AGOF/INS/78/006
Manual 4
Version 1

RECONNAISSANCE LAND RESOURCE SURVEYS
1 : 250,000 scale
ATLAS FORMAT PROCEDURES

by

CSR/FAO Staff

May, 1983

Prepared for the Land Resources Evaluation with Emphasis on Outer Islands Project

at

CENTRE FOR SOIL RESEARCH, BOGOR
INDONESIA

MINISTRY OF AGRICULTURE GOVERNMENT OF INDONESIA

UNITED NATIONS DEVELOPMENT PROGRAMME AND
FOOD AND AGRICULTURE ORGANIZATION

FOREWORD

This manual presents the findings of the joint Centre for Soil Research (CSR)/FAO working group convened in July 1982 to design standard formats for a 1:250,000 scale, reconnaissance land resource survey atlas, as part of the activities of the Government of Indonesia/UNDP/FAO Project - Land Resources Evaluation with Emphasis on Outer Islands.

The working group operated under the overall supervision of Dr. D. Muljadi (Director, CSR) and the joint chairmanship of Mr. Soepraptohardjo (CSR) and D.L. Gallup (FAO). The manual was compiled by F.J. Dent (FAO) and D.L. Gallup. The working group consisted of the following personnel:

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INTRODUCTION

The Centre for Soil Research (CSR), is responsible for the inventory, classification, mapping and evaluation of Indonesia's soil and land resources for agricultural uses to serve the needs of the country.

For the past ten years CSR survey activities have concentrated on detailed, semi-detailed and detailed reconnaissance studies for specific agriculturally oriented development projects. However, in 1981 priority was given to the inventory, mapping and evaluation of land resources at reconnaissance level (1:250,000) to generate urgently needed data for use in regional agricultural planning at Provincial level; and the selection of potential and priority areas for agricultural development in general and the transmigration programme in particular.

Although the techniques involved in physically carrying out a reconnaissance land resource survey are relatively well known and understood by CSR personnel, it was felt that improvements could be made in the presentation of results to better satisfy the needs of the users.

Previously, survey results were presented in map and narrative report form. However, narrative report preparation is time consuming resulting in considerable time gaps between the completion of field operations and the publication of data. In addition narrative reports tended to be biased towards the technical reader rather than the non-technical planner who, at least in theory, would be the principal user.

In order to overcome this problem and hopefully to provide more user oriented data it was decided to investigate the feasibility of employing an atlas format consisting of soil and development potential maps supported by tabular presentations of land resource characteristics and suitability evaluations.

Consequently, in July 1982 a working group consisting of CSR and FAO personnel was formed to design standard formats for a 1:250,000 scale, reconnaissance land resource survey atlas. A series of meetings were held over the next six months and preliminary designs tested during field operations of the West Sumatra and Southeast Sulawesi reconnaissance surveys.

This present manual presents the working group findings and although some changes in design and methodology can be expected in the future, this manual

will be used as a basis for the presentation of results generated by current reconnaissance land resource surveys conducted by CSR.

The manual consists of four parts.

PART 1 - is an explanation of entries to be made in Table 1 of the atlas, "Main Characteristics of Landforms, Climate and Soils". Entries are made for mapping units, main soil components of each mapping unit, and soil layers of each soil component. Data on landform and parent material, extent, elevation, major land uses, evidence of erosion and climate are entered for the mapping unit as a whole with each mapping unit being identified by the map unit symbol occurring on the 1:250,000 soil map. Each mapping unit is made up of one or more soil components. These soil components cannot be delineated on the soil map at the scale of survey employed; but an indication of the propotion of the mapping unit occupied by each soil component is given and each soil component is classified according to the USDA, P.P.T. and FAO/Unesco classification systems. Data on Geomorphic component and slope, limiting layer and depth, drainage, permeability, layer and depth, and representative profile reference codes are entered for each soil component. Data on colour, texture, structure, field and laboratory pH, organic matter content, total nitrogen, available P_2O_5 and K_2O, cation exchange capacity, base saturation, free Fe_2O_3, and aluminum saturation are entered for each soil layer. Finally, space is provided for additional remarks on any other features that affect use and management. The data provided under Table 1 in the atlas forms the basis for the evaluation of crop/timber species suitability (by manual or computerized processes) and development project potential.

PART 2 - is an explanation of entries to be made in Table 2 of the atlas, "General Land Suitability and Potential Ratings". Data on map unit symbol, extent, soil component classification (USDA only), and the proportion of the mapping unit occupied by each soil component are repeated for cross-reference purposes. Suitability evaluations for primary uses and potential for project development ratings are then entered for each soil component of each mapping unit. Data on current or present suitability, improvement needs for development, and potential suitability after improvements are entered for crops and timber species chosen to represent cereals (3 crops), root crops and legumes (4 crops), estate and industrial crops (3 crops), pasture (1 crop), and forestry (2 timber species). Representative crops/timber species are chosen from a list of 23

crops and 10 timber species for which adequate data on growth requirements is available, with choice being dependent on prevailing climatic conditions and socio-economic strategy of the study area. Finally, ratings are entered to indicate potential for irrigation project development, drainage project development, cereals project development, root crop and legumes project development, and estate and industrial crop project development. Potential ratings for pasture and forestry project development are only entered for those soil components having poor or no potential for other primary uses, unless high priority is given to such projects by local authorities.

PART 3 - describes manual procedures employed in determining general land suitability and potential ratings. Land characteristics and land qualities used in the evaluation process are defined and described and growth requirements listed for 23 crops and 10 timber species. The structure of the suitability classification used is described and symbols explained and examples given of the evaluation procedures used. Finally, methods employed in determining ratings of potential for project development are explained.

It should be noted that the land evaluation procedures outlined in PART 3 of this manual involve processing by hand and are labour intensive. Trial runs using the methodology proposed indicated that 40 man/days would be required to complete evaluations of 200 mapping units for 13 representative crops/timber species.

An attractive alternative would be to utilize the land evaluation computer system (LECS) developed by the "Land Resource Evaluation with Emphasis on Outer Islands Project". This system will become operational during 1983 and, with minor adjustments, all required environmental data could be provided from Table 1 of the atlas "Main Characteristics of Landforms, Climate and Soils". Computerized processing would substantially reduce the time required for evaluation and provide more precise data on current and potential suitabilities, viability and effect of improvements needed for development, and time related degradation risks to sustained cultivation.

Consequently, the hand processing techniques described in this manual are seen as an interim measure which will hopefully be replaced by LECS technology when this is operational and technicians become familiar with its use.

PART 4 - describes standard formats to be used in the atlas presentation of results of current CSR reconnaissance surveys. The various components

making up the atlas are listed as they will occur in published form. Standard formats are provided for: "How to Use the Atlas"; "Explanation of Terms and Footnotes Used in Table 1, Main Characteristics of Landforms, Climate and Soils"; and "Explanation of Symbols Used in Table 2, General Land Suitability and Potential Ratings". Examples are given for Table 1 (part 1 and 2), and Table 2 with complete data entry for two hypothetical mapping units. Finally the methodology used in preparing project development potential maps is explained.

PART 1

EXPLANATION OF ENTRIES TO BE MADE IN TABLE 1,
MAIN CHARACTERISTICS OF LANDFORMS, CLIMATE AND SOILS

Column No.

1. Map unit symbol is a listing of all symbols that represent land unit and soil delineations on the map. Symbols are alphanumeric, e.g. A1, A2, H1, etc. The capital letters denote broad landform classes, which are listed below :

Symbol	Landform	Symbol	Lanform
A	Alluvial	M	Mountain
B	Marine	P	Plain
H	Hilly	V	Volcanic
K	Karst	X	Miscellaneous

These landform names and symbols are the ones used in LECS 1/, as listed in appendix IX in the Pedon Coding Manual 2/, and reproduced in this report as appendix I.

In Table 1, map units should be listed in alphabetical and numeric sequence; e.g. A1, A2, A3, followed by B1, B2, then H1, H2, H3, and so on. As far as possible, the arrangement of subclasses within each broad landform class should be in sequence as listed in appendix IX of the Pedon Coding Manual. Thus, mapping units will be grouped by major landforms.

1/ Land Evaluation Computer System (LECS), System and Program Manual, Version 1.1, Land Resources Evaluation with Emphasis on Outer Islands Project, FAO/UNDP INS/78/006, Bogor, March 1980, by S.R. Wood.

2/ Proposed Coding System for Pedon Data for Trial by the Centre for Soil Research, AGOF/INS/78/006, Manual 3, Version 1, Land Resources Evaluation with Emphasis on Outer Islands Project at Centre for Soil Research, Bogor, December 1981, by D.L. Gallup.

Column No.

2. Landforms and Parent Material are named for each map unit. Names should be brief, but distinctive enough that each map unit can be distinguished clearly from all others. No two map units should have the same name.

Landform names from LECS should be used. Most of them are defined in the Catalogue of Landforms of Indonesia, FAO/Soil Research Institute, Bogor, 1976, by J.R. Desaunette. Parent material names will be from the Pedon Coding Manual, pp 17-20, and reproduced in this report as appendix II. Codes will not be used in Table 1.

Two examples of landform and parent materials are ;

A1 Narrow river valleys; alluvium from sedimentary rock

V1 Slightly dissected middle slope of volcanoes; acidic tuff.

If surveyors experience difficulty in recognizing specific landforms, such as "flat/hummocky volcanic plain" (LECS code V804), then the more general term "volcanic plain" (LECS code V8) may be used. However, where possible the more specific landform definition should be used.

3. Extent is indicated by two entries. First is the number of nectares for each map unit. The second is the percentage of the survey area occupied by each map unit.

4. Elevation is estimated as a range of meters above mean sea level. The precision of the estimates varies with the kinds of land units. Low-lying areas with little variation in relief, such as tidal flats or flat coastal plains, may be listed in terms of 0.5 to 1.0, and 2 to 5 meters respectively.

Estimates of elevation of upland areas should be in units of 10's, 50's or even 100's of meters. Some examples of appropriate entries for land units of upland areas are :

rolling plains, 20 to 60 meters

hilly landforms, 350 to 450 meters

dissected mountain slope, 1500 to 2000 meters.

Column No.

5. Major land uses are listed for each unit. If a land unit has more than one land use, the most extensive use should be listed first, the next most extensive second, and so on. Land use classes in the Pedon Coding Manual, pages 21 and 22 will be recorded. Descriptive names such as "cropland, flooded rice, rainfed", will be used rather than the computer codes. Descriptive names are reproduced in this report as appendix III.

6. Evidence of Erosion that was observed within the map unit will be recorded. Such conditions as severe sheet erosion, many small rills, few large gullies, few blowouts and dunes, will be noted. If no erosion features were observed, write "none" in this column.

7. Climate for each map unit should be estimated from data recorded at nearby climatological stations or climatic maps, and from interviews with local people, and observations of soils and vegetation.

The following information should be entered in vertical sequence under column 7 as follows :

1. average annual rainfall in millimeters
2. number of wet months with long term averages of $\geqslant$ 150 millimeters rainfall
3. number of dry months with long term averages of $\leqslant$ 75 millimeters rainfall
4. average annual temperature in ^{o}C
5. maximum month (average) temperature in ^{o}C
6. minimum month (average) temperature in ^{o}C
7. the station number assigned by the Directorate of Meteorology and Geophysics to the nearest representative meteorological station.

8. Classification of soil components and proportion of map units will be given for each component of each map unit. Most map units will have two or three major soil components. The most extensive component should be listed first, the least extensive last, with the first component being preceded by the terms, "Association of", "Complex of", or "Undifferentiated Group of" as applicable.

Column No.

Each soil component will be classified in each of the three classification systems commonly used in Indonesia.

Soil Taxonomy, USDA Agr. Handbook 436, Washington D.C., 1975. If possible, classify soils to the family level for all soils that are suitable for agricultural development. Soils which are not suitable for agricultural development should be classified to the subgroup level, but give a broad textural class, such as sandy, clayey, etc.

PPT, a national, Indonesian system of the Pusat Penelitian Tanah (Centre for Soil Research) Bogor, 1982. If possible, classify soils to the subgroup level.

FAO/UNESCO, Soil Map of the World, Vol. 1, Legend, Paris 1974.

In the column 8a the estimated proportion of the map unit will be given for each major soil component using one of the following appropriate symbols: P - predominant (>75%); D - dominant (50-75%); F - fair (25-49%); M - minor (10-24%); and T - traces (<10%).

9. Geomorphic component and slope are listed for each soil component. Geomorphic component indicates a specific part of the landscape that is characteristic of each kind of soil. Geomorphic terms from the Pedon Coding Manual, pages 14 and 15 should be used. Descriptive terms are reproduced in this report as appendix IV.

The slope of each component is recorded as a range in percent.

Examples of appropriate entries for item 9 are :
footslopes, 3 to 8%, or
terraces, 0 to 2%.

10. Limiting layer and depth is the range in depth (in centimeters) to a soil layer that severely restricts root penetration and downward water movement. If a limiting layer is thin, such as some iron pans, and is underlain by soil that is non-restricting to roots and water, the thickness of the limiting layer should be mentioned also.

The kind of limiting layer should be indicated after its depth. Some common limiting layers include bedrock, ironpan, ironstone,

Column No.

hardpan, claypan, dense massive layers, gravel, concretionary ironstone, plinthite, and manganese pan.

Examples of appropriate entries are:

30 - 50, bedrock

90 - 110, ironpan, 1 - 3 cm thick.

If a soil has no limiting layer within about 1.5 meters from the surface write "none" in this column.

11. Drainage is an indication of the wetness or dryness of a soil. Soil drainage is influenced by several factors including topography, texture, structure, permeability, and availability of water from rainfall, seepage or runoff from nearby higher areas.

The seven drainage classes which will be used in this table are:

very poorly drained	well drained
poorly drained	somewhat excessively drained
somewhat poorly drained	excessively drained.
moderately well drained	

The kind of soils in these drainage classes are described briefly in appendix V.

12. Permeability classes indicate the rate that water moves through the soil . Permeability varies greatly with kinds of soils and between layers in a soil. The rating to be recorded in this column is for the least permeable layer of the soil.

Permeability may be estimated from observations of soil structure, texture, porosity and cracking.

Because permeability estimates are difficult and not precise, the seven classes of the soil survey manual will be combined into three classes as follows :

Class name	cm/hr.
slow	< 0.5
moderate	0.5 to 16
rapid	> 16

Column No.

13. Soil layer and depth for most soil components, two layers called surface soil and subsoil will be listed. A range in depth from the top to the bottom of each layer is recorded in cm. If a soil has three distinctly different layers, a third layer, called substratum, may be listed.

Examples of entries in this column are:
0 to 15/25
15/25 to 85/110.

Definitions of soil layers are presented in appendix VI.

ENTRIES WILL BE MADE IN COLUMNS 14 THROUGH 27
FOR EACH MAJOR LAYER OF EACH SOIL COMPONENT

14. Colour terms from Munsell colour charts will be given for each soil layer. Terms such as reddish brown, black and dark gray will be recorded, rather than their Munsell notations of 2.5YR 4/4, N 2/0 and 10YR 4/1.

15. Texture of each soil layer of each component will be recorded using the following broad textural classes.

Class	Textures included
sandy	sands and loamy sands
loamy	sandy loams, loams and clay loams
silty	silts, silt loams, silty clay loams
clayey	clays, sandy clays, silty clays

If soil layers are gravelly, stony or bouldery appropriate modifiers will precede the textural class; e.g. stony loamy, gravelly sandy, etc.

16. Structure of each layer will be given in general terms expressing strength and kind. The following terms will be used.

Strength	Kind	
weak	granular	blocky (angular & subangular)
moderate	crumb	prismatic
strong	platy	columnar

Column No.

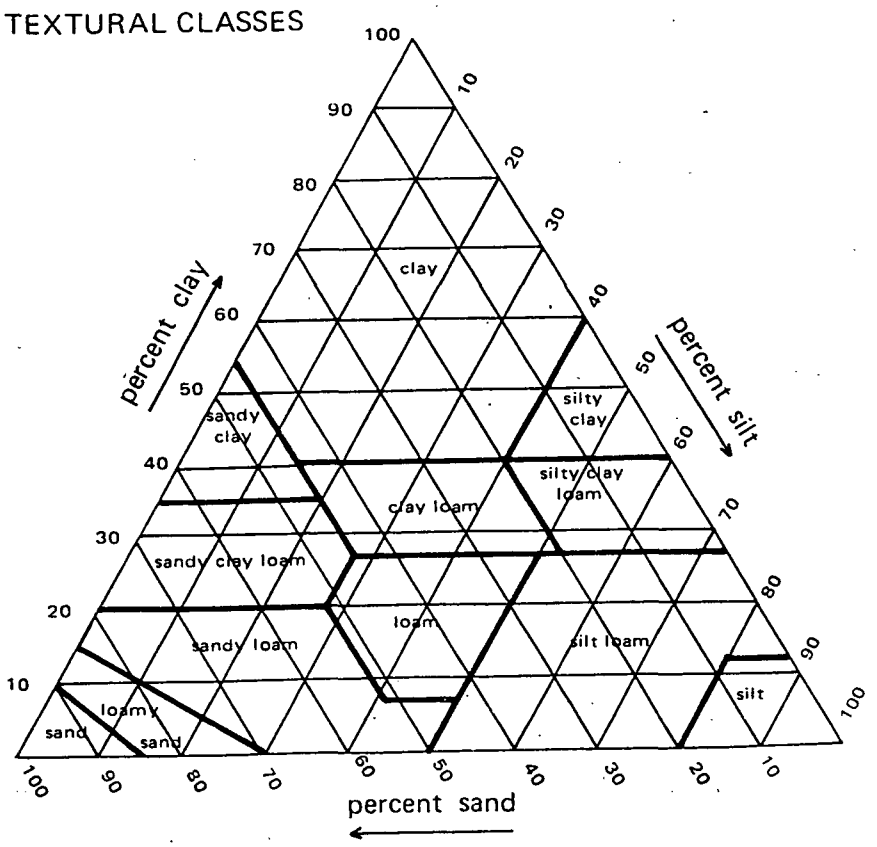
If a layer is structureless, write single grain or massive whichever the layer may be.

17. Field pH of each layer will be given as either a single value, or a range of values if variation is characteristic of the layer concerned.

e.g. 4.5 or 4.5 to 5.0

The entries in columns 18 through 27, of part 2 of Table 1, are based on laboratory data. Hopefully, data will be available for several pedons of each soil component so that ranges in values can be expressed. Ratings such as low, medium and high, are adapted from guidelines of the soil laboratory of the Centre for Soil Research, Bogor.

18. Laboratory textural class refers to the relative proportion (by weight) of sand, silt and clay, as determined in the laboratory on the fine earth fraction (< 2 mm). Texture classes will be named using USDA classes represented in the chart that follows :



Column No.

19. Laboratory pH of each soil layer of each component is given as a range in values based on laboratory data.

For column 19, pH measured in water (1:2.5) will be recorded. Examples of appropriate entries in this column are :

5.0 - 5.5

6.0 - 6.5

20. Organic matter content (% Organic carbon X 1.724) of each layer is expressed according to the following classes :

Class	% O.M.
very low	< 2.0
low	2.0 - 3.5
medium	3.6 - 5.0
high	5.1 - 8.5
very high	> 8.5

21. Total Nitrogen of each layer is expressed in terms of the following classes :

Class	% N.
very low	< 0.10
low	0.10 - 0.20
medium	0.21 - 0.50
high	0.51 - 0.75
very high	> 0.75

22. Available P_2O_5 (phosphate) in each layer is expressed in the following classes based on parts per million (ppm) of available phosphate or phorphorus (P) by one of the laboratory methods listed below :

Class	P_2O_5 (Bray) (ppm)	P(Bray & Kurtz) (ppm)	P_2O_5 (Olsen) (ppm)
very low	< 10	< 3	< 4.56
low	10 - 15	3 - 7	4.57 - 11.4
medium	16 - 25	8 - 20	11.5 - 22.8
high	26 - 35	> 20	> 22.8
very high	> 35		

N.B. The Olsen method actually measures P (ppm). P_2O_5 figures are calculated by multiplying P (ppm) by a conversion factor of 2.28. The Olsen method is preferred for saline/alkaline soils.

Column No.

23. Available K_2O (potash) in each layer is expressed in the following classes, based on milligrams (mg) per 100 grams of soil using the citric acid method, milliequivalents (me) of K using the NH_4OAc, pH 7 method, or by total K_2O (ppm) using the HCl 25% method.

Class	Acid Citrate (mg)	NH_4OAc (me)	Total K_2O (HCl 25%) ppm
very low	< 5	< 0.2	< 10
low	5 - 10	0.2 - 0.3	10 - 20
medium	11 - 15	0.4 - 0.5	21 - 40
high	16 - 25	0.6 - 1.0	41 - 60
very high	> 25	> 1.0	> 60

24. Cation Exchange Capacity (CEC) of each layer will be expressed in one of the following classes based on milliequivalents per 100 grams of soil as measured by the NH_4OAc, pH 7.0 method.

Class	CEC
very low	< 5
low	5 - 16
medium	17 - 24
high	25 - 40
very high	> 40

25. Base Saturation of each layer will be expressed in one of the following classes based on the milliequivalents of exchangeable bases divided by CEC.

Class	% 3/
very low	< 20
low	20 - 35
medium	36 - 50
high	51 - 75
very high	> 75

3/ Percentages were modified slightly from PPT criteria to correspond to base saturation levels used to separate classes in Soil Taxonomy.

Column No.

26. Free Fe_2O_3 (iron oxides), as measured in the laboratory by the Sodium dithionite method and expressed as a range in percent, will be recorded for each soil layer. Examples of appropriate entries are 2.0 - 3.0, 6.5 - 8.0, etc.

No classes of low to high have been established, but this parameter is included for future use when critical levels have been worked out for major crops.

27. Aluminum Saturation, as measured in 1N KCl extract and expressed as a range in milliequivalents per 100 grams of soil, will be recorded for each soil layer. No classes of low to high levels of aluminum have been worked out. Varieties within crops vary considerably in their aluminum tolerance and the variation between crops is very wide. However this parameter is included for future use when levels of aluminum tolerances of major crops are known.

Preliminary data indicate that aluminum becomes limiting to rice growth when saturation level reaches 22 to 70%, depending on variety. When hydrogen ion is included in the calculation of aluminum saturation, the critical level is 35 to 40%.

Appropriate entries for aluminum saturation under column 27 will be ranges in values such as 2.0 - 5.0, 10 - 15, and 20 to 30.

28. Representative pedon includes two columns that are used to record the field and laboratory numbers assigned to representative pedons of the major soils of each mapping unit. Generally, the field number includes the initials of the person who described and sampled the pedon. Examples of field numbers are NS 46 and HS 22.

The laboratory number consists of six digits assigned by the laboratory to the samples from the representative pedon. Use the number assigned to the first or upper most layer. For example, the first layer of pedon NS 46 is numbered 214206.

29. Other features that affect use and management are recorded in the last column. Brief statements should be made concerning any important features that are not mentioned elsewhere in Table 1.

Such features include, but are not limited to :

- surface stoniness and/or rockiness (use terms for classes in the Soil Survey Manual)
- flooding (note depth, duration and probability)
- presence of plinthite (note depth & thickness)
- presence of concretions (note kind, size, depth to and thickness of layer)
- salinity or alkalinity (if known, give range in EC values)
- presence of peat (depth, thickness, kind)
- depth to pyrites (Acid sulfate potential)
- low bulk density
- presence of hardpans, cementation, etc.
- mottling
- unsual topographic features, including micro-relief
- presence of toxic micro-elements
- thixotropy
- ground water (depth and fluctuation, if not apparent from drainage statements)
- Workability problems of surface soil.

N.B. Access to additional data

Although Table 1 provide a comprehensive overview of climate, landform and soil; complete sets of profile descriptions and laboratory analysis of representative pedons listed in column 28 should be cyclostyled and bound for future reference and for users interested in more detailed soils information.

Appendix I. LECS landform definitions and codes

USER CODE	FULL DEFINITION
A	ALLUVIAL LANDFØRMS
A1	ALLUVIØ-MARINE LANDFØRMS
A101	SWAMP- TREE CØVER
A102	MARSH-LØW CØVER
A103	LEVEL LØWLAND CULTIVATED
A104	UNDULATING LØWLAND
A105	DELTA DEPØSITS
A106	ANCIENT SEASHØRE/SANDBAR
A107	INLAND TIDAL SWAMP
A2	ALLUVIAL-RIVERINE LANDFØRMS
A201	NARRØW RIVER VALLEY
A202	BRØAD RIVER VALLEY
A203	MEANDER BELT
A204	UND/RØLLING RIVER VALLEY
A205	RECENT TERRACE
A206	LEVEE
A207	ALLUVIAL FAN
A208	ALLUVIAL LAND
A3	ALLUVIØ-CØLLUVIAL LANDFØRMS
A301	NARRØW INTHILL MINIPLAIN
A302	BRØAD INTHILL MINIPLAIN
A303	RAMIFIED INTHILL MINIPLAIN
A304	UND/RØLL INTHILL MINIPLAIN
A305	ALLUVIØ-CØLLUVIAL FAN
A306	CØLLUVIAL FAN
A307	STRIP FØØTSLØPE CØLLUVIUM
A4	CLØSED ALLUVIAL LANDFØRMS
A401	NARRØW DEPRESSED AREA
A402	CLØSED BASIN/DEPRESSIØN
A403	FRESHWATER SWAMP/MARSH
A404	RECENT LACUSTRINE PLAIN
A405	ANCIENT LAKE BØTTØM
B	MARINE LANDFØRMS
B1	BEACHES
B101	SAND BEACH
B102	MUD BEACH
B103	SHINGLE BEACH
B104	CØVE
B105	MUD FLAT
B2	DUNES AND LIDØ
B201	SHIFTING SAND
B202	FLAT SANDY DEPØSITS
B203	LIDØ
B204	BEACH RIDGE
B205	TØMBØLØ

USER CODE	FULL DEFINITION
B3	RØCKY SEASIDE/BARRIERS
B301	BARRIER/BARRIER FLATS
B302	CLIFF
B303	REEF
B304	WAVE CUT TERRACE
B305	RØCKY CAPE
B306	REEF FLAT
B4	LAGUNA/LAGØØN
B401	LAGUNA
B402	CØRAL REEF-LAGUNAL
B403	CØRAL FLAT-LAGUNAL
B404	LAGØØN
B5	ATØLL/CØRAL
B501	ATØLL
B502	CØRAL REEF-ATØLL
B503	CØRAL FLAT-ATØLL
B6	TIDAL FLATS
B601	BARE/CULT TIDAL FLAT
B602	MARSHY TIDAL FLAT
B603	TIDAL FLAT-MANGRØVE
B7	DELTA ØUTCRØP
B701	SANDY DELTA
B702	SILTY DELTA
B703	CLAYEY DELTA
PO	PLAINS-GENERAL TERMS
PO01	FLAT PLAIN
PO02	UNDULATING PLAIN
PO03	RØLLING PLAIN
PO04	FLAT/HUMMØCKY PLAIN
PO05	FLAT/HILLØCKY PLAIN
PO06	UND/HILLØCKY PLAIN
PO07	RØLL/HILLØCKY PLAIN
PO08	HILLØCKY PLAIN
PO09	HILLY MINIPLAINS
P1	CØASTAL PLAIN
P101	FLAT CØASTPLAIN
P102	UNDULATING CØASTPLAIN
P103	RØLLING CØASTPLAIN
P104	FLAT/HUMMØCKY CØASTPLAIN
P105	FLAT/HILLØCKY CØASTPLAIN
P106	UND/HILLØCKY CØASTPLAIN
P107	RØLL/HILLØCKY CØASTPLAIN
P108	HILLØCKY CØASTPLAIN
P109	CØASTAL HILLY/MINIPLAIN
P2	MARINE TERRACE

USER CODE	FULL DEFINITION
P201	FLAT MARINE TERRACE
P202	UND MARINE TERRACE
P203	RØLL MARINE TERRACE
P204	FLAT/HUMMØCKY MARINE TER
P205	FLAT/HILLØCKY MARINE TER
P206	UND/HILLØCKY MARINE TER
P207	RØLL/HILLØCKY MARINE TER
P208	HILLØCKY MARINE TER
P209	MARINE TER HILLY/MINIPLAIN
P3	RIVER/LAKE TERRACE
P301	FLAT RIVER TERRACE
P302	UNDULATING RIVER TERRACE
P303	RØLLING RIVER TERRACE
P304	FLAT/HUMMØCKY RIVER TER
P305	FLAT/HILLØCKY RIVER TER
P306	UND/HILLØCKY RIVER TER
P307	RØL/HILLØCKY RIVER TER
P308	HILLØCKY RIVER TER
P309	RIVER TER HILLY/MINIPLAIN
P4	ERØSIØN GLACIS
P401	FLAT ERØ/GLACIS
P402	UNDULATING ERØ/GLACIS
P403	RØLLING ERØ/GLACIS
P404	FLAT/HUMMØCKY ERØ/GLACIS
P405	FLAT/HILLØCKY ERØ/GLACIS
P406	UND/HILLØCKY ERØ/GLACIS
P407	RØLL/HILLØCKY ERØ/GLACIS
P408	HILLØCKY ERØ/GLACIS
P409	ERØ/GLACIS HILLY/MINIPLAIN
P5	ACCUMULATING GLACIS
P501	FLAT ACC/GLACIS
P502	UNDULATING ACC/GLACIS
P503	RØLLING ACC/GLACIS
P504	FLAT/HUMMØCKY ACC/GLACIS
P505	FLAT/HILLØCKY ACC/GLACIS
P506	UND/HILLØCKY ACC/GLACIS
P507	RØLL/HILLØCKY ACC/GLACIS
P508	HILLØCKY ACC/GLACIS
P509	ACC/GLACIS HILLY/MINIPLAIN
P6	PIEDMØNT PLAIN
P601	FLAT PIEDMØNT
P602	UNDULATING PIEDMØNT
P603	RØLLING PIEDMØNT
P604	FLAT/HUMMØCKY PIEDMØNT
P605	FLAT/HILLØCKY PIEDMØNT
P606	UND/HILLØCKY PIEDMØNT
P607	RØLL/HILLØCKY PIEDMØNT
P608	HILLØCKY PIEDMØNT
P609	PIEDMØNT HILLY/MINIPLAIN
P7	ERØSIØN REMNANT
P701	HUMMØCK-ØUTLIER
P702	HILLØCK ØUTLIER
P703	HILL-ØUTLIER
P704	HUMMØCK-INLIER
P705	HILLØCK-INLIER
P706	HILL-INLIER
P707	INSELBERG
P708	MØNADNØCK
P709	RØCK HEAP
P8	ERØSIØN SURFACE FEATURES
P800	FLAT RIVER-CUT VALLEY
P801	UND SURFACE < 8% SLØPE
P802	RØLL SURFACE < 15% SLØPE
P803	HUMMØCKY SURFACE < 15% SLØPE
P804	HUMMØCKY SURFACE > 15% SLØPE
P805	UND SURFACE > 15% SLØPE
P806	RØLL SURFACE > 15% SLØPE
P807	HILLØCKY SURFACE < 15% SLØPE
P808	HILLØCKY SURFACE > 15% SLØPE
P809	HILLY SURFACE
P9	SPECIAL FEATURES
P901	DISSECTED TERRACE FØØT
P902	DISSECTED ØLD ALL/CØLL FAN
P903	RØLL SCALPED ANTICLINE
P904	HUMMØCKY SCALPED ANTICLINE
P905	HILLØCKY SCALPED ANTICLINE
P906	TERRACE REMNANT
H	HILLY LANDFØRMS
H1	HILLØCKS/HILL PATTERNS
H101	ISØLATED HILLØCK
H102	HILLØCKS-UND PATTERN
H103	RØLL LAND ISØLATED HILLØCKS
H104	HILLØCKS-RØLL PATTERN
H105	FØØTHILLS
H106	LANIERS/SPURS
H107	RØLLING INTERHILL AREA
H108	RØUNDED HILL/KNØB
H109	UND INTERHILL BØTTØM
H2	PARALLEL RIDGES-BEDDED RØCK
H201	A/B SLØPE CLASSES

USER CODE	FULL DEFINITION
H202	C SLØPE CLASS
H203	D SLØPE CLASS
H204	E SLØPE CLASS
H205	A/B/C SLØPE CLASSES
H206	D/E CLASS 30%-75% SLØPE
H207	D/E CLASS > 50% SLØPE
H208	C/D/E SLØPE CLASSES
H209	TERRACED RIDGE SLØPE
H3	MØD DISSECTED HILL SLØPES
H301	A/B SLØPE CLASSES
H302	C SLØPE CLASS
H303	D SLØPE CLASS
H304	E SLØPE CLASS
H305	A/B/C SLØPE CLASSES
H306	D/E CLASS 30-75% SLØPE
H307	D/E CLASS > 50% SLØPE
H308	C/D/E SLØPE CLASSES
H309	TERRACED HILL SLØPE
H4	DISSECTED HILL SLØPES
H401	A/B SLØPE CLASSES
H402	C SLØPE CLASS
H403	D SLØPE CLASS
H404	E SLØPE CLASS
H405	A/B/C SLØPE CLASSES
H406	D/E CLASS 30-75% SLØPE
H407	D/E CLASS > 50% SLØPE
H408	C/D/E SLØPE CLASSES
H409	TERRACED HILL SLØPE
H5	STRØNG DISSECTED HILL SLØPES
H501	A/B SLØPE CLASSES
H502	C SLØPE CLASS
H503	D SLØPE CLASS
H504	E SLØPE CLASS
H505	A/B/C SLØPE CLASSES
H506	D/E CLASS 30-75% SLØPE
H507	D/E CLASS > 50% SLØPE
H508	C/D/E SLØPE CLASSES
H509	TERRACED HILL SLØPE
H6	VERSANT/PIEDMØNT/FØØTSLØPES
H601	SLT DISSECTED FØØTSLØPE
H602	MØD DISSECTED FØØTSLØPE
H603	DISSECTED PIEDMØNT SLØPE
H604	STRØNG DISSECT PIED/VERSANT
H605	DEEPLY DISSECTED VERSANT
H606	NØN-SLT DISSECT FØØTSLØPE
H607	SLT-MØD DISSECT PIEDMØNT
H608	SLT-MØD DISSECT VERSANT
H609	TERRACED PIED/FØØTSLØPE
H7	FRØNT/ESCARPMENT > 30% SLØPE
H701	SLT DISSECTED-CLASS C SLØPE
H702	MØD DISSECTED-CLASS C SLØPE
H703	DISSECTED CLASS C SLØPE
H704	STRØNG DISSECT CLASS C SLØPE
H705	MØD DISSECTED CLASS D SLØPE
H706	DISSECTED CLASS D SLØPE
H707	STRØNG DISSECT CLASS D SLØPE
H708	DISSECTED CLASS E SLØPE
H709	STRØNG DISSECT CLASS E SLØPE
H8	STRUCTURAL SLØPES
H800	SLT DISSECT DIPSLØPE (A)
H801	MØD DISSECT DIPSLØPE (AB)
H802	MØD DISSECT DIPSLØPE (BC)
H803	STRØNG DISSECT DIPSLØPE (BC)
H804	MØD DISSECT DIPSLØPE (CD)
H805	STRØNG DISSECT DIPSLØPE (CD)
H806	MØD DISSECT DIPSLØPE (DE)
H807	STRØNG DISSECT DIPSLØPE (DE)
H808	SCARPSLØPE C/D CLASS
H809	SCARPSLØPE D/E CLASS
H9	SUMMIT AREAS-REMNANTS
H901	FLAT SUMMIT
H902	UNDULATING SUMMIT
H903	RØLLING SUMMIT
H904	HUMMØCKY SUMMIT
H905	HILLØCKY SUMMIT
M	PLATEAU/MØUNTAIN LANDFØRM
M1	PLATEAU/HIGH PLAIN
M101	FLAT PLATEAU
M102	UNDULATING PLATEAU
M103	RØLLING PLATEAU
M104	HUMMØCKY PLATEAU
H105	SERRATED PLATEAU
H106	HILLØCKY PLATEAU
H107	STRØNGLY DISSECTED PLATEAU
H108	EXTREMELY DISSECTED PLATEAU
M2	NØN-SLTLY DISSECT MØUNTSLØPE
M201	A/B MØUNTSLØPE < 30%
M202	C MØUNTSLØPE 30-50%
M203	D MØUNSLØPE 60-75%

USER CODE	FULL DEFINITION
M204	E MØUNTSLØPE > 75%
M205	A/B/C MØUNTSLØPE < 50%
M206	C/D MØUNTSLØPE 30-75%
M207	D/E MØUNTSLØPE > 50%
M208	C/D/E MØUNTSLØPE > 20%
M209	TERRACED MØUNTAIN SLØPE
M3	MØD DISSECTED MØUNTAIN SLØPE
M301	A/B MØUNTSLØPE < 30%
M302	C MØUNTSLØPE 30-50%
M303	D MØUNTSLØPE 50-75%
M304	E MØUNTSLØPE > 75%
M305	A/B/C MØUNTSLØPE < 50%
M306	C/D MØUNTSLØPE 30-75%
M307	D/E MØUNTSLØPE > 50%
M308	C/D/E MØUNTSLØPE > 20%
M309	TERRACED MØUNTAIN SLØPE
M4	DISSECTED MØUNTAIN SLØPE
M401	A/B MØUNTSLØPE < 30%
M402	C MØUNTSLØPE 30-50%
M403	D MØUNTSLØPE 50-75%
M404	E MØUNTSLØPE > 75%
M405	A/B/C MØUNTSLØPE < 50%
M406	C/D MØUNTSLØPE 30-75%
M407	D/E MØUNTSLØPE > 50%
M408	C/D/E MØUNTSLØPE > 20%
M409	TERRACED MØUNTAIN SLØPE
M5	STRØNG DISSECT MØUNTSLØPE
M501	A/B MØUNTSLØPE < 30%
M502	C MØUNTSLØPE 30-50%
M503	D MØUNTSLØPE 50-75%
M504	E MØUNTSLØPE > 75%
M505	A/B/C MØUNTSLØPE < 50%
M506	C/D MØUNTSLØPE 30-75%
M507	D/E MØUNTSLØPE > 50%
M508	C/D/E MØUNTSLØPE > 20%
M509	TERRACED MØUNTAIN SLØPE
M6	SPECIAL FEATURED SLØPES
M601	TALUS SLØPE
M602	RØUGH BRØKEN/RØCKY SLØPE
M7	SPECIAL MØUNTAIN FEATURES
M701	PEAK/PINACHØ
M702	SERRATED SCARPS/CRAGS
M703	HØRN
M704	TØWER
M705	ARÊTE
M706	TETØN
M8	CIRQUE/NATURAL TERRACE
M800	DISSECT VALLØN/VALLEY HEAD
M801	CIRQUE SLØPE
M802	UNDULATING CIRQUE FLØØR
M803	RØLLING CIRQUE FLØØR
M804	CAT STEP
M805	CØRRUGATED SLØPE BREAK
M806	FLAT-RØLLING NATURAL TERRACE
M807	RØLL-HILLY NATURAL TERRACE
X	MISCELLANEØUS LANDFØRMS
X1	ØUTCRØPS
X101	BLUFF
X102	RØCK ØUTCRØP
X2	SALT PAN/SALT WØRKS
X3	SETTLEMENT
X301	VILLAGE
X302	TØWN
X4	RIVER BED
X401	STRAIGHT RIVER BED
X402	MEANDERING RIVER BED
X403	DEEPLY INCISED RIVER BED
X5	LAKES
X501	SALINE/BRACKISH LAKE
X502	FRESH LAKE
X503	HØT WATER PØND
X504	RESERVØIR
X6	MISCELLANEØUS LANDTYPES
X601	BADLANDS
X602	RØUGH BRØKEN RØCKY LAND
X603	MØUNTAIN SCREE
X604	SCREE/FAN/DEBRIS CØNE
X605	LANDSLIDE SCAR
X606	LAND/EARTH SLIDE/LANDSLIP
X607	SØLIFLUX STREAM/FLØW/SLUMP
X7	NARRØW VALLEY LANDTYPES
X701	V-SHAPED VALLEY
X702	GULLY/RAVINE/FLUME
X703	GØRGE
X704	CANYØN
X705	TERRACED VALLEY SIDE/BØTTØM
X706	TERRACED VALLEY HEAD/VALLØN
X707	EMBAYMENT/CØVE
X708	DISSECT VALLØN/DEEP RAVINES
X709	RIVER-CUT VALLEY

USER CODE	FULL DEFINITION
X8	SUMMIT TYPES
X801	SHARP SUMMIT/CREST LINE
X802	CØNVEX RØUNDED SUMMIT
X803	FLAT SUMMIT
X804	MØUNTAIN PASS
X805	SADDLE
V	VØLCANIC LANDFØRMS
V1	CRATERS
V101	CRATER
V102	CALDERA
V103	VØLCANIC VENT
V2	VØLCANO UPPER SLØPES
V201	SLT-DISSECT UPPER SLØPE
V202	MØD-DISSECT UPPER SLØPE
V203	DISSECTED UPPER SLØPE
V204	STRØNG DISSECT UPPER SLØPE
V3	VØLCANØ MIDDLE SLØPE
V301	SLT-DISSECT MIDDLE SLØPE
V302	MØD-DISSECT MIDDLE SLØPE
V303	DISSECTED MIDDLE SLØPE
V304	STRØNG DISSECT MIDDLE SLØPE
V305	FLAT PART MIDDLE SLØPE
V306	ELØNGATED SPUR/VØLCANIC RIDGE
V307	BENCHED MIDDLE SLØPE
V308	TERRACED MIDDLE SLØPE
V4	VØLCANØ LØWER SLØPE
V401	SLT-DISSECT LØWER SLØPE
V402	MØD-DISSECT LØWER SLØPE
V403	DISSECTED LØWER SLØPE
V404	STRØNG DISSECT LØWER SLØPE
V405	FLATTISH LØWER SLØPE
V406	VØLCANIC RIDGE
V407	TERRACED LØWER SLØPE
V5	LAVA FLØWS
V501	RECENT LAVA FLØW
V502	ANCIENT LAVA FLØW
V503	VERY ANCIENT DISSECT FLØW
V504	SCØRIES/CINDER CØNE
V505	CØMBINED LAVA/LAHAR FLØW
V506	LAVA FLØW RØE/VØLCANIC RIDGE
V507	LAVA PLAIN
V508	LAVA PLATEAU
V509	LAVA DØME
V510	LAVA FIELD
V6	LAHAR LANDTYPES
V601	TERRACED FØØTSLØPE/BØULDERY
V602	UND-RØLL VALLEY/BØULDERY
V603	TERRACED FØØTSLØPE/HUMMØCKY
V604	SLØPE WITH CATSTEP/HILLØCKS
V605	TALUS SLØPE WITH BLØCKS
V7	PLANÉZE LANDTYPES
V701	LEVEL PLANÉZE FLAT NØNDISECT
V702	LEVEL PLANÉZE UND DISECT
V703	LEVEL PLANÉZE RØLL STGDISECT
V704	SLØPE PLANÉZE
V705	INTERVØLCANIC PLAIN UND
V706	INTERVØLCANIC PLAIN RØLL
V707	INTERVØLANIC PLAIN HUMMØCKY
V8	VØLCANIC PLAIN LANDTYPES
V801	FLAT VØLCANIC PLAIN
V802	UNDULATING VØLCANIC PLAIN
V803	RØLLING VØLCANIC PLAIN
V804	FLAT/HUMMØCKY VØLCANIC PLAIN
V805	UND/HUMMØCKY VØLCANIC PLAIN
V806	RØLL/HUMMØCKY VØLCANIC PLAIN
V807	UND/HILLØCKY VØLCANIC PLAIN
V808	RØLL/HILLØCKY VØLCANIC PLAIN
V809	TILTED VØLCANIC PLAIN
V9	VØLCANIC ØUTCRØPS
V901	BATHØLITH
V902	DYKE
V903	BØSS
V904	STØCK
V905	NECK/PLUG
V906	SPINE
V907	PITØN
K	KARST LANDFØRMS
K1	KARST PLATEAU/TERRACE
K101	UND/RØLL HUMMØCKY PLATEAU
K102	UND/RØLL HILLØCKY PLATEAU
K103	UND/RØLL HILLY PLATEAU
K104	PLATEAU WITH LAPIES RELIEF
K105	PLATEAU WITH KNØBS/GRØTTØS
K106	PLATEAU WITH CLIFFS/CAVES
K2	GENTLE KARSTIC SLØPES
K201	GENTLE SLØPE-HUMMØCKY
K202	GENTLE SLØPE-HILLØCKY
K203	GENTLE SLØPE-HILLY
K204	GENTLE SLØPE-LAPIES RELIEF
K205	GENTLE SLØPE-KNØBS/GRØTTØS

USER CODE	FULL DEFINITION
K206	GENTLE SLØPE-CLIFFS/CAVES
K3	STEEP KARSTIC SLØPES
K301	STEEP SLØPE-HUMMØCKY
K302	STEEP SLØPE-HILLØCKY
K303	STEEP SLØPE-HILLY
K304	STEEP SLØPE-LAPIES RELIEF
K305	STEEP SLØPE-KNØBS/GRØTTØS
K306	STEEP SLØPE-CLIFFS/CAVES
K4	KARSTIC VERSANTS
K401	HUMMØCKY VERSANT
K402	HILLØCKY VERSANT
K403	HILLY VERSANT
K404	VERSANT-LAPIES RELIEF
K405	VERSANT-KNØBS/GRØTTØS
K406	VERSANT-CLIFFS/CAVES
K407	LØNG RIDGE/VALLEY RELIEF
K5	KARST ØUTCRØPS
K501	HUM
K502	CLIFFS
K503	PINNACLE
K6	KARSTIC DEPRESSIØNS
K601	DØLINE
K602	UVALA
K603	SINKHØLES
K604	KATAVØTHRE
K7	KARSTIC PLAINS/PØLJE
K701	FLAT PØLJE
K702	FLAT PØLJE WITH HILLØCKS
K8	BEDDED CHALK ERØSURFACES
K800	VALLON-DENDRITIC DRAINAGE
K801	UNDULATING ERØSURFACE
K802	RØLLING ERØSURFACE
K803	HUMMØCKY ERØSURFACE
K804	HILLØCKY ERØSURFACE
K805	STRØNG DISECT PARALLEL RIDGE
K806	EXTREME DISECT RØLL HILLØCKS

Appendix II. Parent material names

1. Mode of accumulation or deposition
   - Alluvium (including fans and pedisediments)
   - Eolian, mixed or undifferentiated
   - Eolian and/or ejecta, ash
   - Eolian, loess
   - Eolian, sand
   - Lacustrine (including glacial-lacustrine)
   - Marine
   - Organic sediment
   - Local colluvium
   - Residual material
   - Soliflucate
   - Solid rock (also includes material under a paralithic or lithic contact)
   - Unconsolidated mineral sediments, unspecified.

2. Origin or source of materials

   Mixed lithology and composition
   - Unknown or generalized
   - Noncalcareous or acid
   - Calcareous
   - Mixed lithology, unspecified
   - Igneous, metamorphic, and sedimetary
   - Igneous and metamorphic
   - Igneous and sedimetary
   - Metamorphic and sedimentary.

   Conglomerate
   - Conglomerate, unspecified
   - Noncalcareous
   - Calcareous.

Igneous rocks

- Unspecified kind
- Coarse (or Intrusive)
  - Basic (e.g. Gabbro, Nepheline rocks, Peridotite)
  - Intermediate (e.g. Diorite, Monzonite, Tonalite)
  - Acid (e.g. Granite)
- Fine (Extrusive)
  - Basic (e.g. Basalt)
  - Intermediate (e.g. Andesite)
  - Acid (e.g. Rhyolite, Trachyte)
  - Ultrabasic.

Metamorphic rocks

- Unspecified kind
- Gneiss, unspecified
  - Acidic
  - Basic
- Serpentine
- Schist and Thyllite, unspecified
  - Acidic
  - Basic
- Slate
- Quartzite.

Sedimentary rocks

- Unspecified kind
- Marl, unspecified
- Glauconite, unspecified.

Interbedded sedimentary rocks

- Unspecified kind
- Limestone, Sandstone, and Shale, with or without Siltstone
- Limestone and Sandstone
- Limestone and Shale
- Limestone and Siltstone
- Sandstone and Shale
- Sandstone and Siltstone
- Shale and Siltstone.

Sandstone
- Unspecified kind
- Noncalcareous
  - Arkosic
  - Other noncalcareous
- Calcareous.

Shale
- Unspecified kind
- Noncalcareous
- Calcareous.

Siltstone
- Unspecified kind
- Noncalcareous
- Calcareous.

Limestone
- Either unspecified kind or calcitic
- Chalk
- Marble
- Dolomitic
- Phospahatic
- Arenaceous (sandy)
- Argillaceous (shaly)
- Cherty, unspecified or calcitic.

Phyroclastic consolidated
- Unspecified kind
- Tuff, unspecified (including Ignembrites)
  - Acidic
  - Basic
- Volcanic Breccia, unspecified
  - Acidic
  - Basic
- Tuff-Breccia
- Lava flow.

Ejecta - Ash

- Unspecified kind
- Acidic
- Basic, unspecified
  - Basaltic ash
  - Andesitic ash
- Cinders
- Pumice
- Scoria
- Volcanic bombs.

Miscellaneous organic material

- Unspecified kind
- Mossy material
- Herbaceous material
- Woody material
  - Wood fragments (< 1 m in length)
  - Wood fragments (logs or stumps)
- Charcoal
- Coal
- Other organic materials.

Appendix III. Land use descriptions

- Cropland, flooded rice, rainfed
- Cropland, flooded rice, irrigated
- Cropland estate tree crops
- Cropland, small holdings tree crops
- Cropland, general (extensive management, includes upland rice)
- Cropland, irrigated (not flooded rice)
- Forest or woodland, grazed
- Forest ungrazed
- Grassland or grazing land
- Grassland, irrigated
- Horticultural crop (intensive management, includes special drainage and/or irrigation practices)
- Landfill (includes soil - nonsoil mix)
- Surface mines, pit or spoil
- Nearly barren or barren land
- Swamp or marshland
- Swamp or marsh, drained
- Urban land
- Woodland, open.

Appendix IV. Geomorphic component

- Summit
- Upper slope
- Middle slope
- Lower slope
- Foot slope
- Terrace (includes fans)
- Plain.

Appendix V. Brief description of soils in seven drainage classes

Very poorly drained. These soils are wet to the surface most of the time. Most of them are in low-lying level areas. These soils are wet enough to prevent growth of most crops (except rice) unless artificially drained. Surface colours are black to gray. Generally, subsurface colours are gray or light grey, but may be greenish or bluish. Mottles if present have low chroma, generally 2 or less.

Poorly drained. These soils are wet at or near the surface during a considerable part of the year, so that field crops (except for rice) cannot be grown, unless artificially drained. Most of these soils are low-lying and level. They have a saturated zone caused by a layer of slow permeability, seepage or a combination of both. Surface colours of most of these soils are black or grey. Generally, subsurface colors are grey or light grey, commonly with mottles of chroma of 3 or more.

Somewhat poorly drained. These soils are wet near the surface for long enough periods that planting and/or harvesting operations are hindered and yields of some field crops are low, unless artificial drainage is provided. They have a layer with slow permeability or additions of water through seepage or both. Commonly, surface colours are greyish brown to yellowish. Subsurface layers are greyish and mottles of high chroma are at depths between about 20 to 50 cm.

Moderately well drained. These soils are wet near enough to the surface for long enough periods that planting or harvesting operations are delayed for short periods and yields of some field crops are a little lower than on well drained soils. They have a layer with slow permeability or additions of water by seepage, or both. Commonly, these soils have dark- colored surface horizons and mottles of high chroma in the lower part of the subsoil.

Well drained. These soils retain moisture for some time after rainfall, but water passes through them readily. They are not wet long enough after heavy rains to delay planting or harvesting operations or suppress yield of field crops. Most well drained soils have reddish, brownish or yellowish surface and subsurface layers. If high chroma mottles are present they

are deeper than 100 cm.

Somewhat excessively drained. These soils are rapidly permeable and have low water-holding capacity. Without irrigation only drought resistant crops can be grown and yields are low. Many of these soils are sandy and porous. Soil colors are reddish, brownish, yellowish or grayish. If mottles are present they are inherited from the weathered rock in which they formed rather than from wet condition.

Excessively drained. These soils are rapidly permeable and have low water holding capacity. They are not suited for crop production unless irrigated. Most of them are sandy, gravelly or stony and are very porous. Many of them are steep. Generally, excessively drained soils are reddish, brownish, yellowish or grayish. They are free of mottles associated with wetness.

Appendix VI. Definition of soil layers

Surface soil is the layer which is either darkened by humus in undisturbed soils or is disturbed by tillage operations in cultivated soils. It is usually referred to as the soil ordinarily moved by tillage or it's equivalent soil thickness (10 - 25 cm). It is sometimes thinner in heavy clay soils or thicker where deeply ploughed. The plough pan is included in the surface soil.

It is important for supplying plant food, particularly for field crops, and regulates the penetration of water into the soil. It's properties determine whether tillage operations are easy or difficult.

Subsoil is the layer below the surface soil which has undergone effects of soil forming processes. Its thickness is usually considered as the thickness of the solum minus the surface soil.

It is important in determining internal soil drainage, dry season moisture retention and for supplying plant food, particularly for tree crops and deep rooted field crops

Substratum is the material underlying the subsoil or where there is no subsoil, the layer directly under the surface soil.

The substratum may influence soil drainage and moisture retention and may also play a role in plant nutrition.

PART 2

EXPLANATION OF ENTRIES TO BE MADE IN TABLE 2,
GENERAL LAND SUITABILITY AND POTENTIAL RATINGS

Column No.

Columns 1,2 and 3 indicating Map Unit Symbol, Extent and Soil Component, respectively, are included for the users convenience allowing for quick cross-reference between Table 1 and Table 2.

1. Map unit symbol - enter the same alphanumeric symbols as listed in column 1 of Table 1.

2. Extent is indicated by one entry of the number of hectares for each map unit as listed in the first entry of column 3, Table 1.

3. Soil component is indicated by two entries. The first lists the USDA Soil Taxonomy "sub-group", e.g. Typic Pelluderts, entered in the same sequence as the first entry of column 8, Table 1. Note that the family description is not required for Table 2. The second entry indicates the estimated proportion of the map unit for each soil component represented by appropriate symbols (P,D,F,M or T) as listed in column 8a, Table 1.

Column 4 through 16 indicate suitabilities for 5 Primary Uses, namely :

- Cereals (columns 4 through 6)
- Root Crops and Legumes (columns 7 through 10)
- Estate and Industrial Crops (columns 11 through 13)
- Pasture (column 14)
- Forestry (columns 16 and 17)

Cereals are divided into wetland and dryland, while Root Crops and Legumes, Estate and Industrial Crops, and Forestry are divided into lowland and highland.

Suitability for each primary use division is given for a representative crop(s) or timber species.

Choice of crop or timber species representatives is made from those listed in PART 3, section 3.1 and will be dependent on pre-

Column No.

vailing climatic conditions and socio-economic strategy applying to the survey area as a whole.

Representative crops and timber species are chosen at the outset with the same crop/timber species being evaluated for each mapping unit and their soil components.

If any mapping unit has an average annual rainfall of less than 1,000 mm (see Table 1, column 7, entry 1) then "sorghum" will be the crop choice for column 6 (Cereals, Dryland) with suitability evaluations being made for every soil component of each mapping unit.

4. Cereals, Wetland - suitability for wetland rice is indicated under three entries.

The first entry under heading 'C' indicates current or present suitability represented by an alphanumeric symbol comprising suitability class or order and major limiting quality (if any), e.g. S3w.

The second entry under heading 'I' identifies improvements needed for development represented by combined letter symbols indicating the type of improvement and level of input required,e.g M/Mi.

The third entry under heading 'P' indicates potential suitability after improvements (if any) represented by an alphanumeric symbol comprising suitability class or order, e.g. S2.

The process of evaluation is described in PART 3, section 4.

5. Cereal, Dryland - suitability for either 'upland rice' or 'maize' (choose one) is indicated by three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

6. Cereal, Dryland - refer back to the mapping unit description under Table 1, column 7 (climate), entry 1 (average annual rainfall in mm). If the average annual rainfall is less than 1,000 mm for any mapping unit give suitability for 'sorghum'. If the average annual rainfall is 1,000 mm or more give suitability for either 'upland rice' or 'maize' (whichever remains after selection made for column 5).

Three entries are made under headings C,I and P as described for column 4 above.

Column No.

The process of evaluation is described in PART 3, section 4.

Columns 7,8,9 and 10 are used to list suitabilities for 'Root Crops and Legumes" allowing for the choice of one root crop and one legume under lowland conditions and one root crop and one legume under highland conditions.

7. Root Crops, lowland - Choose one crop from "cassava","sweet potato", "yam" or "cocoyam". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

8. Legumes, Lowland - Choose one crop from "soybean" or "groundnut". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

9. Root Crops, Highland - At present "white potato" is the only representative crop for which adequate data is available. Indicate suitability by making three entries under headings C,I and P as described under column 4 above.

The process of evaluation is described in PART 3, section 4.

10. Legumes, Highland - At present "phaseolus bean" is the only representative crop for which adequate data is available. Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

Columns 11,12 and 13 are used to list suitabilities for "Estate and Industrial Crops" allowing for the choice of two crops under lowland conditions and one crop under highland conditions.

11. Estate and Industrial Crops, Lowland - Choose one crop from "cotton", "sugarcane", "cocoa", "rubber", "oil palm", "banana", "coconut", or "cloves". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

12. Estate and Industrial Crops, Lowland - Choose one crop from those remaining as listed for column 11. Indicate suitability by making

Column No.

three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

13. Estate and Industrial Crops, Highland - Choose one crop from "tea" or "coffee". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

14. Pasture (grasses) - Limited data is presently only available for grasses. Indicate suitability for all mapping units by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

Columns 15 and 16 are used to list suitabilities for "Forestry" allowing for the choice of one timber species under lowland conditions and one timber species under highland conditions.

15. Forestry, Lowland - Choose one timber species from "Teak", "Mahogany", "Leucena leucocephela", "Acacia auriculformis", or "Melaleuca leucodendron". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

16. Forestry, Highland - Choose one timber species from "Agathis loranthifolia", "Altingia excelsa","Albizia falcataria", "Eucalyptus grandis", or "Pinus merkusii". Indicate suitability by making three entries under headings C,I and P as described for column 4 above.

The process of evaluation is described in PART 3, section 4.

Columns 17 through 27 indicate "Potential for Project Development" to provide general guidelines to planners in selecting preliminary sites that merit further study.

17. Irrigation potential is indicated by entering one of the following symbols :

++ (indicating good potential)

\+ (Poor or marginal potential)

\- (no potential)

The process of evaluation is described in PART 3, section 5.

Column No.

18. Drainage potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

19. Cereals, Wetland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

20. Cereals, Dryland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

21. Root Crops and Legumes, Lowland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

22. Root Crops and Legumes, Highland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

23. Estate and Industrial Crops, Lowland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

24. Estate and Industrial Crops, Highland potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

25. Pasture [1/] potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

26. Forestry, Lowland [1/] potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

27. Forestry, Highland [1/] potential is indicated by entering the appropriate symbol as described under column 17 above.

The process of evaluation is described in PART 3, section 5.

1/ Refer to PART 3, section 5.39 - "Pasture and Forestry Projects-General Statement" before evaluating potential for project development.

PART 3

DESCRIPTION OF GENERAL LAND SUITABILITY AND POTENTIAL RATING PROCEDURES

1. INTRODUCTION

The principles of land suitability and land potential evaluation involve the matching of defined attributes of a mapped unit of land against defined requirements of a specific land use.

Evaluations of reconnaissance surveys are from necessity general in nature as the mapped units of land are larger in area and their attributes are wider in range than in more detailed surveys.

The basic aim of reconnaissance surveys is to provide an initial screening of suitabilities and potential for primary agricultural and forestry uses. Where reconnaissance findings identify potential for project development, the area concerned is then subject to more detailed investigations and evaluation.

The data generated by current reconnaissance surveys for evaluation purposes consist of 15 land characteristics which are grouped under 7 land qualities. These are matched against tabulated requirements of representative crops and timber species chosen from a listing of 23 crops and 10 timber species grouped under 5 primary uses. The following sections define and describe the land characteristics and qualities; the requirements of the representative crops and timber species; and the method of evaluation.

2. LAND CHARACTERISTICS AND LAND QUALITIES

2.1 Definitions (FAO, 1976)

"A land characteristics is an attributes of land that can be measured or estimated".

"A land quality is a complex attribute of land which acts in a distinct manner in its influence on the suitability of land for a specific kind of use".

Land characteristics are generally not employed directly in evaluations as problems arise from the interaction between characteristic. Land qualities can sometimes be estimated or measured direct-

ly; but are more usually described by means of a grouping of two or more land characteristics.

In the evaluation of current reconnaissance surveys 15 land characteristics are grouped under 7 land qualities as follows :

	Land Qualities	Land Characteristics
t	Temperature Regime	1. Annual Average Temp. (^{o}C)
w	Water Availability	1. Dry months (< 75 mm) 2. Average Annual Rainfall (mm)
r	Rooting Conditions	1. Soil Drainage Class 2. Soil Texture (surface) 3. Rooting Depth (cm)
f	Nutrient Retention	1. CEC me/100g soil (subsoil) 2. pH (surface soil)
n	Nutrient Availability	1. Total Nitrogen 2. Available P205 3. Available K20
x	Toxicity	1. Salinity mmhos/cm(subsurface)
s	Terrain	1. Slope % 2. Surface Stoniness 3. Rock Outcrops.

2.2 Descriptions

The following descriptions indicate data source for each characteristic as listed under Table 1, parts 1 and 2. Where ratings, classes, and values are the same as described in part 1 of this manual the user is referred to the section concerned. However, full descriptions are given where different ratings, classes or values are used for evaluation.

t - Temperature Regime

1. Annual Average Temp. (^{o}C) - Data source is Table 1, part 1, column 7, entry 4. The description is found in PART 1 of this manual.

w - Water Regime

1. Dry months (< 75 mm) - Data source is Table 1, part 1, column 7, entry 3. The description is found in PART 1 of this manual.

2. Average Annual Rainfall (mm) - Data source is Table 1, part 1, column 7, entry 1. The description is found in PART 1 of this manual.

r - Rooting Conditions

1. Soil Drainage Class - Data source is Table 1, part 1, column 11. The description is found in PART 1 of this manual.

2. Soil Texture (surface) - Data source is Table 1, part 2, column 18. The description is found in PART 1 of this manual. However, in the tabulated crop and timber species requirements the following textural groupings are used :

- gravels (includes cinders, fragmental material, gravel and sandy gravel)
- sands
- loamy sand
- sandy loam
- loam
- sandy clay loam
- silt loam
- silt
- clay loam
- silty clay loam
- sandy clay
- silty clay
- structured clay (clays having all structures except "structureless-massive")
- massive clay (clays which are 'structureless-massive").

(Data source for structure is Table 1, part 1, column 16).

3. Rooting Depth (cm) - Data source is Table 1, part 1, column 10. The description is found in PART 1 of this manual. However, if a range of depth is entered in column 10, use the shallower depth for evaluation purposes.

f - Nutrient Retention [1/]

1. CEC me/100g soil (subsoil) - Data source is Table 1, part 2,

1/ The Nutrient Retention quality refers to the capacity of the soil to retain added nutrients, as against losses caused by leaching as indicated by CEC. The inclusion of pH as a characteristic under this quality also serves as a means of indicating the soils fixing capacity.

column 24. The description is found in PART 1 of this manual.

2. pH (surface) - Laboratory analysis is preferred, data source being Table 1, part 2, column 19, described in PART 1 of this manual, page 10. However, if laboratory data is not available then field pH may be used, data source being Table 1, part 1, column 17, described in PART 1 of this manual. Where a range of pH is entered in either column 19 or 17, cases may occur where the range crosses two suitability classes. In such instances use the poorer suitability class for evaluation purposes.

n - Nutrient Availability [2/]

1. Total Nitrogen (surface) - Data source is Table 1, part 2, column 21. The description is found in PART 1 of this manual.
2. Available P_2O_5 (surface) - Data source is Table 1, part 2, column 22. The description is found in PART 1 of this manual.
3. Available K_2O (surface) - Data source is Table 1, part 2, column 23. The description is found in PART 1 of this manual.

x - Toxicity

1. Salinity mmhos/cm (subsoil) - Data source is Table 1,part 2, column 29. - "other features that affect use and management". E.C. mmhos/cm is only determined if salinity is suspected for the mapping unit concerned. Subsoil values should be determined for evaluation purposes rather than surface soil as considerable variation over short distances is a common feature of surface soil salinity.

2/ The Nutrient Availability quality refers to the quantities of major nutrients present, as determined by analysis of samples from the surface soil.

s - Terrain [3/]

1. Slope % - Data source is Table 1, part 1, column 9. The description is found in PART 1 of this manual. However,as a range in slope is entered in column 9, cases may occur where the range crosses two suitability classes. In such cases use the poorer suitability class for evaluation purposes.

2. Surface stoniness - Data source is Table 1, part 2, column 29 - "Other features that affect use and management". Surface stoniness is only recorded if present. Class codes are used in the tabulated primary use requirements as follows :

Code	Stoniness Classes (FAO, 1977)
0	No stones or very few stones; too few stones to interfere with tillage. Stones cover less than 0.01% of the area.
1	Fairly stony; sufficient stones to interfere with tillage but not to make inter-tilled crops impractical. Stones cover 0.01% to 0.1% of the area (stones 15 to 30cm in diameter, 10 to 30 meters apart).
2	Stony; sufficient stones to make tillage of inter-tilled crops impracticable, but the soil can be worked for hay crops or improved pasture if other soil characteristics are favourable. Stones cover 0.1% to 3.0% of the area. (Stones 15 to 30cm in diameter, 1.6 to 10 meters apart).
3	Very stony; sufficient stones to make all use of machinery impracticable, except for very light machinery or hand tools where other soil characteristics are especially favourable for improved pastures. Stones cover 3.0% to 15% of the area. (Stones 15 to 30cm in diameter, 75 to 160cm apart).
4	Exceedingly stony; sufficient stones to make all use of machinery impracticable. Stones cover 15% to 90% of the land. (Stones 15 to 30cm in diameter, less than 75cm apart).

3/ The Terrain quality is related to the management inputs required for sustained production of representative crops or timber species. Slope directly influences present run-off and soil erosion, especially if mechanization is considered at a high input level. Surface stoniness is also important with regarded to limitations related to mechanization and together with rock outcrops restricts the surface area available for plant growth.

5	Rubble land; land essentially paved with stones which occupy more than 90% of the surface area.

3. Rock outcrops - Data source is Table 1, part 2, column 29 - "Other features that affect use and management". Rock outcrops are only recorded if present. Class codes are used in the tabulated use requirements as follows :

Code	Rock Outcrop Classes (FAO, 1977)
0	No rocks or very few rocks; no bedrock exposure or too few to interfere with tillage. Less than 2% bedrock exposed.
1	Fairly rocky; sufficient bedrock exposures to interfere with tillage but not to make inter-tilled crops impracticable. Depending on the pattern of outcrops, exposures are roughly 35 to 100 meters apart and cover 2% to 10% of the surface.
2	Rocky; sufficient bedrock exposures to make tillage of inter-tilled crops impracticable, but soil can be worked for hay crops or improved pasture if other soil characteristics are favourable. Rock exposures are roughly 10 to 35 meters apart and cover about 10% to 25% of the area, depending on their pattern.
3	Very rocky; sufficient rock outcrops to make all use of machinery impracticable, except for light machinery where the other soil characteristics are especially favourable for improved pasture. Rock exposures, or patches of soil too shallow over rock for use, are roughly 3.5 to 10 meters apart and cover about 25% to 50% of the surface, depending on their pattern.
4	Extremely rocky; sufficient rock outcrops (or very shallow soil over rock) to make all use of machinery impractical. Rock outcrops are about 3.5 meters apart or less and cover some 50% to 90% of the area.
5	Rock outcrops; over 90% of the land is exposed bedrock.

3. GENERAL LAND SUITABILITY RATINGS

3.1 Introduction

The purpose of evaluations based on current reconnaissance surveys is to indicate expected potential for representative crops/tim-

ber species of five primary agricultural/forestry uses.

Representative crops/timber species requirements are expressed as value or class ranges by four suitability ratings for each land characteristic arranged in land quality groupings.

The five primary uses and their representative crops/timber species are listed below :

1. Cereals

   Wetland - rice.

   Dryland - upland rice, maize, sorghum.

2. Root Crops and Legumes

   Lowland - cassava,sweet potato,yam,cocoyam,soybean,groundnut.

   Highland - white potato, phaseolus bean.

3. Estate and Industrial Crops

   Lowland - cotton,sugarcane,cocoa,rubber,oil palm,banana, coconut,cloves.

   Highland - coffee,tea.

4. Pasture (grasses)

5. Forestry

   Lowland - Teak,Mahogany,Leucena leucocephela,Acacia auriculformis,Melaleuca leucodendron.

   Highland - Agathis loranthifolia,Altingia excelsa,Albizia falcataria,Eucalyptus grandis,Pinus merkusii.

3.2 Representative crop and timber species requirements

The following tables list requirements for 23 crops and 10 timber species. The first column identifies relevant land characteristics grouped by land qualities. Columns 2 to 5 list ratings for four suitability classes. The 6th column indicates the data source (Table and column number) for matching recorded land characteristic estimates or measurements against the crop/timber species requirements.

Wetland Rice

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-29	30-32 24-22	33-35 21-18	> 35 < 18	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	0-3	3.1-9	9.1-9.5	> 9.5	Table 1, col 7
2. Average annual rainfall (mm)	> 1500	1200-1500	800-1200	< 800	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	somewhat poor, moderately well	very poor, poor	well	somewhat excessive, excessive	Table 1, col 11
2. Soil texture (surface)	sandy clay loam, silt loam, silt, clay loam	sandy loam, loam, silty clay loam, silty clay, structured clay	loamy sand, massive clay	gravels, sands	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	41-50	20-40	< 20	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.5-7.0	7.1-8.0 5.4-4.5	8.1-8.5 4.6-4.0	> 8.5 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	very high	high	medium-low	very low	Table 1, col 22
3. Available K_2O (surface)	≥ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 3	3.1-5	5.1-8	> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-3	3-5	5-8	> 8	Table 1, col 9
2. Surface stoniness	0			≥ 1	Table 1, col 29
3. Rock outcrops	0		1	≥ 2	Table 1, col 29

Upland Rice

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-26	27-30 19-18	31-32 17-16	> 32 < 16	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	5-8	8.1-8.5 < 5	8.6-9	> 9	Table 1,col 7
2. Average annual rainfall (mm)	> 1500	1500-1000	1000-750	< 750	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	poor, somewhat poor	very poor, somewhat excessive	excessive	Table 1,col 11
2. Soil texture (surface)	sandy clay loam, silt loam, silt, clay loam, silty clay loam.	sandy loam, loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 60	40-59	20-39	< 20	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1,col 24
2. pH (surface soil)	5.0-6.0	6.1-7.0 4.9-4.5	7.1-8.5 4.5-4.0	> 8.5 < 4.0	Table 1,col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ low	very low			Table 1,col 21
2. Available P_2O_5 (surface)	≥ high	medium	low	very low	Table 1,col 22
3. Available K_2O (surface)	≥ low	very low			Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 3	3-5	5-8	> 8	Table 1,col 29
s - Terrain					
1. Slope %	0-5	5-15	15-24	> 24	Table 1,col 9
2. Surface stoniness	0		1	≥ 2	Table 1,col 29
3. Rock outcrops	0		1	≥ 2	Table 1,col 29

Maize

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-26	27-30	31-32 20-18	> 32 < 18	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	1-7	7.1-8.0	8.1-9	> 9	Table 1, col 7
2. Average annual rainfall (mm)	> 1200	1200-900	900-600	< 600	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat poor	poor, somewhat excessive	very poor, excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 60	40-59	20-39	< 20	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.0-7.0	7.1-7.5 5.9-5.5	7.6-8.5 5.4-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	very high	high	medium - low	very low	Table 1, col 22
3. Available K_2O (surface)	≥ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-4	4.8	> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	≥ 2	Table 1, col 29
3. Rock outcrops	0		1	≥ 2	Table 1, col 29

Sorghum

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	27-32	33-37 26-18	38-40 17-15	> 40 < 15	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	4-8	8.1-8.5 4.1-2.5	8.6-9.5 2.4-1.5	> 9.5 < 1.5	Table 1, col 7
2. Average annual rainfall (mm)	600-1500	1500-2000 600-400	2000-4000 400-250	> 4000 < 250	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat excessive	poor, somewhat poor	very poor, excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 60	40-59	20-39	< 20	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.0-7.5	7.6-8.0 5.9-5.5	8.1-9.0 5.4-5.0	> 9.0 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	≥ high	medium	low	very low	Table 1, col 22
3. Available K_2O (surface)	≥ low	very low			Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-6.5	6.5-12.5	> 12.5	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	≥ 2	Table 1, col 29
3. Rock outcrops	0		1	≥ 2	Table 1, col 29

Cassava ✓

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	22-28	29-30 21-20	31-35 19-18	> 35 < 18	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	2-4	4.1-6 < 2	6.1-7	> 7	Table 1, col 7
2. Average annual rainfall (mm)	1000-2000	2000-4000 1000-750	> 4000 750-500	< 500	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excess	somewhat poor, excessive	very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam	loamy sand, sandy loam, silty clay loam, sandy clay	sands, silty clay, structured clay	gravels, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 100	75-99	50-74	< 50	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.5-6.5	6.6-7.5 5.4-5.0	7.6-8.5 4.9-4.0	> 8.5 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	≥ high	medium	low-very low		Table 1, col 22
3. Available K_2O (surface)	≥ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3	3-6	> 6	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-8	8-16	> 16	Table 1, col 9
2. Surface stoniness	0		1	≥ 2	Table 1, col 29
3. Rock outcrops	0		1	≥ 2	Table 1, col 29

Sweet Potato

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20–22	23–26 19–18	27–30 17–16	> 30 < 16	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	1–7	7.1–8 < 1	8.1–9	> 9	Table 1, col 7
2. Average annual rainfall (mm)	800–1500	1500–2500 800–600	2500–4000 600–400	> 4000 < 400	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	Moderately well, well	somewhat excessive	poor, somewhat poor	very poor excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam	loamy sand, sandy loam, silty clay loam, sandy clay	sands, silty clay, structured clay	gravels massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 75	50–74	20–49	< 20	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.5–6.5	6.6–7.0 5.4–5.0	7.1–8.0 4.9–4.0	> 8.0 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ low	very low			Table 1, col 21
2. Available P_2O_5 (surface)	⩾ high	medium	low–very low		Table 1, col 22
3. Available K_2O (surface)	⩾ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2–3.5	3.5–7	> 7	Table 1, col 29
s - Terrain					
1. Slope %	0–5	5–15	15–20	> 20	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

White Potato

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	16-20	21-22 15-14	23 13-12	> 23 < 12	Table 1, col 7
w - Water Availability					
1. Dry months (<75mm)	3-7	7.1-8 < 3	8.1-9	> 9	Table 1, col 7
2. Average annual rainfall (mm)	750-3000	> 3000 750-500	500-400	< 400	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well	somewhat poor, somewhat excess	poor, very poor, excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam	loamy sand, sandy loam, silty clay loam, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 75	50-74	30-49	< 30	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.0-6.5	6.6-7.0 4.9-4.5	7.1-8.0 4.4-4.0	> 8.0 < 4.0	Table 1, col 19 ot 17
n - Nutrient Availability					
1. Total N (surface)	⩾ low	very low			Table 1, col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1, col 22
3. Available K_2O (surface)	⩾ low	very low			Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3.5	3.5-7	> 7	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Yams

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-30	20-25	31-32	> 32 < 20	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	< 5	5.1-6	6.1-7	> 7	Table 1, col 7
2. Average annual rainfall (mm)	1200-2000	2000-5000 1200-800	> 5000 800-600	< 600	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well	poor, somewhat poor, somewhat excessive	very poor, excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam	loamy sand, sandy loam, silty clay loam, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 75	50-74	25-49	< 25	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.5-6.5	6.5-7.5 5.4-5.0	7.6-8.5 4.9-4.5	> 8.5 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1, col 22
3. Available K_2O (surface)	⩾ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3	3-6	> 6	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-8	8-16	> 16	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Cocoyam/Taro

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-32	> 32 24-22	21-20	< 20	Table 1, col 7
w - Water Availability					
1. Dry months (<75mm)	< 5	5.1-6	6.1-7	> 7	Table 1, col 7
2. Average annual rainfall (mm)	2500-5000	> 5000 2500-1500	1500-1000	< 1000	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	poor, somewhat poor, moderately well	very poor	well	somewhat excessive, excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam	loamy sand, sandy loam, silty clay l[illegible] sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 75	50-74	30-49	< 30	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.5-6.5	6.6-7.5 5.4-5.0	7.6-8.5 <5.0	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1, col 22
3. Available K_2O (surface)	⩾ medium	low	very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3	3-6	> 6	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-8	8-16	>16	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Soybean

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	23-28	29-30 22-20	31-32 19-18	> 32 < 18	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	3-7.5	7.6-8.5 < 3	8.6-9.5	> 9.5	Table 1, col 7
2. Average annual rainfall (mm)	100-1500	1500-2500 1000-700	2500-3500 700-500	> 3500 < 500	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat excessive	poor, somewhat poor	very poor excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	30-49	15-29	< 15	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.0-7.0	7.1-7.5 5.9-5.5	7.6-8.5 5.4-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	≥ high	medium	low - very low		Table 1, col 22
3. Available K_2O (surface)	≥ very low				Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2.5	2.5-4	4-8	> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	≥ 2	Table 1, col 29
3. Rock outcrops	0		1	≥ 2	Table 1, col 29

Groundnut

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-30	31-33 24-20	34 19-18	> 34 < 18.	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	< 8	8.1-9	9.1-9.5	> 9.5	Table 1, col 7
2. Average annual rainfall (mm)	900-2000	2000-3000 900-400	> 3000 400-250	< 250	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well, somewhat excessive	moderately well, excessive	somewhat poor	very poor, poor	Table 1, col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam	loamy sand, silt loam, silt	clay loam, silty clay loam, sandy clay, silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	30-49	15-29	< 15	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.0-7.0	7.1-7.5 5.9-5.5	7.6-8.5 5.4-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1, col 22
3. Available K_2O (surface)	⩾ very low				Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 3	3-4	4-6	> 6	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Phoseolus Bean

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	22-26	27-30 21-18	31-32 17	> 32 < 17	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	2-8	8.1-9 1.9-1	9.1-9.5 < 1	> 9.5	Table 1, col 7
2. Average annual rainfall (mm)	900-2000	2000-3000 900-600	> 3000 600-350	< 350	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat excessive	poor, somewhat poor	very poor excessive	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt	loamy sand, sandy loam, clay loam, silty clay loam	sands, sandy clay, silty clay, structured clay	gravels, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	30-49	15-29	< 15	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.0-7.0	7.1-7.5 5.9-5.5	7.6-8.5 < 5.5	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ low	very low			Table 1, col 21
2. Available P_2O_5 (surface)	⩾ very low				Table 1, col 22
3. Available K_2O (surface)	⩾ very low				Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 1	1-2	2-4.5	> 4.5	Table 1, col 29
s - Terrain					
1. Slope %	0-5	5-15	15-20	> 20	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Cotton

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	26-30	31-33 25-22	34-40	⩾ 40 ⩽ 22	Table 1, col 7
w - Water Availability					
1. Dry months (⩽ 75mm)	3-4	4.1-7	7.1-8 2.9-1	⩾ 8 ⩽ 1	Table 1, col 7
2. Average annual rainfall (mm)	1000-1500	1500-1750 1000-700	1750-2200 700-500	⩾2200 ⩽500	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor; excessive	very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	⩾ 80	60-79	35-59	⩽ 35	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	6.5-7.5	7.6-8.0 6.4-6.0	8.1-8.5 ⩽ 6.0	⩾ 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	⩾ high	medium	low	very low	Table 1, col 22
3. Available K_2O (surface)	⩾ low	very low			Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	⩽ 8	8-13	13-20	⩾ 20	Table 1, col 29
s - Terrain					
1. Slope %	0-8	8-15	15-30	⩾ 30	Table 1, col 9
2. Surface stoniness	0		1	⩾ 2	Table 1, col 29
3. Rock outcrops	0		1	⩾ 2	Table 1, col 29

Sugarcane

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-30	31-32 24-23	33-34 22-21	> 34 < 21	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	1-3	< 1	3.1-5	> 5	Table 1,col 7
2. Average annual rainfall (mm)	1500-4000	1500-1200	< 4000 1200-1000	< 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat poor	poor, somewhat excessive	very poor excessive	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silty loam, silt, clay loam, silty clay loam	loamy sand, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 75	55-74	30-54	< 30	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ high	medium	low	very low	Table 1,col 24
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-4.5	7.6-8.5 4.4-4.0	> 8.5 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	very high	high	medium-low	very low	Table 1,col 22
3. Available K_2O (surface)	≥ medium	low	very low		Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 3.5	3.5-5.5	5.5-12	> 12	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-20	> 20	Table 1,col 9
2. Surface stoniness	0		1	≥ 2	Table 1,col 29
3. Rock outcrops	0		1	≥ 2	Table 1,col 29

Coffee (robusta)

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-27	28-30 19-18	31-32 17-16	> 32 < 16	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	2-3	3.1-5 < 2	5.1-6	> 6	Table 1,col 7
2. Average annual rainfall (mm)	2000-3000	3000-4000 2000-1500	4000-5000 1500-1000	> 5000 < 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	poor, somewhat poor	very poor excessive	Table 1,col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	50-99	< 50	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1,col 24
2. pH (surface soil)	5.5-6.0	6.1-7.0 5.4-5.0	7.1-7.5 4.9-4.5	> 7.5 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ low	very low			Table 1,col 21
2. Available P_2O_5 (surface)	≥ low	very low			Table 1,col 22
3. Available K_2O (surface)	≥ low	very low			Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 1	1-3	3-4	> 4	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-30	> 30	Table 1,col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1,col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1,col 29

Tea

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C.	19-21	22-23 18-17	24-27 16-14	> 27 < 14	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0	1		> 1	Table 1,col 7
2. Average annual rainfall (mm)	2500-4000	4000-5000 2500-1800	5000-6000 1800-1300	> 6000 < 1300	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	poor, somewhat poor	very poor, excessive	Table 1,col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	40-99	< 40	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ low	very low			Table 1,col 21
2. pH (surface soil)	4.5-5.0	5.1-5.5 4.4-4.0	5.6-6.5 3.9-3.5	> 6.5 < 3.5	Table 1,col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	≥ high	medium	low	very low	Table 1,col 22
3. Available K_2O (surface)	≥ very low				Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 1	1-2	2-4.5	> 4.5	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1,col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1,col 29

Cocoa

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-28	29-32 24-20	33-35	> 35 < 20	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0		1-2	> 2	Table 1,col 7
2. Average annual rainfall (mm)	1500-2500	> 2500 1500-1200	1200-1000	< 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	somewhat poor, moderately well	somewhat excessive	very poor, poor, excessive	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	60-99	< 60	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ high	medium	low	very low	Table 1,col 24
2. pH (surface soil)	5.0-6.5	6.6-7.5 4.9-4.5	7.6-8.5 < 4.5	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1,col 22
3. Available K_2O (surface)	⩾ low	very low			Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 1	1-3	3-6	> 6	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1,col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1,col 29

Rubber

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	26-30	31-34 25-24	23-22	> 34 < 22	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0	1	2	> 2	Table 1,col 7
2. Average annual rainfall (mm)	2500-4000	4000 2500-2000	2000-1500	< 1500	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor	very poor, poor, excessive	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 200	130-199	80-129	< 80	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1,col 24
2. pH (surface soil)	4.0-7.0	7.1-7.5 3.9-3.0	7.6-8.5 < 3.0	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	⩾ high	medium	low	very low	Table 1,col 22
3. Available K_2O (surface)	⩾ low	very low			Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 1	1-3	3-6	> 6	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1,col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1,col 29

Oil Palm

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	24-28	29-32 23-22	33-34 21-20	> 34 < 20	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	0-1	1.1-2	2.1-3	> 3	Table 1, col 7
2. Average annual rainfall (mm)	2000-3000	3000-4000 2000-1750	4000-6000 1750-1500	> 6000 < 1500	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	poor, somewhat poor	somewhat excessive	very poor, excessive	Table 1, col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay	silty clay, structured clay	gravels, sands, massive clay	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 100	70-99	45-69	< 45	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1, col 24
2. pH (surface soil)	5.0-6.0	6.1-7.0 4.9-4.5	7.1-8.5 < 4.5	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1, col 21
2. Available P_2O_5 (surface)	⩾ medium		low	very low	Table 1, col 22
3. Available K_2O (surface)	⩾ low		very low		Table 1, col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3	3-6	> 6	Table 1, col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1, col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1, col 29

Banana

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-27	28-29 24-23	30-32 22-19	> 32 < 19	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0-1	1.1-2	2.2-3	> 3	Table 1,col 7
2. Average annual rainfall (mm)	2000-4000	4000-5000 2000-1500	1500-1000	> 5000 < 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat excessive	poor, somewhat poor	very poor, excessive	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay	silty clay structured clay	gravels, sands, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 100	70-79	45-69	< 45	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1,col 24
2. pH (surface soil)	6.0-7.0	7.1-7.5 5.9-5.0	7.6-8.5 < 5.0	> 8.5	Table 1,col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	≥ medium	low	very low		Table 1,col 22
3. Available K_2O (surface)	≥ high		medium	low-very low	Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-3	3-6	> 6	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1,col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1,col 29

Coconut

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-28	29-32 24-23	33-34 22-21	> 34 < 21	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0-1	1.1-2	2.1-4	> 4	Table 1,col 7
2. Average annual rainfall (mm)	2000-3000	3000-5000 2000-1300	> 5000 1300-1000	< 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor, excessive	very poor, poor	Table 1,col 11
2. Soil texture (surface)	loamy sand, sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy clay	sands, silty clay, structured clay	gravels, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 150	90-149	40-89	< 40	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ high	medium	low	very low	Table 1,col 24
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.5 4.9-4.0	> 8.5 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	⩾ medium	low	very low		Table 1,col 22
3. Available K_2O (surface)	⩾ medium	low	very low		Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-4	4-8	> 8	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1,col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1,col 29

Cloves (tentative)

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	25-28	29-32 24-23	33-34 22-21	> 34 < 21	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0-1	1.1-2	2.1-4	> 4	Table 1,col 7
2. Average annual rainfall (mm)	2000-3000	3000-5000 2000-1300	1300-1000	> 5000 < 1000	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor, excessive	very poor, poor	Table 1,col 11
2. Soil texture (surface)	loamy sand, sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy clay	sands, silty clay, structured clay	gravels, massive clay	Table 1,col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	50-99	< 50	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	≥ medium	low	very low		Table 1,col 24
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.5 4.9-4.0	> 8.5 < 4.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	≥ medium	low	very low		Table 1,col 21
2. Available P_2O_5 (surface)	≥ medium	low	very low		Table 1,col 22
3. Available K_2O (surface)	≥ medium	low	very low		Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-4	4-8	> 8	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1,col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1,col 29

Pasture

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-30	31-35 19-18	36-40 17-12	> 40 < 12	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0	0-2	2.1-6	> 6	Table 1,col 7
2. Average annual rainfall (mm)	1500-4000	4000-6000 1500-1000	1000-400	> 6000 < 400	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	somewhat poor, moderately well, well	poor, somewhat excessive	very poor, excessive		Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam, sandy clay	loamy sand, structured clay	sands, silty clay, massive clay	gravels	Table 1,col 18 and col 16
3. Rooting depth (cm)	⩾ 30	20-29	15-19	< 15	Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)	⩾ medium	low	very low		Table 1,col 24
2. pH (surface soil)	5.0-6.5	6.6-7.0 4.9-4.5	7.1-8.5 < 4.5	> 8.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)	⩾ low	very low			Table 1,col 21
2. Available P_2O_5 (surface)	⩾ high	medium	low-very low		Table 1,col 22
3. Available K_2O (surface)	⩾ low	very low			Table 1,col 23
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 3	3-5	5-10	> 10	Table 1,col 29
s - Terrain					
1. Slope %	0-8	8-15	15-30	> 30	Table 1,col 9
2. Surface stoniness	0	1	2-3	⩾ 4	Table 1,col 29
3. Rock outcrops	0	1	2-3	⩾ 4	Table 1,col 29

Tectona grandis (Teak)

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	- N	
t - Temperature Regime					
1. Annual average temp. (°C)	22-30	31-34 21		⩾ 34 ⩽ 21	Table 1, col 7
w - Water Availability					
1. Dry months (⩽ 75mm)	3	4 2	5 1	⩾ 5 ⩽ 1	Table 1, col 7
2. Average annual rainfall (mm)	1500-2000	2000-2250 1500-1250	2250-2500 1250-1000	> 2500 ⩽ 1000	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor, excessive	very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam, sandy clay, silty clay	sandy loam, structured clay	loamy sand, massive clay	gravels	Table 1, col 18 and col 16
3. Rooting depth (cm)	⩾ 150	100-149	50-99	⩽ 50	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					Table 1, col
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	⩾ 8.0 ⩽ 4.5	19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	⩽ 4	4-8		⩾ 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	⩾ 50	Table 1, col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1, col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1, col 29

Swietenia macrophylla (Mahogany)

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	22-30	31-34 21-20		> 34 < 20	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	2	3 1	4 < 1	> 4	Table 1, col 7
2. Average annual rainfall (mm)	2000-3000	3000-3500 2000-1750	3500-4000 1750-1500	> 4000 < 1500	Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor, excessive	very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay	loamy sand, silty clay, structured and massive clay	gravels, sands	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	50-99	< 50	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	> 8.0 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1, col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1, col 29

Agathis loranthifolia

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source'
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-24	> 24 19-17		< 17	Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	0-1	1.1-3	3.1-4	> 4	Table 1, col 7
2. Average annual rainfall (mm)	2500-3000	3000-4000 2500-2000	> 4000 < 2000		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well	somewhat poor, somewhat excessive		very poor, poor, excessive	Table 1, col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay, silty clay, structured clay	massive clay	gravels, sands	Table 1, col 18 and col 16
3. Rooting depth (cm)	≥ 150	100-149	50-99	< 50	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	> 8.0 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2	≥ 3	Table 1, col 29
3. Rock outcrops	0	1	2	≥ 3	Table 1, col 29

Altingia excelsa

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	19-21	22-23 18-17	> 23 < 17		Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	1-2	2.1-3 < 1.		> 3	Table 1, col 7
2. Average annual rainfall (mm)	2000-3000	> 3000 2000-1500	< 1500		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	well	moderately well, somewhat excessive	somewhat poor, excessive	very poor, poor	Tables 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sandy loam, sandy clay, structured clay	loamy sand, silty clay, massive clay	gravels, sands	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 150	100-149	50-99	< 50	Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	> 8.0 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2	⩾ 3	Table 1, col 29
3. Rock outcrops	0	1	2	⩾ 3	Table 1, col 29

Albizia falcataria

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	21-30	31-34 20-19	> 34 < 19		Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	0-2	2.1-4		> 4	Table 1, col 7
2. Average annual rainfall (mm)	2500-3000	3000-4000 2500-2000	> 4000 < 2000		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	somewhat poor, excessive		very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam, sandy clay, structured clay	gravels, sands, loamy sand, sandy loam, silty clay	massive clay		Table 1, col 18 and col 16
3. Rooting depth (cm)	> 100	50-99	< 50		Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	> 8.0 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2-3	⩾ 4	Table 1, col 29
3. Rock outcrops	0	1	2-3	⩾ 4	Table 1, col 29

Leucaena leucocephala

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	21-30	31-34 20-19	> 34 < 19		Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	3-4	4.1-6 < 3		> 6	Table 1, col 7
2. Average annual rainfall (mm)	750-1000	1000-2000 750-600	> 2000 < 600		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	somewhat poor, excessive	very poor, poor		Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam, sandy clay, structured clay	gravels, sands, loamy sand, sandy loam, silty clay	massive clay		Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	< 50			Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	7.0-8.0	8.1-8.5 6.9-6.0	5.9-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2-3	> 4	Table 1, col 29
3. Rock outcrops	0	1	2-3	> 4	Table 1, col 29

Acacia auriculformia

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	23-30	31-34 22-21	> 34 < 21		Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	2-3	3.1-6 < 2	> 6		Table 1, col 7
2. Average annual rainfall (mm)	1300-2500	2500-4000 1300-1000	> 4000 < 1000		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	poor, somewhat poor, excessive	very poor		Table 1, col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	sands, loamy sands, sandy clay, structured clay	gravels, silty clay, massive clay		Table 1, col 18 and col 16
3. Rooting depth (cm)	> 50	< 50			Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	7.0-7.5	7.6-8.0 6.9-6.0	8.1-8.5 5.9-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8	8-15	> 15	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Tables 1, col 9
2. Surface stoniness	0	1	2-3	≥ 4	Tables 1, col 29
3. Rock outcrops	0	1	2-3	≥ 4	Tables 1, col 29

Eucalyptus grandis

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	20-30	31-34 19-17	> 34 16-14	< 14	Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	0-2	2.1-4	4.1-5	> 5	Table 1,col 7
2. Average annual rainfall (mm)	1500-2000	2000-4000 1500-1000	> 4000 1000-750	< 750	Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	somewhat poor, excessive		very poor, poor	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay, structured clay	gravels, sands, silty clay, massive clay		Table 1,col 18 and col 16
3. Rooting depth (cm)	> 100	50-99	< 50		Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5-7.0	7.1-7.5 5.4-5.0	7.6-8.0 4.9-4.5	> 8.0 < 4.5	Table 1,col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8		> 8	Table 1,col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2-3	⩾ 4	Table 1,col 29
3. Rock outcrops	0	1	2-3	⩾ 4	Table 1,col 29

Melaleuca leucadendron

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (°C)	21-30	> 30			Table 1, col 7
w - Water Availability					
1. Dry months (< 75mm)	2-4	> 4 < 2			Table 1, col 7
2. Average annual rainfall (mm)	1200-1600	> 1600 1200-800	< 800		Table 1, col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	somewhat poor	excessive	very poor, poor	Table 1, col 11
2. Soil texture (surface)	loam, sandy clay loam, silt loam, silt clay loam, silty clay loam, sandy clay, structured clay	loamy sand, sandy loam, silty clay, massive clay	sands	gravels	Table 1, col 18 and col 16
3. Rooting depth (cm)	> 100	50-99	< 50		Table 1, col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	7.0-7.5	7.6-8.0 6.9-6.0	8.1-8.5 5.9-5.0	> 8.5 < 5.0	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 4	4-8	8-15	> 15	Table 1, col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1, col 9
2. Surface stoniness	0	1	2-3	≥ 4	Table 1, col 29
3. Rock outcrops	0	1	2-3	≥ 4	Table 1, col 29

Pinus merkusii

Land Characteristics grouped by Land Qualities	Land Suitability Ratings				Data Source
	S1	S2	S3	N	
t - Temperature Regime					
1. Annual average temp. (^{o}C)	19-21	22-23 18-17	> 23 < 17		Table 1,col 7
w - Water Availability					
1. Dry months (< 75mm)	1-2	2.1-3 < 1	> 3		Table 1,col 7
2. Average annual rainfall (mm)	2500-3000	3000-4000 2500-2000	> 4000 < 2000		Table 1,col 7
r - Rooting Conditions					
1. Soil drainage class	moderately well, well, somewhat excessive	excessive	somewhat poor	very poor, poor	Table 1,col 11
2. Soil texture (surface)	sandy loam, loam, sandy clay loam, silt loam, silt, clay loam, silty clay loam	loamy sand, sandy clay, structured clay	gravels, sands, silty clay, massive clay		Table 1,col 18 and col 16
3. Rooting depth (cm)	> 100	50-99	< 50		Table 1,col 10
f - Nutrient Retention					
1. CEC me/100g soil (subsoil)					
2. pH (surface soil)	5.5.-7.0	7.1-8.0 5.4-4.5		> 8.0 < 4.5	Table 1, col 19 or 17
n - Nutrient Availability					
1. Total N (surface)					
2. Available P_2O_5 (surface)					
3. Available K_2O (surface)					
x - Toxicity					
1. Salinity mmhos/cm (subsoil)	< 2	2-4	4-8	> 8	Table 1,col 29
s - Terrain					
1. Slope %	0-15	15-30	30-50	> 50	Table 1,col 9
2. Surface stoniness	0	1	2-3	⩾ 4	Table 1,col 29
3. Rock outcrops	0	1	2-3	⩾ 4	Table 1,col 29

4. GENERAL LAND SUITABILITY EVALUATION PROCEDURES

4.1 Introduction

Table 2 - "General Land Suitability and Potential Ratings" consists of two parts. It is an interpretive table, that in the first part (columns 4 to 16) shows the general suitability of each soil component of each mapping unit for representative crops/timber species of five primary uses. Each crop/timber species column is divided into three sections with the headings : C = Current or present suitability; I = Improvements needed for development; and P = Potential suitability after improvement. In the second part of Table 2 (columns 17 to 27) each soil component is rated as to its potential for agricultural development projects including drainage and irrigation projects; projects for cereals, root crops and legumes, estate and industrial crops, and projects for pasture and forestry.

The ratings of potential for project development in the second part of Table 2 are based mainly on the suitability ratings in the first part.

The following sections describe the suitability classification and symbols used; explain how current or present suitability (C) is determined; show how improvements needed for development (I) are identified; and explain how potential suitability after improvements (P) is determined.

4.2 Suitability Classification and Symbols

Within the FAO Framework for Land Evaluation (FAO, 1976) each category of classification retains its basic meaning when applied to different areas and different types of land use.

In reconnaissance surveys carried out in Indonesia by the Centre for Soil Research three categories of decreasing generalization are recognized :

i. Land Suitability Orders : reflecting kind of suitability.
ii. Land Suitability Classes : reflecting degrees of suitability within Orders.
iii. Land Suitability Subclasses: reflecting kinds of limitations within Classes.

4.2.1 Land Suitability Orders - These indicate whether soil components of the mapping units are assessed as suitable or not suitable for the primary use concerned and under columns C and P they are represented by the symbols S and N respectively. The two suitability orders are defined as follows :

Order S Suitable : Land on which sustained use of the kind under consideration is expected to yield benefits which justify the inputs, without unacceptable risk of damage to land resources.

Order N Not Suitable : Land which has qualities that appear to preclude sustained use of the kind under consideration.

4.2.2 Land Suitability Classes - These reflect degrees of suitability. The classes are numbered consecutively, by arabic numerals, in sequence of decreasing degrees of suitability within the Order.

Three suitability classes are recognized in the Order S Suitable, together with the following names and definitions:

Class S1 Highly Suitable : Land having no significant limitations to the sustained application of the given type of use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.

Class S2 Moderately Suitable : Land having limitations which in aggregate are moderately severe for sustained application for the given type of use; the limitations will reduce productivity or benefits

and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class S1 land.

Class S3 Marginally Suitable : Land having limitations which in aggregate are severe for sustained application of the given type of use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will only be marginally justified.

No suitability classes are used for the Order N not Suitable. In most cases components of mapping units assessed as being not suitable for the given type of use will have limitations which appear so severe as to preclude any possibility of successful application of the type of use in question. However, in some cases components of mapping units assessed as being not suitable for the given type of use may have limitations which may be correctable with existing knowledge but at a cost which may not be currently acceptable by development agencies and which will be largely beyond the resources of an individual farmer.

4.2.3 Land Suitability Subclasses - These reflect kind of limitations. Subclasses are indicated by lower case letters following Class symbols S2 and S3 and Order symbol N. There are no subclasses in Class S1 as this by definition has no significant limitations.

In reconnaissance surveys subclass symbols refer to land quality limitations as follows :

Symbol	Limitation
t	Temperature regime limitations
w	Water regime limitations
r	Rooting condition limitations
f	Nutrient retention limitations
n	Nutrient availability limitations
x	Toxicity limitations
s	Terrain limitations.

It should be noted that Subclasses are only used in the evaluation of current or present suitability (columns headed C). Suitability Orders and Classes are used for the evaluation of both current or present suitability and potential suitability after improvements (columns headed C and P).

4.3 Evaluating Current or Present Suitability (Columns C)

Evaluation is made by matching the measured or estimated values or classes of land characteristics against the ranges of requirements listed for each of the crops/timber species.

A basic principle in the matching exercise is the application of "the law of the minimum". This means that the most limiting rating out of the land characteristics grouped in a single land quality is taken as the rating for that quality.

For example, if land characteristics grouped under land quality r - "Rooting Conditions" produce the following ratings for wetland rice :

1. Soil Drainage Class = S1
2. Soil Texture (surface) = S2
3. Rooting Depth (cm) = S3

Then the suitability rating for land quality r - "Rooting Conditions" will be S3.

The same principle holds true for the final evaluation of current or present suitability.

For example if the following ratings of all land qualities are produced by matching land characteristic values or classes against the ranges of requirements for wetland rice :

t - Temperature regime = S1
w - Water Availability = S1
r - Rooting Conditions = S3
f - Nutrient Retention = S2
n - Nutrient Availability = S2
x - Toxicity = S1
s - Terrain = S1

Then the final evaluation of current or present suitability will be S3. The symbol S3r will be entered in column C for wetland rice indicating that the current or present suitability of the soil component of the mapping unit is S3 - marginally suitable, while the small case letter r indicates that the major limitation is the land quality r - "Rooting Conditions".

If two or more land qualities were rated as having S3 limitations in the above example the final evaluation would still be rated as S3; but the symbol entered in column C would include small case letter subclass symbols of each quality concerned.

The above evaluation process is, of course, qualitative; but gives a general assessment of current or present suitability and indicates the major limiting qualities and characteristics. The next step is to identify what improvements are needed and feasible in order to determine potential suitability.

4.4 Identifying Improvements Needed for Development (Column I)

To identify improvements needed for development it is necessary to refer again to the land quality groupings of land characteristics. Some limiting characteristics cannot be improved. Those that can be improved will vary as to the level (cost inclusive of labour) of input required to achieve improvement. The following list indicates possible improvements by land characteristics and the level of input required.

Land Characteristics grouped by Qualities	Improvement and Symbol ( )	Level of Input
t - Temperature Regime		
1. Annual Average Temp.	no improvement possible	-
w - Water Availability		
1. Dry months	irrigation works - (I)	Hi
2. Average Annual Rainfall	irrigation works - (I)	Hi
r - Rooting Conditions		
1. Soil Drainage Class	artificial drainage - (J)	Hi
2. Soil Texture	no improvement possible	-
3. Rooting Depth	generally no improvement possible if root restricting layer is thick. If root restricting layer is thin then mechanical break-up of the layer may be possible-(K)	Hi
f - Nutrient Retention		
1. CEC	Liming-source available locally (L)	Li
	Liming-no local source (L)	Mi
2. pH	Liming-source available locally (L)	Li
	Liming-no local source (L)	Mi
n - Nutrient Availability		
1. Total Nitrogen	Manure/fertilizer application (M)	Li
2. Available P_2O_5	Fertilizer application for S2 rating (M)	Li
	Fertilizer application S3/N ratings (M)	Mi
3. Available K_2O	Fertilizer application for S2 rating (M)	Li
	Fertilizer application S3/N ratings (M)	Mi
x - Toxicity		
1. Salinity	Reclamation of saline soils ratings S2/S3 (N)	Mi
	Reclamation of saline soils rating N (N)	Hi

s - Terrain

1.Slope	Sawah construction for wetland rice slopes < 3%	(P)	Li
	Sawah construction for wetland rice slopes 3-8%	(P)	Mi
	Sawah construction for wetland rice slopes 8-15%	(P)	Hi
	Contour grass strips slopes 0-8%	(Q)	Li
	Moderate standard bench terrace without designed water disposal, slopes > 8%	(R)	Mi
	High standard bench terrace with fully designed water disposal, slopes > 8%	(T)	Hi
2.Surface stoniness	Stone picking for ratings S2/S3 only	(S)	Mi
3.Rock outcrops	no improvement possible		-

Levels of input indicate costs of improvements in general terms as follows :

Li = low input, can generally be borne by the landowner.

Mi = moderate input, can be borne by the landowner with credit facilities.

Hi = high input, requires government funds or long term credit to the landowner.

Where a combination of improvements is required, two of low input (Li) will result in an overall moderate input (Mi), similarly two of moderate input (Mi) will result in an overall high input (Hi). Where a combination of improvements with different input levels is required the overall input is that of the highest level (e.g. inputs Li and Hi = Hi overall input). If the limiting quality or any of the combination of limiting qualities cannot be improved then the symbol (X) is used to indicate that improvement is not possible.

Under columns headed "I" for primary uses a combined symbol is entered to show the type of improvement(s) and the level of input, e.g.

M/Mi = fertilizer application S3/N ratings/moderate input

MP/Hi = fertilizer application S3/N ratings (Mi), sawah construction for wetland rice slopes 8-15% (Hi)/overall high input

X = no improvement possible.

4.5 Evaluation of Potential Suitability after Improvements (Column P)

It is assumed that the implementation of improvements needed for development entered under column "I" will correct the most limiting qualities identified by subclass symbols entered in column "C". This will result in a potential suitability at least one class higher than the current or present suitability. For example :

- if the "C" suitability rating is S2 and improvements are possible, then "P" suitability rating will be S1.
- if the "C" suitability rating is S3, improvements are possible but S2 limitations still exist, then "P" suitability ratings is S2.
- if the "C" suitability rating is S3, improvements are possible and no S2 limitations exist, then "P" suitability ratings is S1.
- if the "C" suitability ratings is N, improvements are possible, but S3 limitations still exist, then "P" suitability rating is S3.
- if the "C" suitability rating is N, improvements are possible, but S2 limitations still exist, the "P" suitability rating is S2.
- if the "C' suitability rating is N, improvements are possible and no other limitations exist, then "P" suitability rating is S1.
- if no improvements are possible (X entered in the "I" column), then suitability ratings for "C" and "P" are the same.

Only class symbols are entered for potential suitability. The evaluation is subjective at best, as only general suitabilities can be interpreted from reconnaissance surveys.

An example of the complete evaluation procedure is given in Figure 1.

Figure 1. Example of Suitability Evaluation

Representative Crop : Maize
Mapping Unit Symbol : T 31
Soil Component Name : Typic Ustropepts

Characteristics and Quality Ratings	Value	C Rating	Improvement/ Input level	P Rating
Annual average temp.	26°C	S1		
t - Quality rating		S1		
Dry months	3	S1		
Average annual rainfall	1,850 mm	S1		
w - Quality rating		S1		
Soil drainage	well	S1		
Soil texture(surface)	sandy loam	S2		
Rooting depth	no limitation	S1		
r - Quality rating		S2r		S2
CEC (surface)	high	S1		
pH (surface)	5.5	S2		
f - Quality rating		S2f		S2
Total N (surface)	low	S2		
Available P_2O_5 (surface)	medium	S3		
Available K_2O (surface)	high	S1		
n - Quality rating		S3n	M/Mi	
Salinity (subsoil)	no limitation	S1		
x - Quality rating		S1		
Slope	0-0.5%	S1		
Surface stoniness	0	S1		
Rock outcrops	0	S1		
s - Quality rating		S1		
		C = S3n	I = M/Mi	P = S2

Current or present suitability = Marginally suitable, nutrient availability limitation

Improvements for development = (M) fertilizer application S3 rating, (Mi) moderate input.

Potential suitability = Moderately suitable.

5. GENERAL RATINGS OF POTENTIAL FOR DEVELOPMENT PROJECTS

5.1 Introduction

These ratings of potential for development are general in nature. They are a first estimate (based on physical features) of the general suitability of areas of land for one or more of five primary uses.

Because of the limitations of small-scale reconnaissance maps and the subjectivity of the suitability ratings, these estimates of potential for agriculture development should be used with caution. These ratings of potential will provide general guidelines to planners in selecting preliminary sites that merit further study. Detailed surveys of soils, topography, hydrology, economic feasibility, transportation, availability of services, etc., will be needed before final decisions are made on sites to be developed.

5.2 Potential for Development Ratings and Symbols

Three levels of potential are given in Table 2. They are as follows :

Symbol	Potential
++	good
+	poor or marginal
-	no

When rating the potential of map units, consideration should be given to their size and shape, as well as their general suitability for a proposed use. Map delineations, either singularly or in combination with others, should be large enough to accommodate the planned development project. Map units that consist of long narrow delineations bordered by map units with no potential will be judged as having low or no potential, even though the soils may be well suited for the proposed development. General guidelines for rating the potential of components of map units are in the paragraphs that follow.

Note that potentials for irrigation and drainage projects are separated from potentials for cereals, root crops and legumes and estate and industrial crops, even though drainage or irrigation, or both, may be needed to reach the highest potential suitability of a soil.

But to introduce these improvements into each primary use would make this part of Table 2 very complicated. Therefore, the potential for development projects, based on the production of these crops, are rated according to the present moisture state of soils, i.e., under rainfed conditions.

When rating the potential for development, the potential suitability (column P) will be used, except where irrigation (I) or drainage (J) are listed as improvements needed. If irrigation or drainage are needed to bring a soil to its highest potential suitability, then the present suitability for a primary use will be the basis for rating potential for development projects.

If a soil has been rated as having a good potential for an irrigation or a drainage project, it may be assumed that after such projects are installed the potential for other agricultural development project will be enhanced.

5.3 Evaluating Potential for Project Development

5.3.1 Irrigation Project

Potential is good if a component has the following features:

a. an apparent source of surface or ground water
b. topography is flat or undulating (Table 1, col.9)
c. the dry season is two months or longer or there are frequent dry periods of 10 to 15 days (Table 1, col.7)
d. when irrigated, the soil is moderately or highly suited for wetland rice, dryland cereals, root crops, legumes, and estate or industrial crops. (Table 2, col.4-13)
e. erosion and salinity hazards are low (Table 1, col.6, 29).

Potential is poor or marginal if a component meets the requirements for good potential except for the following features:

a. topography is rolling (Table 1, col.9)
b. when irrigated, the soil has low suitability for food, estate or industrial crops (Table 2, col.4-13)
c. erosion and salinity hazards are moderate (Table 1, col.6, 29).

5.3.2 Drainage Project

The first consideration in evaluating potential drainage

projects should be the opportunities for disposal of excess water. For example, it may not be feasible to drain closed basins and most drainage works in tidal flats are very expensive to construct, operate and maintain.

Potential is good if a component has the following features :

a. drainage is poor or very poor. (Table 1, col. 11)
b. disposal of excess water appears to be easy and construction, operation and maintenance costs are not high
c. after drainage, the soil is moderately or highly suitable for food,estate or industrial crops (Table 2,col.4-13)
d. hazards of erosion, extreme acidity or salinity are low (Table 1, col. 6, 29).

Potential is poor if a component has the following features :

a. drainage is somewhat poor to very poor (Table 1, col.11)
b. disposal of excess water appears to be difficult and/or costly.
c. after drainage, the soil is poorly or marginally suited for food, estate or industrial crops (Table 2, col. 4-13)
d. hazards of extreme acidity or salinity are moderate (Table 1, col. 29)
e. erosion hazard is low (Table 1, col. 6).

5.3.3 Cereals, Wetland (See Table 1, col.9; Table 2, col.4)
Potential is good if a component is moderately or highly suited for wetland rice. In addition, topography should be smooth enough that extensive areas can be developed without large and expensive terraces.

Potential is poor if a component is marginally suited for wetland rice and/or topography is such that large, expensive terraces will be required to develop the area.

Components of map units that are not suitable for wetland rice will be rated as having no potential for development projects.

5.3.4 Cereals, Dryland (See Table 2, col. 5 and 6)

Potential is good if a component is rated moderately or highly suitable for representative dryland cereal crops, and improvement costs are not high, irrigation or drainage costs not considered.

Potential is poor if a component is marginally suited for representative dryland cereal crops and/or improvements costs are high.

Components of map units that are rated not potentially suitable for these crops will be rated as having no potential for development projects.

5.3.5 Lowland Root Crops and Legumes (see Table 2, col 7 and 8)

Potential is good if a soil is rated as moderately or highly suitable for either or both representative crops, and improvement costs are not high, irrigation and drainage costs not considered.

Potential is poor if a soil is marginally suited for the representative crops and/or improvement costs are high.

Soils rated as not potentially suitable for these crops will be rated as having no potential for development projects.

5.3.6 Highland Root Crops and Legumes (see Table 2, col 9 and 10)

Potential is good if a soil is rated as moderately or highly suitable for either or both representative crops, and improvement costs are not high, irrigation and drainage costs not considered.

Potential is poor if a soil is marginally suited for the representative crops and/or improvement costs are high.

Soils rated as not potentially suitable for these crops will be rated as having no potential for development projects.

5.3.7 Lowland Estate and Industrial Crops (see Table 2, col 11 and 12).

Potential is good if a soil is rated as moderately or highly suitable for either or both representative crops. Im-

provement costs, exclusive of irrigation and drainage, may be low to high as it is assumed that developers of estate and industrial crop projects will have the resources to pay for high improvement costs.

Potential is poor if a soil is rated as marginally suited for the representative crops.

Soils rated as not potentially suited for these crops will be rated as having no potential for development projects.

5.3.8 Highland Estate and Industrial Crops (see Table 2,col. 13)

Potential is good if a soil is rated as moderately or highly suitable for the representative crop. Improvement costs may be low to high, exclusive of irrigation and drainage.

Potential is poor if a soil is rated marginally suitable for the representative crop.

Soils rated as not potentially suited for this crop will be rated as having no potential for development projects.

5.3.9 Pasture and Forestry Projects - General Statement

Many soils and land units that have good potential for cultivated crops also have good potential for pasture and forestry. However, in most provinces the development of land for cereals, root and legume crops, and estate and industrial crops has a higher priority than improvements of pastures and forests. Therefore, components of map units that are rated as having good potential for such crops will not be rated as having potential for pasture or forestry projects, unless provincial or local officials have set high priorities for such projects.

Soils rated as having poor or no potential for cereals, root and legume crops, or estate and industrial crops will always be rated for pasture and forestry projects.

5.3.10 Pasture (see Table 2, col 14)

Potential is good if a soil is rated as moderately or

highly suitable for pasture and improvement costs are low to medium.

Potential is poor if a soil is rated as marginally suitable for pasture and/or improvement costs are high.

Soils are rated as not potentially suitable for pasture will be rated as having no potential for development of pasture projects.

5.3.11 Lowland Forestry (see Table 2, col 15)

Potential is good if a soil is rated as moderately or highly suitable for the representative timber species, improvement costs are low or medium, and desirable tree species have been removed from the area.

Potential is poor if a soil is rated as marginally suitable for the timber species and/or improvement costs are high.

Soils rated as not potentially suitable for the timber species will be rated as having no potential for development of forestry projects.

5.3.12 Highland Forestry (see Table 2, col 16)

Potential is good if a soil is rated as moderately or highly suitable for the representative timber species, improvement costs are low or medium, and desirable tree species have been removed from the area.

Potential is poor if a soil is rated as marginally suitable for the timber species and/or improvement costs are high.

Soils rated are not potentially suitable for the timber species will be rated as having no potential for development of forestry projects.

PART 4

PRESENTATION OF RESULTS

1. INTRODUCTION

Reconnaissance survey findings are produced in "atlas" form. Each atlas will consist of the following components :

a. Title page (standard format giving name of the survey, date, and Centre for Soil Research Report Number);
b. Explanation of how to use the atlas (standard format on inside cover of the atlas);
c. Table of Contents;
d. Location map combined with map sheet index;
e. Reconnaissance Soil Map Sheets, 1:250,000 scale (number of map sheets will depend on the size and configuration of the survey area);
f. Map showing Potential for Irrigation Project Development (reduced to 1:500,000 or 1:1,000,000 scale);
g. Map showing Potential for Drainage Project Development (reduced as above);
h. Map showing Potential for Wetland Rice Project Development (reduced as above);
i. Map showing Potential for Dryland Cereals Project Development (reduced as above);
j. Map showing Potential for Root Crop and Legumes Project Development (reduced as above);
k. Map showing Potential for Estate and Industrial Crops Project Development (reduced as above);
l. Map showing Potential for Pasture Project Development (reduced as above);
m. Map showing Potential for Forestry Project Development (reduced as above);
n. Explanation of Terms and Footnotes used in Table 1, parts 1 and 2;
o. Table 1, part 1, Main Characteristics of Landforms, Climate and Soils;
p. Table 1, part 2, Main Characteristics of Landforms, Climate and Soils;
q. Explanation of Symbols used in Table 2;
r. Table 2, General Land Suitability and Potential Ratings.

Components a,c,d and e above do not require further explanation. The following sections provide standard formats or explain how the remaining components are prepared.

2. HOW TO USE THE ATLAS (component b, above)

The following is suggested as a standard format for all current reconnaissance surveys carried out by personnel of the Centre for Soil Research.

HOW TO USE THE ATLAS

This atlas presents the findings of a reconnaissance land resource survey carried out by personnel of the Centre for Soil Research, Bogor, Indonesia.

The brief description of contents which follows is intended to assist users in their understanding of survey results.

It should be realized at the outset that evaluations of reconnaissance surveys are from necessity general in nature as the mapped units of land are larger in area and their attributes are wider in range than is the case in more detailed surveys. Evaluations made are subjective and should be used with caution; but will provide general guidelines for planners in selecting preliminary sites that merit further study.

The atlas is basically composed of a series of maps and tables.

Reconnaissance Soil Map - this consists of a number of map sheets at a scale of 1:250,000 (see Map Index) delineating mapping units. Each mapping unit represents the geographic location and spatial extent of a parcel of land with a defined set of climate, landform and soil attributed which are presented in Table 1, parts 1 and 2 -"Main Characteristics of Landforms, Climate and Soils". Cross reference between the reconnaissance soil map and Table 1 and Table 2 is achieved through the use of mapping unit symbols.

Development potential for the survey area as a whole is shown by a series of up to 8 smaller scale maps (1:500,000 or 1:1,000,000, depending on convenience). The number of maps presented will depend on the prevailing physical conditions and socio-economic strategy of the study area. A full presentation will provide maps showing areas with project develop-

ment potential for irrigation,drainage,wetland rice,dryland cereals,root crops and legumes,estate and industrial crops,pasture,and forestry. However, development potential for pasture and forestry projects is not determined for mapping units having good potential for other agricultural uses,unless such projects are given high priority by local authorities.

The maps showing development potential are derived from evaluations of General Land Suitability and Potential Ratings, presented in Table 2. Suitability evaluations, expressed in terms of present or current suitability, improvements needed for development, and potential suitability; are presented for 13 representative crops and timber species grouped under 5 primary agricultural and forestry uses. Choice of crops and timber species is dependent on prevailing physical conditions and socio-economic strategy of the study area, and the availability of data on crop/timber species requirements. Simple ratings for project development potential are then derived from the suitability ratings and certain physical attributes listed in Table 1.

Both Table 1 and Table 2 contain numerous codes and symbols. Consequently, each table is provided with explanations of terms and footnotes.

3. PROJECT DEVELOPMENT POTENTIAL (components f through m)

3.1 Introduction

Table 2, "General Land Suitability and Potential Ratings", presents potential for project development under eleven columns (17 to 27). When completed in full,project development potential is indicated by soil component for irrigation, drainage, wetland cereals (rice), dryland cereals, lowland root crops and legumes, highland root crops and legumes, lowland estate and industrial crops, highland estate and industrial crops, pasture, lowland forestry, and highland forestry. However, in most studies potential for pasture and forestry development projects will only be evaluated for those soil components having poor or no potential for other primary agricultural uses.

To assist users in the easy identification of project development potential it will be beneficial if results are also presented in map form at reduced scale. To simplify the process a series of

up to eight maps are proposed illustrating potential for irrigation, drainage,wetland cereals (rice),dryland cereals,root crops and legumes (combining lowland and highland suitabilities),estate and industrial crops (combining lowland and highland suitabilitie),pasture and forestry (combining lowland and highland suitabilities). These maps will be prepared at a scale of 1:500,000 or 1:1,000,000, with choice of scale being dependent on the size and shape of the study area which will influence photographic reduction options. The following sections describe the steps taken in the preparation of such maps.

3.2 Preparation of Project Development Potential Maps

Underlying problems in map preparation are as follows :

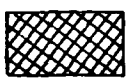
- Potential for project development ratings (Table 2, columns 17 to 27) are entered for each soil component of every mapping unit. However, only the mapping units themselves are delineated on the soil map. Consequently, a way must be found to show development potential for each mapping unit as a whole.
- If the above problem is solved, then development potential will be expressed in terms of proportional extent of each mapping unit. Difficulties arise here as the proportion of each mapping unit occupied by an individual soil component is expressed as a range (Table 1, column 8a), e.g. D = 51-75%.

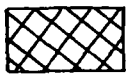
The following steps overcome these problems.

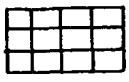
3.2.1 Map format

Each potential for project development map will identify mapping units (as delineated on the soil map) with the following potential :

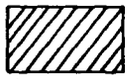
Good Potential

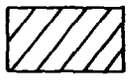
 : > 75% of the land has good potential

 : 50-75% of the land has good potential

 : 25-49% of the land has good potential

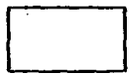
Poor Potential

 : > 75% of the land has poor potential

 : 50-75% of the land has poor potential

 : 25-49% of the land has poor potential

No Potential *)

 : > 75% of the land has no potential

3.2.2 Determination of mapping unit development potential

Considerable variation will occur in the number of soil components per mapping unit and the proportion of a mapping unit occupied by each soil component.

As mentioned above, the proportion of a mapping unit occupied by an individual soil component (Table 1, column 8a and Table 2, column 3) is expressed as a range : P = >75%, D = 50-75%, F = 25-49%, M = 10-24%, T = < 10%.

In order identify mapping units with good potential or poor potential for > 75%, 50-75%, or 25-49% of their surface area, the following combinations of soil components and proportions has been prepared for easy reference.

A - Mapping Units with >75% of the land with either good (++) or poor(+) development potential (refer to Table 2, column 3).

Number of soil Components		Combination of Proportion Symbols
Definitely:	1	P
	2	D/F
	3	F/F/F
	4	F/F/M/M
	4	D/M/M/T

*) All remaining map units which do not satisfy the criteria (proportion) for good or poor potential.

Possibly:	2	D/M
	2	F/F
	2	D/T
	3	F/M/M
	3	F/M/T
	4	M/M/M/M
	4	F/T/T/T
	4	M/M/M/T
	5	M/M/M/T/T
	5	M/M/T/T/T
	6	M/M/T/T/T/T

B - Mapping Units with 50-75% of the land with either good (++) or poor(+) development potential(refer to Table 2,column 3)

Number of Soil Components		Combination of Proportional Symbols
Definitely:	1	D
	2	F/F
	4	F/M/M/T
	5	M/M/M/M/M
	5	M/M/M/M/T
Possibly :	2	F/M
	2	F/T
	3	F/T/T
	3	M/M/M
	3	M/M/T
	4	M/M/M/T
	4	M/M/T/T
	4	M/T/T/T
	5	T/T/T/T

C - Mapping Units with 25-49% of the land with either good (++) or poor (+) development potential (refer to Table 2, column 3)

Number of Soil Components		Combination of Proportional Symbols
Definitely:	1	F
	3	M/M/M
	3	M/M/T
Possibly :	2	M/T
	2	M/M
	3	T/T/T
	3	M/T/T

The following example taken from Figure 5 illustrates the methods used to determine potential for project development of mapping unit T21.

Data derived from Figure 6:

		Columns										
1	3	17	18	19	20	21	22	23	24	25	26	27
T21	Typic Pelluderts D	-	-	+	+	+	+	+	+	+	++	++
	Vertic Tropaquepts F	-	+	++	+	+	+	++	+			
	Plintic Tropaquepts T	-	+	++	++	++	++	++	++			

Potential for irrigation project development (column 17)

All three soil components are rated (-), consequently > 75% of mapping unit T21 has no potential.

Potential for drainage project development (column 18)

Vertic Tropaquepts and Plinthic Tropaquepts are rated (+) and their combination of proportion symbols is F/T. A corresponding combination is found in list B, consequently 50-75% of mapping unit T21 has poor potential.

Potential for wetland cereals (rice) project development (column 19)

Vertic Tropaquepts and Plinthic Tropaquepts are rated (++) and their combination of proportion symbols is F/T. A corresponding combination is found in list B, consequently 50-75% of mapping unit T21 has good potential.

Potential for dryland cereals project development(column 20)

Plinthic Tropaquepts are rated (++) but the proportion - T is less than 10%. Typic Pelluderts and Vertic Tropaquepts are rated (+) and their combination of proportion symbols is D/F. A corresponding combination is found in list A, consequently > 75% of mapping unit T21 has poor potential.

Potential for root crop and legume project development (column 21,22)

Plinthic Tropaquepts are rated (++) but the proportion - T is less than 10%. Typic Pelluderts and Vertic Tropaquepts are rated (+) and their combination of proportion symbols is D/F. A corresponding combination is found in list A, consequently > 75% of mapping unit T21 has poor potential.

Potential for estate and industrial crop project development (columns, 23,24)

Vertic Tropaquepts and Plinthic Tropaquepts are rated (++) and their combination of proportion symbols is F/T. A corresponding combination is found in list B, consequently 50-75% of mapping unit T21 has good potential.

Potential for pasture project development (column 25)

Typic Pelluderts are rated (+) and the proportion symbol is D. The corresponding symbol is found in list B, consequently 50-75% of mapping unit T21 has poor potential.

Potential for forestry project development (columns 26,27)

Typic Pelluderts are rated (++) and the proportion symbol is D. The corresponding symbol is found in list B, consequently 50-75% of mapping unit T21 has good potential.

3.2.3 Map preparation

Using a ozalite print of the 1:250,000 scale soil map, or a transparent overlay, mapping units are shaded according to potential (see section 3.2.1 above "map format"). When all mapping units are correctly shaded the resulting map is reduced photographically to the chosen scale and prepared for printing.

4. EXPLANATION OF TERMS AND FOOTNOTES USED IN TABLE 1, MAIN CHARACTERISTICS OF LANDFORMS, CLIMATE AND SOILS (component n)

To enable users to understand terms and footnotes employed in Table 1, parts 1 and 2, these are explained on a separate sheet. A standard format can be used for all current reconnaissance surveys, as shown in Figure 2.

5. TABLE 1, PART 1, MAIN CHARACTERISTICS OF LANDFORMS, CLIMATE AND SOILS (component o)

A standard format is used and data entered as described in PART 1 of this manual. An example of complete entry for two hypothetical mapping units is given in Figure 3.

6. TABLE 1, PART 2, MAIN CHARACTERISTICS OF LANDFORMS, CLIMATE AND SOILS (component p)

A standard format is used and data entered as described in PART 1 of this manual. An example of complete entry for two hypothetical mapping units is given in Figure 4.

7. EXPLANATION OF SYMBOLS USED IN TABLE 2, GENERAL LAND SUITABILITY AND POTENTIAL RATINGS (component q)

To enable users to understand symbols employed in Table 2, these are explained on a separate sheet. A standard format can be used for all current reconnaissance surveys, as shown in Figure 5.

8. TABLE 2, GENERAL LAND SUITABILITY AND POTENTIAL RATINGS (component r)

A standard format is used and data entered as described in PART 2 of this manual. An example of a complete entry for two hypothetical mapping units is given in Figure 6.

Figure 2.

EXPLANATION OF TERMS AND FOOTNOTES USED IN TABLE 1, PARTS 1 AND 2 - MAIN CHARACTERISTICS OF LANDFORMS, CLIMATE AND SOILS

Table 1, Part 1

1/ Climate (column 7)

Seven entries numbered 1 to 7 are made in vertical sequence to provide the following information :

1. average annual rainfall (mm)
2. number of wet months with long term averages of > 150 mm rainfall
3. number of dry months with long term averages of < 75 mm rainfall
4. average annual temperature (°C)
5. maximum month (average) temperature (°C)
6. minimum month (average) temperature (°C)
7. station number assigned by the Directorate of Meteorology and Geophysics to the nearest representative meteorological station.

2/ Proportion of Map Unit (column 8a)

Estimated proportion of the map unit is given for each major soil component by using appropriate symbols as follows :

P = predominant (> 75%)
D = dominant (50-75%)
F = fair (25-49%)
M = minor (10-24%)
T = trace (< 10%)

3/ Permeability (column 12)

Three permeability classes are used indicating the rates that water moves through the soil as follows :

Class Name	cm/hr
slow	< 0.5
moderate	0.5-16
rapid	> 16

Table 1, Part 2

4/ Organic Matter Content % Organic Carbon X 1.724 (column 20)

This is given for each soil layer according to the following classes :

Class Name	% O.M.
very low	< 2.0
low	2.0-3.5
medium	3.6-5.0
high	5.1-8.5
very high	> 8.5

5/ Total Nitrogen (column 21)

This is given for each soil layer according to the following classes :

Class Name	% N
very low	< 0.10
low	0.10-0.20
medium	0.21-0.50
high	0.51-0.75
very high	> 0.75

6/ Available P_2O_5 (column 22)

This is given for each soil layer according to the following classes by one of the laboratory methods listed below :

Class Name	P_2O_5 (Bray) (ppm)	P (Bray + Kurtz) (ppm)	P_2O_5 (Olsen) (ppm)
very low	< 10	< 3	4.56
low	10-15	3-7	4.57-11.4
medium	16-25	8-20	11.5-22.8
high	26-35	> 20	> 22.8
very high	> 35		

7/ Available K_2O (column 23)

This is given for each soil layer according to the following class by one of the laboratory methods listed below :

Class Name	Acid Citrate (mg)	NH_4OAc (me)	Total K_2O HCl 25%[2] (ppm)
very low	< 5	< 0.2	< 10
low	5-10	0.2-0.3	10-20
medium	11-15	0.4-0.5	21-40
high	16-25	0.6-1.0	41-60
very high	> 25	> 1.0	> 60

8/ Cation Exchange Capacity (column 24)

This is given for each soil layer according to the following classes based on milliequivalents per 100g of soil as measured by the NH_4OAc, pH 7.0 method.

Class Name	CEC
very low	< 5
low	5-16
medium	17-24
high	25-40
very high	> 40

9/ Base Saturation (column 25)

This is given for each soil layer according to the following classes based on the milliequivalents of exchangeable bases divided by CEC.

Class Name	%
very low	< 20
low	20-35
medium	36-50
high	51-75
very high	> 75

Classes and limits used for footnotes 4/ to 8/ follow criteria established by the Centre for Soil Research, Bogor. Criteria used in footnote 9/ has been slightly modified to correspond to base saturation levels used to separate classes in the USDA Soil Taxonomy.

Figure 3.

Table 1. Main Characteristics of Landforms, Climate and Soils, Part 1.

1.	2.	3.		4.	5.	6.	7.	8.		
Map Unit Symbol	Landform and Parent Material	Extent		Elevation	Major Land Uses	Evidence of Erosion	Climate 1/	Classification of Soil Components		
		Ha	%	m.				U S D A Soil Taxonomy (1975)	P.P.T. (1982)	FAO/Unesco (1974)
T 21	Dissected marine clayey terrace	250	10	20-60	Cropland, flooded rice, irrigated	None	1. 2,100mm 2. 10 months 3. 2 months 4. 26oC 5. 29°C 6. 23°C 7. 1269 a.	Association of: Typic Pelluderts, fine, mixed, isohyperthermic	Grumusol Pelik	Pellic Vertisols
								Vertic Tropaquepts, fine, mixed, nonacid, isohyperthermic	Gleisol Vertik	Eutric Gleysols
								Plinthic Tropaquepts, fine, mixed, nonacid, isohyperthermic	Gleisol Plintik	Plinthic Gleysols
T 31	Almost flat marine terrace, dry	500	20	5-20	Open grazing, sparse grass cover	Slight sheet erosion, few small rills	1. 1,850mm 2. 9 months 3. 3 months 4. 26°C 5. 29°C 6. 23°C 7. 1272 b.	Association of: Typic Ustropepts, fine loamy, mixed isohyperthermic	Kambisol Eutrik	Eutric Cambisols
								Typic Dystropepts, coarse loamy, siliceous, isohyperthermic	Kambisol Distrik	Dystric Cambisols
								Aeric Tropaquepts, fine, loamy, mixed, nonacid, ischyperthermic.	Kambisol Gleiik	Gleyic Cambisols

Table 1, Part 1. continued

8a.	9	10.	11.	12.	13.	14.	15.	16.	17.
Proportion of Map Unit 2/					Field Characteristics by Soil Layer				
	Geomorphic Component and Slope	Limiting Layer and Depth cm.	Drainage	Permeability 3/	Layer and Depth cm.	Colour	Texture	Structure	Field pH
D	Gently undulating terrace, 2-8%	None	Moderately well	Slow	0-20/30	Dark grey, very dark grey	Clayey	Moderate strong blocky	7.0-8.0
					20/30-100/150	Dark grey, very dark grey	Clayey	Moderate strong blocky and prismatic	7.0-8.0
F	Almost flat bottoms of gullies and swales, 0-2%	None	Poor	Slow	0-10/15	Dark greyish brown	Clayey	Weak moderate blocky	7.0-8.0
					10/15-125	Dark grey, dark greyish brown mottled	Clayey	Moderate blocky	7.0-8.0
T	Margins of swales, 0-2%	None	Somewhat poor	Slow	0-15/20	Dark greyish brown	Fine loamy	Moderate blocky	6.0-7.0
					15/20-80/100	Brown, greyish brown	Clayey	Moderate blocky	5.5-6.5
D	Flat, middle part of terrace, 0-0.5%	None	Well	Moderate	0-10	Brown	Coarse loamy	Weak blocky	5.5-6.0
					10-80/100	Reddish yellow, strong brown	Fine loamy	Weak blocky	5.5-6.0
F	Almost flat to gently sloping northern part of terrace, 0-2%	30-50 gravel	Excessive	Rapid	0-5/10	Brown to dark brown	Coarse loamy	Weak blocky	5.0-5.5
					5/10-30/50+	Reddish brown	Coarse loamy over gravelly sand	Weak blocky	5.0-5.5
M	Almost flat concave swales, 0-1%	None	Moderately well	Moderate	0-10/15	Dark greyish brown	Loamy	Weak blocky	5.5-6.0
					10/15-80/100	Grey, greyish Brown	Fine loamy	Moderate blocky	5.5-6.0

Figure 4.

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Table 1. Main Characteristics of Landforms, Climate and Soils, Part 2.

				18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Map Unit Symbol	Soil Component		Laboratory Analysis of Soil Layers										
	U S D A Soil Taxonomy (1975)	Proportion of map Unit	Soil Layer and Depth cm	Textural Class	pH	Organic Matter Content 4/	Total Nitrogen 5/	Available P_2O_5 6/	Available K_2O 7/	Cation Exchange Capacity 8/	Base Saturation 9/	Free Fe_2O_3 %	Aluminium Saturation me
T 21	Association of : Typic Pelluderts	D	0-20/30	Clay	7.2	Medium	Low	Low	Medium	Very high	Very high	1.0-2.0	2.0-5.0
			20/30-100/150	Clay	7.5	Low	Low	Very low	Low	Very high	Very high	1.0-2.0	2.0-5.0
	Vertic Tropaquepts	F	0-10/15	Clay	7.4	Low	Low	Low	Medium	Very high	High	1.0-2.0	2.0-5.0
			10/15-125	Clay	7.4.-8.0	Low	Very low	Very low	Low	High	High	1.0-2.0	2.0-5.0
	Plinthic Tropaquepts	T	0-15/20	Clay loam	6.5	Low	Low	Very low	Medium	Medium	Medium	2.0-3.0	5.0-10
			15/20-80/100	Clay	5.6-6.0	Very low	Very low	Very low	Low	Medium	Medium	2.0-3.0	5.0-10
T 31	Association of : Typic Ustropepts	D	0-10	Sandy loam	5.5	Low	Low	Medium	High	High	High	1.0-2.0	2.0-5.0
			10-80/100	Sandy clay loam	5.6-6.0	Very low	Very low	Low	Medium	High	High	2.0-3.0	2.0-5.0
	Typic Dystropepts	F	0-5/10	Sandy loam	5.0	Very low	Very low	Very low	Medium	Medium	Low	1.0-2.0	5.0-10
			5/10-30/50+	Sandy loam over sand	5.4	Very low	Very low	Very low	Medium	Low	Low	1.0-2.0	5.0-10
	Aeric Tropaquepts	M	0-10/15	Loam	5.3-6.0	Low	Low	Very low	Medium	Medium	Low	1.0-2.0	2.0-5.0
			10/15-80/100	Clay loam	5.5	Very low	Very low	Very low	Low	Low	Low	1.0-2.0	2.0-5.0

Table 1, Part 2. continued

28		29
Representative Profile		Other Features that Affect Use and Management
Field No.	Laboratory No.	
RS 26	214412	Need protection from erosion on a high priority basis. Wedge shaped peds with slickensides on all faces.
RS 27	214501	Slickensides on some ped faces.
TK 4	213600	5-20% of soil mass at some depth in the subsoil is red nodules of Plinthite.
DT 18	215111	Very compact when dry.
TK 11	214101	
RS 10	213262	Flooded in the rainy season to maximum depth of approximately 30cm. Used as water points for cattle grazing.

Figure 5.

EXPLANATION OF SYMBOLS USED IN TABLE 2 - GENERAL LAND SUITABILITY AND POTENTIAL RATINGS

Suitability for Primary Uses (columns 4 to 16)

Suitability for each representative crop and timber species is expressed under three headings :

C = current or present suitability
I = improvement needs for development
P = potential suitability after improvements

C. Current or Present Suitability - explanation of symbols used

Aplhanumeric symbols are used under heading 'C'. Reading from left to right the first one or two entries will be S1, S2, S3 or N expressing suitability orders or classes as follows :

Class S1 Highly Suitable : land having no significat limitations to the sustained cultivation of the crop or timber species, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.

Class S2 Moderately Suitable: land having limitations which in aggregate are moderately severe for sustained cultivation of the crop or timber species; the limitations will reduce productivity or benefits and increase required inputs.

Class S3 Marginally Suitable: land having limitations which in aggregate are severe for the sustained cultivation of the crop or timber species and will so reduce productivity or benefits or increase required inputs, that this expenditure will only be marginally justified.

Order N Not Suitable : land having limitation which are either permanently or presently too severe to allow the sustained cultivation of the crop or timber species. Where limitations are correctable with existing knowledge the cost involved may be beyond the resources of an individual farmer.

Small case letters entered after S2, S3 or N identify major limitations and determine the suitability subclass as follows :

t = temperature regime limitations
w = water regime limitations
r = rooting condition limitations
f = nutrient retention limitations
n = nutrient availability limitations
x = toxicity limitations
s = terrain limitations.

I. Improvement Needs for Development-explanation of symbols used

A combination symbol is used under heading 'I' comprising possible improvements/level of input required (cost inclusive of labour)

Possible Improvements

I = irrigation works
J = artificial drainage works
K = mechanical break-up of root restricting layer
L = liming
M = manure/fertilizer application
N = reclamation of saline soils
P = sawah construction
Q = contour grass strips
R = moderate standard bench terrace
T = high standard bench terrace
S = stone picking.

Level of Inputs Required

Li = low input, can generally be borne by the landowner
Mi = moderate input can be borne by the landowner with credit facilities
Hi = high input, requires government funds or long term credit to the landowner.

An example of a typical combination symbol entered under heading 'I' could be M/Mi indicating that the possible improvement is 'manure/fertilizer application' which would require a 'moderate input level'.

If a limitation cannot be corrected then no improvements are possible. This condition is represented by the symbol
X = no improvement possible.

P. Potential Suitability After Improvements - explanation

It is assumed that the implementation of improvements needed for development entered under heading 'I' will correct the major limitations identified by subclass symbols entered under heading 'C'. This will result in a potential suitability at least one class higher than the current or present suitability. If no improvements are possible then the suitability class will be unchanged.

The same class and order symbols as described under heading 'C' are used, i.e. S1, S2, S3 or N.

No subclass symbols are used as major limitations are assumed to have been corrected, or remain unchanged if improvements are not possible.

Potential for Project Development (columns 17 to 27)

Three levels of potential for project development are given as follows :

Symbol	Potential
++	good
+	poor or marginal
-	no

Note that evaluations of potential for Pasture and Forestry project development are not made for soil components rated as having good potential for other primary uses unless local authorities have set high priorities for such projects.

Figure 6.

Table 2. General Land Suitability and Potential Ratings

1.	2.	3.		4.			5.			6.			7.			8.			9.			10.		
Map Unit Symbol	Extent (ha)	Soil Component		Suitability for Primary Uses																				
				Cereals									Root Crops and Legumes											
		USDA Soil Taxonomy (1975)	Proportion of Map Unit	Wetland			Dryland						Lowland						Highland					
				Rice			Upland rice			Maize			Cassava			Soybean			White Potato			Phaseolus Bean		
				C	I	P	C	I	P	C	I	P	C	I	P	C	I	P	C	I	P	C	I	P
T 21	250	Typic Pelluderts	D	S3ns	MP/Hi	S2	S3rfn	X	S3	S3rn	X	S3	S3rn	X	S3	S3rn	X	S3	Nt	X	N	S3r	X	S3
		Vertic Tropaquepts	F	S3n	M/Mi	S2	S3rfn	X	S3	S3rn	X	S3	Nr	J/Hi	S3	S3rn	X	S3	Ntr	X	N	S3r	X	S3
		Plinthic Tropaquepts	T	Nn	M/Mi	S2	Nn	M/Mi	S2	Nn	M/Mi	S3	S3n	JM/Hi	S2	S3rn	JM/Hi	S2	Nt	X	N	S3r	J/Hi	S2
T 31	500	Typic Ustropepts	D	S3rn	JM/Hi	S2	S2rn	X	S2	S3n	M/Mi	S2	S2rn	X	S2	S2rfn	X	S2	Nt	X	N	S2rf	X	S2
		Typic Dystropepts	F	Nrn	X	N	Nnr	X	N	Nn	X	N	Nr	K/Hi	S3	Nr	X	N	Ntr	X	N	Nr	X	N
		Aeric Tropaquepts	M	Nn	M/Mi	S2	Nn	M/Mi	S2	Nn	M/Mi	S2	S3n	M/Mi	S2	S3fn	LM/Mi	S2	Nt	X	N	S3f	L/Li	S1

11.			12.			13.			14.			15.			16.			17.	18.	19.	20.	21.	22.	23.	23.	25.	26.	27.
																		Potential for Project Development										
Estate and Industrial Crops									Pasture (grasses)			Forestry								Cereals		Root Crops/ legumes		Estate/ Industrial Crops		Pas- ture	Forestry	
Lowland						Highland						Lowland			Highland			Irrigation	Drainage									
Sugarcane			Coconut			Coffee						Tectona grandis			Eucalyptus grandis					Wet- land	Dry- land	Low- land	High- land	Low- land	High- land		Low- land	High- land
C	I	P	C	I	P	C	I	P	C	I	P	C	I	P	C	I	P											
S3rn	X	S3	S3r	X	S3	S3rf	X	S3	S3fn	X	S3	S2wrf	X	S2	S2wrf	X	S2	-	-	+	+	+	+	+	+	+	++	++
S3rn	X	S3	Nr	J/Hi	S2	S3rf	X	S3	S3fn	X	S3	Nr	J/Hi	S2	Nr	J/Hi	S2	-	+	++	+	+	+	++	+			
Nn	M/Mi	S2	S3rn	JM/Hi	S2	S3r	J/Hi	S2	S3n	M/Mi	S2	S3r	J/Hi	S2	S2wr	IJ/Hi	S1	-	+	++	++	++	++	++	++			
S3n	M/Mi	S1	S3w	I/Hi	S2	S2wr	X	S2	S3w	I/Hi	S2	S2r	X	S2	S2w	I/Hi	S1	+	-	+	++	++	++	++	++			
Nrn	X	N	S3wrn	X	S3	Nr	X	N	S3wrn	X	S3	Nr	X	N	S3r	IK/Hi	S2	-	-	-	-	+	-	+	-	+	-	++
Nn	M/Mi	S2	S3wn	IM/Hi	S2	S2wrfn	IL/Mi	S1	S3wn	IM/Hi	S1	S2rf	JL/Hi	S1	S2wf	IL/Hi	S1	+	-	++	++	++	++	++	++			