1,2	1	1
II	"	4	2	2	3	1,2	1	1
III	"	4	2	2	4	1,2	1	1
I	WL_1	2	1	1	1	1,2	1	1
II	"	2,4	1,2	1,2	2	1,2	1	1
III	"	4	2	1,2	3	1,2	1	1
IV	"	4	2	1,2	4	1,2	1	1
I	"	9	1	1	1	1,2	2	1,2
I	$WL_{2,4}$	3,10	1	1	1	1	2	3
II	"	2	1	1	1	1,2	1	1
III	"	1	1	2	1	1,2	1	1
III	WL_1	2,4	1,2	1,2	2	1,2	1	1
IV	"	4	1,2	1,2	3	1,2	1	1
I	"	9	1	1	1	1,2	2	1,2
I	WL_4	11,12	1	1	1	3	2	1,2,3

Table 5b. Moisture Availability for Rainfed Paddy (m).

Grade	Ag.Ec. zone	Soil type	water table	Drainage
I	WL_1, WL_1	5,6,7	2	4
I	WL_2	5	2	4,5
II	WM_1, WL_1	8	2	4
II	WL_2	6,7	2	3
II	WL_4	5	2	4,5
III	WL_2	8,10	2	4
III	WL_4	6,7,8,10	2	3,4

The moisture availability for annual crops was graded by estimating the number of dry periods which are longer than 14 days. The gradings are presented in table 5c.

Table 5c. Moisture Availability for Annual Crops(m)

Grade	Agro-Eco. zone	Soil type	Water table	Drainage
I	WM_1, WL_1	1,2,3,4 9,10	1,2	1,2,3
I	WL_2, WL_4	3,10	2	3
II	WL_2	1,2,4,9	1	1,2
III	WL_4	1,2,4	1	1

Table 6. Nutrient Availability for Crop Growth (n)

Grade	Soil type	Gravel	Natural Fertility	GEC	PH
II	6,7,9,10	1	1	1	2
III	2,3,8	1	2	1	1
IV	1,4	2	2	2	1
IV	11,12,13	1	2	3	1
IV	5	1	3	1	2

Table 7. Oxygen Availability for Crop Growth (o)

Grade	Drainage
I	1,2
II	3
III	4
IV	5

Table 8. Resistance to Erosion (e)

Grade	Soil types	texture	physio-graphic unit	Slope	Vegetation
I	1,2,3,4	1,2	2,3,4	3,4	1,2,4
I	9,10	1,2	5	1,2	2,3,4
I	11,12	3	1	1	2,3,4,5
II	1,2,3,4	1,2	2,3,4	3	2,3,4
II	1,2,3,4	1,2	2,3,4	5,6	1,2
II	1,2,3,4	1,2	3,4	6,7,8	1
III	1,2,3,4	1,2	3,4	6,7	2
III	1,2,3,4	1,2	3,4	5	3
III	1,2,3,4	1,2	2,3,4	4	5
IV	1,2,3,4	1,2	3,4	8	2
IV	1,2,3,4	1,2	3,4	6	3
IV	1,2,3,4	1,2	3,4	5	5
V	1,2,3,4	1,2	3,4	6,7,8	3
I	1,2,3,4	1,2	2,3,4	3	5
I	1,2,3,4	1,2	2,3,4	5	1

Table 9. Absence of a Salinization Hazard (s)

Grade	Physiographic Unit	Position	Mode of salinization
I	5	above 1' MSL	
II	1	above 1' MSL	salt spray
III	5	below 1' MSL	tidal intrusion

Table 10. Absence of Toxicity Hazard (t)

Grade	physiographic unit	position	type of problem
I	1,2,3,4	All upper slopes	
II	5	Wide valleys not in proximity to highland	
II	5	lands close to highlands	interflow problem due to high Iron content
III	2,3,4	narrow valleys	do
IV	5	tidal marshes	sulphate toxicity on draining
IV	1	all positions	excess Calcium causing precoagulation of latex in rubber

Table 11. Availability of Sufficient Radiation (r)

Grade	Physiographic unit	Position
I	1,2,3,4	all uplands
I	5	most positions
II	2,3,4	narrow valleys 50 meter

Table 12a. Availability of a Good Harvesting Period for Rubber (h)

Grade	Agro.ec. zone	Number of available days
I	WL_4	240 - 280
I	WL_1, WL_2	200 - 240
III	WM_1	$\angle$ 200

Table 12b. Availability of a Good Ripening and Harvesting Period for Paddy (h)

Grade	Agro-Ec.zone	% of successful harvest
I	WL_4	>80
II	WL_1, WL_2	50-80
III	WM_1	<50

Table 13. Bearing Capacity (Paddy Lands) (b)

Grade	Soil type	Possibility for mechanization
I	8	Mechanization possible all seasons
II	6,7	" " when not too wet
III	5	" " only when extremely dry

Table 14. Absence of Flooding Hazards (f)

Grade	Physiographic unit	position	degree of flooding
I	5	above f_1	no damaging flooding in 90% of years
II	2,3,4	valleys	flash flooding
III	5	below f_1	damaging floods in 10% of years

Table 15. Availability of Sufficient Land Space to Achieve Optimum Planting Density (s)

Grade	Rockiness class
I	1
II	2
III	3
IV	4

Table 16. Availability of a Suitable Temperature Regime (c)

Grade	agro-ec. zone
I	WL_1, WL_2, WL_4
II	WM_1

Table 17. Land Quality Requirements for High Performance of Land Utilization Types (for Interpretations of the code letters refer to tables 5 to 15)

Land Quality	Land Utilization Types									
	1	3	5	7	8	9	11	13	15	16
m	I	I,II	I,II	I to IV	I	I,II	I,II	I	I to IV	I
n	II,III	II,III	II,III	II, III	II	II,III	II,III	II,III	II, III	II,III
o	I	I,II	I,II	III,IV	III,IV	I,II	I	I	I	I
e	I	I,II	I	I	I	I to II	I,II	I	I to IV	I,II
s	I	I	I,IIa	I	I	I	I	I	I	I
t	I	I	I	I	I	I	I	I	I	I
r	I	I	I	I	I	I	I	I	I	I
h	NR	I	NR	I	I	NR	NR	I	NR	NR
b	NR	NR	NR	I,II	I	I	NR	I	NR	NR
f	I	I	I	I	I	I	I	I	I	I
a	I	I,III	I	I	I	I	I,II	I	Ito III	I
c	I,II	I	I	I,II	I,II	I,II	I,II *	I,II	I,II	I,II

NR = NOT RELEVANT

I* I FOR CINAMMON

6. CROP REQUIREMENTS

The land quality requirements of each crop type proposed for optimal performance is shown in Table 17. The combinations of land qualities at which there is sub-optimal performance are tabulated in tables 18-25.

Table 18. Land Quality (LQ) combinations for Tea (Class II & III)

Class II

LQ	Combinations of LQ		
m	II	I	I
0	I	I	I
e	I	I	II
a	I	II	I

Class III

LQ	Combinations of LQ				
m	I,II	I	III	I	I
0	I	I	I	II	I
e	II	I	II	I	III
a	II	III	I	I	I

Table 19. Land Quality Combinations for Rubber (Class II & III)

Class II

LQ	required combinations of LQ				
m	I,II	I,II	III	I	I
0	I	I	I	I	I
e	III	I,II	I,II	I	II
a	I,II	III	I,II	I,II	I
h	I	I	I	II	I
c	I	I	I	I	I

Table 19. continued. Land Quality Combinations for Rubber

Class III

LQ	Combinations of LQ					
m	III	I,II	I,II	I,II	I,II	I,II
o	I	I	II	I	I	I
e	III	III	I,II	I,II	IV	I,II
a	III	I,II	I,II	III	III	I,II
h	I	II	I	II	I	II
c	I	I	I	I	I	I

Table 20. Land Quality Combinations for Coconut (Class II & III)

ClassII

LQ	Combinations of LQ				
m	I,II	I,II	I	I,II	I
o	I	II	I	I	III
e	I	I	I	II	I
a	II	I	I	I	I
c	I	I	II	I	I

Class III

LQ	Combinations of LQ			
m	III	II	I	I
o	I	I	I	I
e	II	II	I	II
a	I	II	II	I
c	I	I	II	II

Table 21. Land Quality Combinations for Irrigated Paddy(Class II & III)

Class II

LQ	Combinations of LQ			
s	I	I	I	I
t	I	I	I	I
r	I	I	I	I
h	II	I	II	I
b	I	II	II	III
f	I	II	I	I

Table 21. Class III

LQ	combinations of LQ					
s	I	I	I	II	I	I
t	I	III	II	I	I	I
r	I	II	II	I	I	I
h	I,II	I	II	I	II	II
b	I,II	I,II	II	I	I	III
f	II	I	II	III	II	I,II

Table 22. Land Quality Combinations for Rainfed Paddy (Class II & III)

Class II

LQ	combinations of LQ		
m	II	II	I
n	II	III	II
s	I	I	I
t	I	I	I
r	I	I	I
h	II	II	II
b	I,II	I	II
f	I,II	I,II	II

Class III

LQ	Combinations of LQ					
m	III	II	I	II	II	I
N	II,III	II	IV	IV	III	II
s	I	I	I	I	I	I
t	I	I	I	I	I	I
r	I	I	I	I	II	I
h	II	II	II	I	II	III
b	I,II	II	III	III	I	II
f	I,II	II	I,II	I,II	II	II

Table 23 Land Quality Combinations for Pasture (Class II & III)

Class II

LQ	combinations of LQ			
m	II	II	I	III
e	II	I	I	I
a	I	II	II	I

Class III

LQ	combinations of LQ			
m	II	II	I	I
e	I	II	I	II
a	III	II	III	II

Table 24. Land Quality Combinations for Minor Export Crops(Class II & III)

Class II

LQ	combinations of LQ					
m	I	I	I	II	II	II
e	I	II	III	I	II	I
a	III	II	I	II	I	I

Class III

LQ	combinations of LQ				
m	I	I	II	II	II
e	II	III	I	II	III
a	III	II	III	II	I

Table 25. Land Quality Combinations for Annual Crops(Class II & III)

Class II

LQ	combinations of LQ		
m	I	II	III
e	II	II	I
a	I	I	I
n	II	II	II

Class III

LQ	combinations of LQ				
m	III	II	II	I	I
e	II	II	I	II	III
a	I	II	II	II	I
n	II	II	II	II	II

7. MAPPING UNITS

The mapping units of the land classification map are presented in table 26. The major unit in the land classification is the agro-ecological zone. There are 4 agro-ecological zones demarkated in the map WM_1, WL_1, WL_2, WL_4. Next the physiographic region and the position of the land in the physiographic unit is taken into the classification. The physiographic units are next subdivided on the type of vegetation cover i.e. forest, well managed land and poorly cultivated land, homesteads etc., The poorly managed lands are demarkated to show the extent of poor management in the area and the need for extensive rehabilitation work. The next subdivision is the slope class and then the rock cover is taken next. A soil type or soil complex is associated with each of the final subunit of land.

Table 26. The Mapping Units

For the interpretations of the code number under each heading refer to table 3 and 4.

Symbol	Land use/vegetation	Slope class	Rock class	Soil group
Mountainous region upper slopes.				
1	1	3,4,5,6,7	1,2,3,4	2,4
2	2	"	1	"
2x*	2	"	2	"
3	3	3,4,5,6,7	1	2,4
3x	3	"	2	"
3xx	3	"	3	"
3xxx	3	"	4	"

The symbol x may be placed before or on top or bottom of the digit symbol in the land classification map depending on the space availability.

Table 26. continued. The Mapping Units

Symbol	Land use/vegetation	Slope class	Rock class	Soil group
Mountainous region valleys				
4	6	1	1	6
4a(not in map; narrow valleys)	6	1	1	6
Highland plain upper slopes				
5	1	3,4,5,6,7	1,2,3,4	2,4
6	2	"	1	"
6x	2	"	2	"
7	3	"	1	"
7x	3	"	2	"
7xx	3	"	3	"
7xxx	3	"	4	"
Highland plain valleys				
8	6	1	1	6
8x	6	1	1	5,6
(not shown in map ; narrow valleys less than 50m wide)				
Mantle plain low hillocks upper slopes				
9	4	3,4,5	1	1
10	2	"	1	1
11	3	"	1	1
Mantle plain high hillocks upper slopes				
12	2	3,4,5	1	2
13	3	"	1	2
13x	3	"	2	2
Mantle plain lower slopes				
14	2,3,4,5	1,2	1	3

Table 26. continued. The Mapping Units

Symbol	Land use/vegetation	Slope class	Rock class	Soil group
Mantle plain valleys				
15	6	1	1	8
15a	6	1	1	8
	(narrow valleys not shown in map)			
16	6	1	1	6
16a	6	1	1	6
	(narrow valleys not shown in map)			
17	6	1	1	5
17a	6	1	1	5
	(narrow valleys not shown in map)			
Flood plain levee				
18	2,3,4,5	1,2	1	9
19	"	1	1	10
Flood plain back slope				
20	6	1	1	8
21	6	1	1	7
Flood plain backswamp				
22	3/6	1	1	5/14
25	3	1	1	14
Coastal plain				
23	2,3,4,5	1	1	11
24	"	1	1	12,13

8. LAND SUITABILITY

The present land suitability is evaluated first. For some lands which grade low certain improvement specifications are given and the potential suitability is evaluated. The improvement in the suitability gradings brought about by improvement in the management whose costs should be within the capacity of the farmer (probably through easy credit facilities) is shown by the difference in gradings between the land utilization types with higher management level and land utilization types with lower management level.

The land suitability evaluation is only a physical land suitability evaluation and no economic or social criteria are considered, other than the qualitative economic and social criteria considered for the land utilization types.

The lands are classified into 4 suitability classes as follows:-

Class I. Suitable land where the combination of land qualities are fairly optimum and no significant limitations are expected in most years.

Class II. Moderately suitable land where the lands have few limitations for the considered land use.

Class III. Marginally suitable lands in which the land qualities grade so low that there are fairly severe limitations for the sustained application of a given use.

Class IV. Unsuitable land for a considered land utilization type.

8.1. Present Land Suitability

The present land suitability of the lands for the considered land utilization types are shown in table 27 The code numbers used for the map units and the land utilization types are as used in tables.

Table 27. Land Suitability Ratings

High management level

Land unit	Slope class	Land Utilization Type 1	3	5	9	11	13	15	16
Agro-ecological zone WM_1									
2	3	I	IV	II	I	I	I	I	I
2x	3	II	IV	III	II	I	II	I	II
2xx*	3	III	IV	IV	III	III	IV	I	III
2	4	I	IV	II	I	I	II	I	I
2x	4	II	IV	III	II	I	IV	I	II
2xx*	4	IV	IV	IV	III	II	IV	I	III
2	5	II	IV	III	I	I	IV	I	I
2x	5	III	IV	IV	II	II	IV	I	II
2xx*	5	IV	IV	IV	III	II	IV	I	III
2	6	II	IV	IV	I	II	IV	I	II
2x	6	III	IV	IV	III	II	IV	I	III
2xx*	6	IV	IV	IV	IV	III	IV	I	II
2	7	III	IV	IV	III	II	IV	I	III
2x	7	IV	IV	IV	IV	III	IV	I	IV
2xx*	7	IV	IV	IV	IV	IV	IV	I	IV
2xxx*	3,4,5,6,7	IV	IV	IV	IV	IV	IV	II	IV
Agro-ecological zone WL_1									
6	3	I	I	I	I	I	I	I	I
6x	3	II	II	II	II	I	II	I	II
6xx*	3	III	III	IV	III	II	IV	I	III
6	4	I	I	I	I	I	II	I	I
6x	4	II	II	II	II	I	III	I	II

* this omit is not in the map at present

\+ down grade 2 classes for cinnamon

Table 27 continued. Land Suitability Ratings

Land unit	Slope class	1	3	5	9	11	13	15	16
Agro-ecological zone WL_1									
6xx	4	IV	III	IV	III	II	IV	I	III
6	5	II	I	II	I	I	IV	I	I
6x	5	III	II	III	II	II	IV	I	II
6xx*	5	IV	III	IV	III	II	IV	I	III
6	6	II	II	IV	I	II	IV	I	II
6x	6	III	III	IV	III	II	IV	I	III
6xx*	6	IV	IV	IV	IV	III	IV	I	IV
6	7	III	III	IV	III	II	IV	I	III
6x	7	IV	III	IV	IV	III	IV	I	IV
6xx*	7	IV	IV	IV	IV	IV	IV	I	IV
6xxx*	3,4,5, 6,7	IV	IV	IV	IV	IV	IV	II	IV
Agro-ecological zone WL_2									
6	3	II	I	I	I	I	II	I	II
6x	3	III	I	II	II	II	III	I	III
6xx*	3	IV	II	IV	III	III	IV	I	IV
6	4	II	I	I	I	I	III	I	II
6x	4	III	I	II	II	II	IV	I	III
6xx*	4	IV	II	IV	III	III	IV	I	IV
6	5	II	I	II	I	I	IV	I	II
6x	5	III	I	III	II	II	IV	I	III
6xx*	5	IV	II	IV	III	III	IV	I	IV
6	6	III	II	IV	II	I	IV	I	III
6x	6	III	II	IV	III	III	IV	I	IV
6xx*	6	IV	III	IV	IV	IV	IV	I	IV
6	7	III	II	IV	IV	III	IV	I	IV
6x	7	IV	II	IV	IV	IV	IV	I	IV
6xx*	7	IV	III	IV	IV	IV	IV	I	IV
18	1	II	I	I	I	I	II	I	I
19	1	III	IV	II	I	III	III	II	III

Table 27 continued. Land Suitability Ratings

Land unit	Slope class	Land Utilization Type 1	3	5	9	11	13	15	16
Agro-ecological zones WL_2 & WL_4									
9	3	NA	NA	I	II	I	II	NR	NR
9	4	NR	NR	I	II	I	III	NR	NR
9	5	NR	NR	II	II	I	IV	NR	NR
10	3	III	II	II	II	II	III	I	II
10	4	III	II	II	II	II	IV	I	II
10	5	III	II	II	II	II	IV	I	II
12	3	II	I	I	I	I	II	I	I
12	4	II	I	I	I	I	III	I	I
12	5	II	I	II	I	I	IV	I	I
12x	3	III	I	II	II	II	II	I	II
12x	4	III	I	II	II	II	III	I	II
12x	5	IV	I	III	II	II	IV	I	II
14	1	III	III	I	I	III	I	II	II
Agro-ecological zone WL_4									
23	1	IV	IV	I	II	III	III	NR	IV
24	1	IV	IV	II	IV	IV	II	NR	IV

Land unit	Slope class	Low Management Level Land Utilization Type 2	4	6	10	12	14	15
Agro-ecological zone WM_1								
3	3	II	IV	III	II	II	II	I
3x	3	III	IV	IV	III	III	III	I
3xx	3	IV	IV	IV	III	III	IV	I
3	4	II	IV	III	II	II	III	I
3x	4	III	IV	IV	III	III	IV	I
3xx	4	IV	IV	IV	III	III	IV	I
3	5	IV	IV	IV	II	II	IV	I
3x	5	IV	IV	IV	III	III	IV	I
3xx	5	IV	IV	IV	IV	IV	IV	I
3	6	IV	IV	IV	III	III	IV	I
3x,xx	6	IV	IV	IV	IV	IV	IV	I
3	7	IV	IV	IV	IV	IV	IV	I

Table 27 continued. Land Suitability Ratings

Land unit	Slope class	Land Utilization Type 2	4	6	10	12	14	15
Agro-ecological zone WM_1								
3x,xx	7	IV	IV	IV	IV	IV	IV	I
3xxx	3,4,5,6,7	IV	IV	IV	IV	IV	IV	II
Agro-ecological zone WL_1								
7	3	II	III	II	II	II	II	I
7x	3	III	III	III	III	III	III	I
7xx	3	IV	IV	IV	III	III	IV	I
7	4	II	III	II	II	II	III	I
7x	4	III	III	III	III	III	IV	I
7xx	4	IV	IV	IV	III	III	IV	I
7	5	IV	III	III	II	II	IV	I
7x	5	IV	III	IV	III	III	IV	I
7xx	5	IV	IV	IV	IV	IV	IV	I
7	6	IV	IV	IV	III	III	IV	I
7x,xx	6	IV	IV	IV	IV	IV	IV	I
7	7	IV	IV	IV	IV	IV	IV	I
7x,xx	7	IV	IV	IV	IV	IV	IV	II
7xxx	3,4,5,6,7	IV	IV	IV	IV	IV	IV	II
Agro-ecological zone WL_2								
7	3	III	II	II	III	II	II	I
7x	3	IV	III	III	IV	III	III	I
7xx	3	IV	III	IV	IV	IV	IV	I
7	4	III	II	II	III	II	III	I
7x	4	IV	III	III	IV	III	IV	I
7xx	5,6,4,7	IV	IV	IV	IV	IV	IV	I
7	5	III	II	III	III	III	IV	I
7x	5	IV	III	IV	IV	III	IV	I
7	6	IV	III	IV	IV	III	IV	I
7x	6	IV	III	IV	IV	IV	IV	I
7	7	IV	III	IV	IV	IV	IV	I
7x	7	IV	III	IV	IV	IV	IV	I
7xxx	3,4,5,6,7	IV	IV	IV	IV	IV	IV	II

Table 27 continued. Land Suitability Ratings

Land unit	Slope class	Land Utilization Type 2	4	6	10	12	14	15
Agro-ecological zone WL_2								
18	1	II	II	II	II	III	II	I
19	1	IV	IV	III	III	IV	III	II
Agro-ecological zone WL_2, WL_4								
9	3	NR	NR	III	II	II	III	NR
9	4	NR	NR	III	II	II	III	NR
9	5	NR	NR	III	II	II	IV	NR
11	3	III	II	III	III	II	II	I
11	4	IV	II	IV	III	III	III	I
11	5	IV	II	IV	II	III	IV	I
13	3	III	II	II	II	III	II	I
13	4	III	II	II	II	III	III	I
13	5	III	II	II	II	III	IV	I
13x	3	IV	III	III	IV	IV	III	I
13x	4	IV	III	III	IV	IV	IV	I
13x	5	IV	III	IV	IV	IV	IV	I
14	1	III	III	II	II	III	I	II
Agro-ecological zone WL_4								
23	1	IV	IV	II	III	III	III	NR
24	1	IV	IV	II	III	IV	II	NR

Land unit	Slope class	Land Utilization Type 7	8	16	18
Agro-ecological zone WL_1					
4	1	III	III	I	II
4a	1	IV	IV	II	III
Agro-ecological zone WL_1					
8	1	II	II	I	II
8a	1	III	III	II	III
15	1	II	II	II	II
15a	1	III	III	II	III
16	1	II	II	I	II

Table 27 continued Land Suitability Ratings

Land unit	Slope class	Land Utilization Type 7	8	16	18
Agro-ecological zone WL_1					
16a	1	III	III	I	III
17	1	III	III	I	III
17a	1	IV	IV	II	IV
Agro-ecological region WL_2					
15	1	II	III	II	II
15a	1	III	III	II	III
16	1	II	III	I	II
16a	1	III	IV	I	III
17	1	III	III	II	III
17a	1	IV	IV	II	IV
18	1,2	II	IV	IV	I
19	1	1	IV	IV	I
20b	1	II	III	II	II
20c	1	III	IV	I	IV
21b	1	I	II	I	II
21c	1	III	III	I	IV
22b	1	II	III	I	II
22c	1	III	IV	I	IV
Agro-ecological zone WL_4					
15	1	I	III	I	II
15a	1	III	III	I	III
16	1	I	III	I	II
16a	1	III	IV	I	III
17	1	III	III	I	II
17a	1	IV	IV	II	III
20b	1	I	III	III	II
20c	1	II	IV	II	IV
20d	1	III	IV	I	IV
21b	1	I	III	I	II
21c	1	II	IV	I	IV
21d	1	III	IV	II	IV
22b	1	II	III	I	IV
22c	1	III	IV	I	IV
22d	1	III	IV	II	IV

The other solution to flood control is to have reservoirs upstream of the river and control the discharge to the river. This solution is much more costly but has the benefit that more lands will be available for paddy cultivation and also there is the possibility of obtaining irrigation water for the paddy lands. It is seen in table 5b that the paddy lands in the agro-ecological regions WL_2 and WL_4 do not have sufficient moisture availability to carry out paddy cultivation in purely rainfed conditions.

The benefits of both solutions will be analysed in section 8.3 of this report in terms physical suitability of the lands benefited.

8.2.3 Irrigation

For a major part only surface irrigation requirements will be discussed in this report. Surface irrigation practice requires that land should be fairly flat i.e. 0 - 1% slopes for class I and 1-4% for class II irrigable land. This type of terrain is available only in the paddy lands. Therefore the evaluation of the potential suitability after the improvement of the land quality moisture availability (i.e. introduction of surface irrigation) will be discussed only for paddy lands. As some of the paddy lands are already being irrigated the suitability evaluation is already presented in table 27 under the land utilization type irrigated paddy.

Another possibility for introduction of irrigation is the application of drip irrigation methods in the case of perennial crops notably for tea, rubber, coconut etc. This idea came about duting the field work period which coincided with an extreme drought occurrence. Tea bushes in the region were suffering at various degrees due to drought. Some bushes were dormant, others were being predisposed to termits attack and were dying off. Some estate managers realising the extreme necessity of maintaining a full complement of tea bushes per unit area were even resorting to hand watering of their tea plantations. As mentioned in section 1.5.2 some hills in the highland plain have almost perennial streams. This water could be utilized at least in the lower slopes for drip irrigating perennial crops. Drip irrigation could be adopted

in sloping lands as the drip lines can be run on the contour.

8.2.4 Provision of Intercepter Drains

The lands in narrow valleys were identified as being liable to occurrence of interflow from highlands and toxicity problems were seen to occur. One way to alleviate the problem will be to provide a intercepter drain to intercept the interflow. This intercepted water could be used for irrigation of paddy after a suitable lapse of time to allow for aeration of the water. Anicuts could be built along the canal to enable the irrigation of the paddy lands.

8.2.5. Improvement Specification For Rubber Harvesting

One problem of cultivating rubber in areas with high rainfall is the reduction in the number of tapping days bringing down the yield. Some improvements can be made to increase the number of tapping days. The Rubber Research Institute takes the view that tapping can be continued in the wintering period of rubber in well fertilized rubber plantations during Feb/March. This is a very dry period and at least 20 more days of tapping can be achieved. This facto. has being taken into account in dealing with the 2 land utilization types well managed and poorly managed rubber. It seems that a further 30 days of tapping per year can be availed of by installing rain guards. Experiments have been going on for years on rain guards , and just now a fairly satisfactory design has been achieved (Dissanayake, 1980). With this improvement the lands in agro-ecological region WL_1 will be upgraded by one unit in the potential suitability evaluation due to the land quality availability of a good harvesting period coming upto class I.

8.2.6 Other Improvements

A few other improvements could be achieved by breeding salinity resistant varieties of paddy for the lands subject to salinity and also by breeding Oidium resistant varieties of rubber for the WM_1 region.

8.3 Potential Suitability

The potential suitability of the lands where improvements have been made are presented in table 28.

Table 28. Potential Suitability of Paddy on Introduction of Flood Control Measures and Irrigation

Land unit	Paddy rainfed flood control no irrigation WL_4 region	Land Utilization Type: Paddy rainfed flood control no irrigation WL_2 region	Paddy flood WL_4	Irrigated control WL_2
20c	III	III	II	II
20d	IV		IV	
21c	III	II	I	II
21d	IV		IV	
22c	III	III	II	II
22d	IV		IV	

Table 29. Potential Suitability of Paddy Lands with intercepter drains

Agro-ecological region WM_1	
4 a	II/III
Agro-ecological region WL_1	
8 a	II
15 a	II
16 a	II
17 a	III
Agro-ecological region WL_2	
15 a	II
16 a	II
17 a	III
Agro-ecological region WL_4	
15 a	II
16 a	III
17 a	III

9. CONCLUSION

The main observation made during this study has been a widespread fairly poor level of management especially with regard to the conservation of the land. Therefore it is urged that a great deal of attention be paid to mobilise action to enforce better use of the land. This action will be paid for in higher returns from the land.

It is also stressed that administrators and politicians realize that lands require management and cannot be haphazardly taken for cultivation and also that there are lands unsuitable for cultivation. They should realize that unsuitable land better be left undisturbed or reforested rather than enforce a proposed rule that all land owners should cultivate their land or face punishment. The unsuitable paddy lands could take on an alternate crop like sedges which would be more successfully grown and be more profitable. If the rules are enforced and paddy is forced on these lands, land owners will loose their investment year after year as is happening now too in some areas. This loss is also a national loss. If any new land is opened up, there should be strict enforcement of soil conservation measures. One gets nervous when successive governments announce crash food drives whereby an open licence is given for the rape of the land. No one should be allowed to destroy a natural resource which should be available for successive generations over centuries to use.

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APPENDIX I

AREAS OF MAP UNITS

The areas of the map units are presented in Table 30. The areas were computed by placing a dotted grid on the land classification map and counting the appropriate dots or squares. The map units 2,3,6,7, 7,9, 10, 11, 12, & 13 were also subdivided into approximate slope classes. These slope classes were obtained from the 1: 63360 topographic sheets and are not accurate. The units of the flood plain (especially the Nilwala flood plain) too were subdivided according to their position in relation to the 1' mean sea level contour and the 10 year return period flood line.

The boundaries of the agro-ecological zones retained in the study are indicated in the map annexed.

Table I Areas of Map Units

Map Unit	Slope Class	Area ha
Agro-ecological zone WM_1		
1	3,4,5,6,7,8	6260
2	total	1170
2	3	100
2	4	830
2	5	210
2	6	30
2x	total	440
2x	3	30
2x	4	190
2x	5	190
2x	6	30
3	total	7830
3	3	450
3	4	5360
3	5	1890
3	6	130

Table I continued

Map Unit	Slope Class	Area ha
3x	total	2830
3x	3	80
3x	4	1360
3x	5	1270
3x	6	100
3x	7	20
3xx	total	1460
3xx	3	100
3xx	4	660
3xx	5	630
3xx	6	70
3xxx	3,4,5,6,7	1750
4	1,2	1720
	total WM_1	23460
Agro-ecological zone WL_1		
5	3,4,5,6,7,8	6170
6	total	550
6	3	100
6	4	240
6	5	210
6x	total	110
6x	4	60
6x	5	50
7	total	6910
7	3	1290
7	4	4790
7	5	830
7x	total	2660
7x	3	50
7x	4	1760
7x	5	830
7x	6	20
7xx	total	1970
7xx	3	70

Table I continued

Map Unit	Slope Class	Area ha
7xx	4	960
7xx	5	890
7xx	6	50
7xxx	3,4,5,6,7	1050
8	1,2	2940
10	4	100
11	4	130
13	total	230
13	3	50
13	4	160
13	5	20
13x	total	80
13x	4	60
13x	5	20
16	1,2	230
18	1,2	390
21b*	1	60
	total WL_1	23580
Agro-ecological zone WL_2		
5	3,4,5,6,7,8	10380
6	total	1730
6	4	1310
6	5	400
6	6	20
7	total	9150
7	3	150
7	4	6590
7	5	2220
7	6	190
7x	total	2590
7x	3	210
7x	4	1180
7x	5	920
7x	6	280

* b - lands in the Nilwala Ganga flood plain above the 10 year return period flood line.

Table I continued

Map Unit	Slope Class	Area ha
7xx	total	1150
7xx	3	130
7xx	4	360
7xx	5	560
7xx	6	100
7xxx	3,4,5,6,7,8	680
8	1,2	1070
9	total	4910
9	3	2400
9	4	2410
9	5	100
10	total	410
10	3	230
10	4	180
11	total	690
11	3	500
11	4	160
11	5	30
12	total	5670
12	3	1200
12	4	4180
12	5	290
12	total	10020
13	3	1410
13	4	8270
13	5	340
13	4	80
13x	1,2	70
14	1,2	390
15	1,2	1390
16	1,2	390
18	1,2	760
19	1,2	

Table I continued

Map Unit	Slope Class	Area ha
20	1, total	2930
20*	1	780
20b* 1)	1	30
20c* 2)	1	2060
20d* 3)	1	60
21	1, total	5930
21*	1	370
21b* 1)	1	50
21c* 2)	1	4340
21d* 3)	1	1170
22	1, total	1050
22*	1	130
22c* 2)	1	360
22d* 3)	1	560
23	1	180
	total WL_2	61620
Agro-ecological zone WL_4		
5	3,4,5,6,7	700
9	total	6860
9	3	4870
9	4	1990
10	total	1230
10	3	910
10	4	320
11	total	1930
11	3	1310
11	4	620

* flood plains other than Nilwala, Polwatte
* 1) b Nilwala Ganga flood plain above the 10 year return period flood line
* 2) c Nilwala Ganga flood plain lands below the 10 year return period flood line but above 1 foot mean sea level.
* 3) d Nilwala and Polwatte Gange flood plain lands below 1 foot mean sea level.

Map Unit	Slope Class	Area ha
12	total	840
12	3	420
12	4	420
13	total	1930
13	3	490
13	4	1440
13x	4	30
14	1,2	410
15	1,2	110
16	1,2	260
20	1, total	760
20*	1	660
20d* 3)	1	100
21	1, total	1830
21*	1	690
21c* 2)	1	310
21d* 3)	1	830
22	1, total	870
22*	1	490
22d* 3)	1	380
23	1	1460
24	1	500
25	1	50
	total WL 4	19750

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APPENDIX II

YIELD ESTIMATES FOR LAND CLASSES UNDER DIFFERENT LAND UTILIZATION TYPES

The following broad yield levels are anticipated for each of the crops for which data are available on lands belonging to the different suitability classes.

Crop	Land Suitability Classes				
	S_1	S_2	S_3	N	Unit
Rubber	>1500	1000-1500	750-1000	<750	lb#acre dry rubber
Tea	>2750	2000-2750	1250-2000	<1250	kg#made tea#ha
Coconut	>5000	3500-5000	2500-3500	< 2500	nuts#acre
Paddy	> 780	50-80	40-50	< 40	bu#acre

PART II

LAND USE STUDY

1. MATERIALS AND METHODS

The land use survey was carried out by interpretation of black and white panchromatice aerial photographs.

1.1. Materials

The aerial photographs used were of scale 1:25,000 (approx.) flown in 1972, 1973, 1974 and 1975 for different parts of the district. These photographs were analysed using a "WILD" mirror stereoscope. The final land use map was prepared on a scale of 1:63,360 on a sheet of polyester film. The interpreted land use boundaries were transfered from the aerial photographs on to the base map using and optical pantograph (Kargl Reflecting Projector).

1.2. Methods

Correlations were first established between the photo image and the actual land use in the field. This part of the work was done during the soil survey and land classification of the Matara District. Once the correlations were established the aerial photos covering the whole district were interpreted for demarcating the various types of land use. The broad basis for the various categories of the land use are as proposed by the Commission on World Land Use Survey (1974) of the International Geographical Union, suitably modified for local conditions and intended purpose of the survey.

2. DESCRIPTION OF THE MAPPING UNITS

The Land Use and the forest cover in Matara district were first classified into nine main categories in accordance with the World Land Use Legend. During the aerial photo interpretation studies these nine categories were again sub-divided into twenty (20) sub-units. The complete classification is presented below:-

Map unit	Classification	
	1	SETTLEMENTS AND ASSOCIATED NON-AGRICULTURAL LANDS
1		Towns, villages, industrial and factory sites
	2	HORTICULTURE
2		Homestead Gardens
	3	TREE AND OTHER PERENNIAL CROPS
	3a.	Coconut plantations
3	3a.1	Well managed coconut plantations
4	3a.2	Poorly managed coconut plantations
	3b.	Tea plantations
5	3b.1	Well managed tea plantations
6	3b.2	Poorly managed tea plantations
7	3c.	Rubber plantations
	3d.	Cinnamon plantations
8	3d.1	Well managed cinnamon plantations
9	3d.2	Poorly managed cinnamon plantations
10	3e	Small holdings (mixed crops without coconut)
	4	CROPLAND
11	4.1	Rain-fed paddy lands
12	4.2	Irrigated paddy lands
	5	UNIMPROVED PASTURE LAND
		Patna and other grasslands
	6	ANNUAL CROPS
14		Market gardens
	7	WOODLAND
15	7.1	Dense forests
16	7.2	Swamp forests
	8	WATER BODIES
17	8.1	Tanks and reservoirs
	8.2	Lagoons, swamps and marshes

9 UNPRODUCTIVE LANDS

19 9.1 Barren lands

20 9.2 Scrublands

2.1 Detail description of the mapping units

Map unit 1 Towns, villages, industrial and factory sites

This category consists of highly populated towns like Weligama, Matara, Devinuwara, and Dickwella. Also smaller towns and villages too are added to this category. Apart from these residential areas, Tea factories, Rubber factories, Tile factories and estate labour lines are too included in this mapping unit.

The total extent of this map unit is 1045 ha. and it is 0.8% of the total area of the district.

Map unit 2 Homestead gardens

These are family residential areas with houses and gardens. In these home gardens the most common trees are coconut, jak, breadfruit, arica-nut palm, mango papaw and bananas. Normally these homestead gardens are found in the lower parts of the slope of the upland area.

In Matara district, homestead gardens have been mapped over 25,770 ha., which is 20% of the entire district

Map unit 3 Well managed coconut plantations

In this map unit only pure stands of coconut palm areas are included. Areas with regular density of coconut palms are separated out and classified as well managed coconut plantations. They occur mainly along the coastal belt and also in the central part of the project area.

Well managed coconut has been mapped over an area of 3495 ha., and this is 3% of the total acreage of the Matara district.

Map unit 4 Poorly managed coconut plantations

The coconut plantations without a uniform stand of coconut palm and irregular heights of palms were mapped as poorly managed coconut plantations.

This map unit has been mapped over an area of 4910 ha., which is 4% of the total area of the district.

Map unit 5 Well managed tea plantations

In the project area, tea plantations are confined to the central and northern regions. They grow on higher elevations. Soil conservation practices have been observed in the field in these tea estates. This type of tea estates are classified as well managed tea plantations.

Well managed tea plantations are mapped over 1265 ha., and this is 1% of the total extent of the survey area.

Map unit 6 Poorly managed tea plantations

This map unit consists of tea estates on very rocky lands as well as estates which have not carried out proper soil conservation practices. Occurrence of bare patches in the plantations areas is a common feature in this map unit.

Under the map unit 6 an area of 12090 ha., of poorly managed tea plantations are mapped, which is 9.3% of the total land area.

Map unit 7 Rubber plantations

Rubber is one of the main export crops in Sri Lanka. Most of the rubber areas in this part of the country lie below 2000 feet MSL. Except on coastal belt these rubber plantations are present in all land types of the

survey area. This sub-unit is not further sub-divided as well managed rubber and poorly managed rubber plantations as it is difficult to identify the difference between them on the aerial photos.

The total extent of the rubber area is 10730 ha., which is 8.5% of the whole area surveyed.

Map unit 8 Well managed cinnamon plantations

Cinnamon is one of the minor export crops which grows even on low elevations. This is found as small estates unevenly distributed over the district. Soil conservation practices have been observed in the field and some estates use chemical fertilizers too, to improve the yields. The cinnamon estates which are thus maintained are classified as well maintained cinnamon plantations.

The extent of this map unit is 230 ha., and it is 0.21% of the total extent of the land area of the Matara district.

Map unit 9 Poorly managed cinnamon plantations

The cinnamon estates on very rocky lands and estates which are not properly maintained as described in the above unit are classified as poorly managed cinnamon plantations. Bare patches caused due to surface soil erosion are observed in the field as well as on interprotation of aerial photos. Such areas are also included in this map unit.

The total extent of poorly managed cinnamon is 3980 ha., which is 3% of the total acreage of the area surveyed.

Map unit 10 Small holdings (mixed crops without coconut)

This a complex area with small allotments of tea, rubber and cinnamon (coconut areas excluded). Considering the complexity of the area and the final map scale those individual tea, rubber and cinnamon allotments are grouped together and mapped as small holdings. It is observed that this area is confined to the northern part of the project area.

The total area of this map unit is 8330 ha., this is 6% of the total land area of the district.

Map unit 11 Rain-fed paddy lands

Most of the paddy lands lie in the valley bottoms of the landscape and some are found on the terrace slopes. These paddy lands are cultivated during the rainy seasons. Usually farmers cultivate only one season of the year, but these areas could be cultivated if they get sufficient rains in time in both Yala and Maha seasons. In the southern part of the survey area rain-fed paddy lands lie in the flood plains of Nilwala Ganga and Polwatte Ganga.

Rain-fed paddy lands comprise 16800 ha., which is 13% of the total land area of the district

Map unit 12 Irrigated paddy lands

Out of all the paddy lands of the Matara district only a small extent falls within this map unit. Some of the irrigated paddy lands receive water from small village tanks such as Kekunadura, Denagama, Ellewela, Hali Ela and Sultanagoda. Other paddy areas were irrigated from the anicuts on Nilwala Ganga and its tributories. These paddy lands were cultivated in both Yala and Maha seasons.

Irrigated paddy lands cover an extent of 1760 ha., which is 1.4% of the Matara district.

Map unit 13 Patna and other grasslands

Patna lands are found in the northern part of the survey area and they occupy the steep slopes of the high mountains. These patna lands are not used for grazing purposes and they are periodically burned away by villagers for no known reason. In the central and northern part of the survey area are found some fallow lands with other varieties of grass which may be used to feed cattle.

There are 2190 ha., of patna and other grasslands. This is 2% of the total land area surveyed.

Map unit 14 Market gardens

Lands in this map unit are used for cultivating vegetables such as brinjals, cucumber, snake grourd, etc. and yams like sweet potato, dehi ala, manioc etc., Normally these lands occur on the lowest part of the upland areas which is slightly higher than the paddy lands. This unit is easily identified on the aerial photos due to its prominent rectangular parcelling pattern.

The total extent of the market gardens is 150 ha., and this is 0.12% of the total land area of the Matara district.

Map unit 15 Dense forests

The dense forests areas occur in the central and northern regions of the Matara district. They are found in the hilly and mountaneous landscapes. Hora, Milla, Dun, Alubo are some of the trees species that are found in these forests. The aerial photographs taken in different years show a rapid change in the forest pattern during that period, due to clearing of forests for various purposes.

These have been mapped over an extent of 22570 ha., which is 17.5% of the total land area of the district.

Map unit 16 Swamp forests

Kirala (Sonneratia Caseoleris), Wel ātha (Anona Glabra), and Gin pol (Nipa Fruticans) are common trees that has grown wildly in these swampy forest areas. These forests are normally found on the edges of lagoons and marshy lands. An example of such an area is Kiralakele. Most of these swamp forests are subjected to seasonal flooding and salt water intrusions.

The total extent of these forests amount to 110 ha., which is 0.08% of the total survey area.

Map unit 17 Tanks and reservoirs

There are a few small village tanks within the project area which are used for irrigating a limited area of paddy lands, and also for domestic purposes. The storage capacity of these tanks are limited due to their size, which is smaller in nature. Names of some of these tanks appear in the description of the map unit 12.

The total area of these tanks amount to 530 ha., which is 0.4% of the total land area of the district.

Map unit 18 Lagoons, swamps and marshes

This mapping unit consists of all the natural water bodies formed within depressions closer to the coastal areas. Some marshes are located in the flood plains of Matara district. These areas are predominantly covered with salt tolerant weeds and water-loving plants like Salvenea, Lunuwila, Ketala, Pan etc.,

This unit covers an extent at 430 ha., which is 0.3% of the entire area of the district.

Map unit 19 Barren Lands

Recent beach sand areas are classified under this mapping unit. The natural vegetation cover of these areas are either very thin or absent. These lands can be considered as agriculturally unproductive.

The extent of these lands amount to 510 ha., and this is 0.39% of the total land area of the district.

Map unit 20 Scrublands

The large amount of fallow lands which is present in this district is predominantly covered with a dense growth of scrub. As a result of forest clearing a fair amount of scrublands are found adjacent to dense forest areas. Rock outcrops too are found in most of these scrublands. Completely abandoned tea, cinnamon and rubber plantations found in the northern parts of the district are also mapped under this unit.

These scrublands are mapped over an extent of 11900 ha., which is 9% of tahe total land of the district.

2.2 Extents of the mapping units

The areas of the land use map units are presented in table I. Computation of areas was done using a Planimeter on a print of the land use map of the Matara district (scale 1:63,360).

Map unit	Land Use unit	Land Use Sub-unit	Classification	AGRO-ECOLOGICAL REGIONS WL_4	WL_2	WL_1	WM_1	Total extent
1	1	-	Towns, villages, industrial and factory sites	820	130	05	90	1045
2	2	-	Homestead gardens	6500	12560	3100	3610	25770
	3	3a	Coconut plantations					
3		3a.1	Well managed coconut	2030	1450	--	15	3495
4		3a.2	Poorly managed coconut	3380	1500	25	05	4910
		3b	Tea plantations					
5		3b.1	Well managed tea	--	200	25	1040	1265
6		3b.2	Poorly managed tea	--	4160	3170	4760	12090
7		3c	Rubber plantations	540	7850	1850	490	10730
		3d	Cinnamon plantations					
8		3d.1	Well managed cinnamon	50	180	--	--	230
9		3d.2	Poorly managed cinnamon	750	3220	--	10	3980
10		3e	Small holdings	30	1750	4000	2550	8330
	4		Cropland					
11		4.1	Rain-fed paddy lands	3240	10010	1800	1750	16800
12		4.2	Irrigated paddy lands	500	1180	80	--	1760
	5		Unimproved pasture land					
13			Patna and other grasslands	--	310	600	1280	2190

Continuation

Map unit	Land use unit	Land use sub - unit	Classification	WL_4	WL_2	WL_1	WM_1	Total extent
	6		Annual crops					
14			Market gardens	130	20	--	--	150
	7		Woodland					
15		7.1	Dense forests	690	9900	6010	5970	22570
16		7.2	Swamp forests	110	--	--	--	110
	8		Water bodies					
17		8.1	Tanks and reservoirs	180	350	--	--	530
18		8.2	Lagoons, swamps and marshes	140	290	--	--	430
	9		Unproductive lands					
19		9.1	Barren lands	510	--	--	--	510
20		9.2	Scrublands	950	6300	2460	2190	11900
			Total	20550	61360	23125	23760	128795

Total area of Matara District = 128,795 ha.

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