

Land Suitability Classification and Mapping of Tea Lands in Ratnapura District

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ABSTRACT

The productivity of crops varies with the soil and climatic conditions. Therefore, the crop and its cultivar should be carefully selected to suit the soil and climatic conditions. Presently, many tea growers undertake tea cultivation without paying much attention on suitability of land. Such tea growers often face many problems related to productivity. If the land is classified and mapped according to the suitability for the crop, proper planning to achieve the maximum productivity is possible at the crop establishment stage.

A case study was undertaken with the objective of classifying and mapping present tea lands within the Ratnapura district. Necessary maps and aerial photographs were obtained from the Survey Department and productivity, rainfall and other field data were collected from corporate sector tea estates in the Ratnapura district.

Land suitability maps containing details of Agro-Ecological Regions (AER), elevations and different categories of tea lands were compiled. The present study revealed that the total extent of tea lands in the Ratnapura district in 2002 was 31,116 ha. A macro level classification of tea lands was done to identify four major productivity regions within the district based on the tea yield of corporate sector estates. A micro level and detailed land suitability classification was also performed on 12 selected tea estates after detailed soil investigations. A set of maps were developed for the selected estates giving details of different land suitability classes and their limitations for tea cultivation.

It was found that the tea lands at higher elevations (AER - WM) in the Ratnapura district are more productive than those at lower elevations (AER - WL). Moreover, results revealed that estates have tea lands with varying degrees of limitations. These information should be considered when making investments on infilling, replanting

and crop diversification to obtain maximum returns. Tea maps developed by this study also provide useful information for tea factories and other tea related infrastructure development programmes in the district.

Key words: land suitability, mapping, productivity, Ratnapura, tea

INTRODUCTION

The natural home of the tea plant is considered to be within the localities of Naga, Manipuri and Lushai Hills along the Assam-Burma frontier in the west, through to China, probably as far as the Che-Kiang (Zhejiang) province in the east, and from this line generally to the south through the hills of Burma and Thailand into Vietnam (Hajra, 2001).

Tea was first introduced to Sri Lanka in 1824 and again in 1839, for experimental purposes, and planted in the Royal Botanical Garden in Peradeniya. James Taylor was the first to plant tea in commercial level replacing coffee which was fast dying because of the dreaded coffee rust in 1860s. The first tea plantation was Loolecondra Estate in Kandy district and tea was reported to be first manufactured in 1867 in this estate. About 4,047 ha was under tea by 1875 and this extent was increased to 19,750 ha by 1885 (Wimaladharm, 2003). The total tea extent of Sri Lanka in 1989 was 221,110 ha and it declined to 192,730 ha by 1993. The tea extent further declined to about 180,170 ha in 2001. Presently the tea industry contributes to about 3.1% of the GDP and 13% of the total exchange earnings (Anon, 2004).

In order to obtain maximum returns from agriculture, it is necessary to provide optimum conditions for the growth of the respective crop. In this respect, environmental factors including soil are of great importance. Land suitability classification could be used as a decisive tool in identifying suitable lands for tea cultivation in a given region. Panabokke (1970), Smith (1971), Desaunettes *et al.* (1974), De Silva (1979) and De Alwis (1976) have undertaken land suitability classification studies in Sri Lanka (Perera, 1989a and 1989b, Perera and Fonseka, 1990). Furthermore, De Alwis *et al.* (1980) presented a simplified method of suitability classification for tea lands. In addition to classifying lands into suitability classes, such studies are useful for minimizing soil erosion, planning for sustained productivity, maintaining an ecological balance in agriculture and for evaluating the level of resource management. Also, results of these studies help to identify lands that are to be given high priority in soil conservation, soil rehabilitation and for crop diversification *etc.*

At present, cultivation of tea is being done without paying much attention on the suitability of the land. As a result, growers are facing many problems related to the low

productivity and profitability of tea cultivations owing to low yields and high casualties. If the land is classified and mapped according to the suitability for crops, better planning is possible before cultivation so that higher productivity can be achieved. Therefore, classification and mapping of tea lands is of utmost importance for identifying the most suitable lands for tea cultivation and diversifying unsuitable lands into other crops such as timber and energy plantations or forests.

Taking these factors into consideration, the land suitability classification project was undertaken at the Tea Research Institute, Low country Regional Centre as a case study covering all the corporate sector estates in the Ratnapura district. The main objectives of the present study were to classify present tea lands into different suitability classes and produce maps of present tea lands with Agro-Ecological Regions (AER) and elevations.

MATERIALS AND METHODS

Present tea land demarcation and mapping

Aerial photographs taken in the year 2002 (scale 1:20,000), Agriculture Base Mapping Project (ABMP) maps (scale 1:50,000), present land use maps (scale 1:250,000) and flight indexes were obtained from the Survey Department of Sri Lanka.

Past yield and rainfall data for more than ten years (from 1990 to 2003) were collected from the corporate sector estates in the Ratnapura district for analysis and interpretation.

District boundary, AER boundaries and Divisional Secretariat (DS) boundaries were demarcated on the maps. Apart from tea lands, roads, streams and key places (towns etc.) were also identified and shown as base details in the maps. The selected locations of the aerial photographs were first extracted from the flight index and copied to the 1:50,000 ABMP maps in this study. There were approximately 300 photographs to cover one ABMP sheet.

Present tea lands were identified and demarcated on transparent overlays using a Stereoscope from which two-dimensional (2D) aerial photograph could be transformed into three-dimensional (3D) image. The tea lands were identified by the particular pattern shown in the aerial photograph. This task required much experience to distinguish tea lands from abandoned paddy lands and patana lands with a very similar pattern of variation to tea. Therefore, field investigations were necessary to verify and validate the presence of demarcated tea lands. The roads, streams and other important places or sites were also demarcated for the purpose of locating the tea lands. In addition to verifying the validity of the demarcated tea lands, field tours were useful to classify tea lands into four categories as follows.

- Corporate sector estates
- Small holding/proprietary estates (<50 ac)
- Home gardens with tea
- Tea with coconut or rubber (mixed or inter-cropping)

All these details were then copied onto 1:50,000 ABMP maps using the Optical Pantograph converting the scale from 1:20,000 in the aerial photograph to 1:50,000 in the ABMP maps and correcting the tilt effect of the aircraft taking photographs. These details were then fed into Geographical Information System (GIS) and maps were printed.

Land suitability classification

The second step of this study was the land suitability classification by which the present tea growing areas and individual lands were further classified into several classes based on their productivity level and suitability for tea cultivation. There were two sub-classifications as given below.

- Macro level classification
- Micro level classification

Macro level classification

This was a broad classification where different productivity regions were identified. The productivity of 32 corporate sector estates over the last ten year period (Made tea kg/ha/yr) was used for this classification. Accordingly, tea lands in the district were grouped into four tea productivity regions *viz.* estates yielding less than 1000, 1000-1500, 1500-2000 and more than 2000 kg/ha/yr (Table 1).

Micro level classification

Due to soil heterogeneity, all tea lands in a given region or in an estate are not equally productive. The most productive estates, divisions or fields may still have less productive or unsuitable divisions, fields or blocks and *vice versa*. Hence, it is also necessary to undertake in-depth studies of a particular estate, division or a field to further identify such different land suitability classes.

Table 1. Productivity regions of tea and their corresponding yield categories

Productivity Region	Yield (made tea kg/ha/yr)
01	>2000
02	2000-1500
03	1500-1000
04	<1000

Due to constraint of time and as a case study, only twelve estates were selected representing major AERs in the district and considering the availability of required data for the in-depth study. They were Rasagalla, Pettiagalla, Hatherleigh, Meddakande, Hapugastenne, Galboda, Depedene, Keragala, Mutwagalla, Rye/Wikiliya, Endane, Madampe estates. The main land factors or land characteristics known to influence productivity of tea lands that were considered in this classification are as follows.

- Landform class or slope
- Soil depth
- Rockiness

These main land factors or land characteristics had several classes as shown in the Table 2. The method of classifying the present lands into these classes and the corresponding degree of limitation are also given in the Table 2. Accordingly, a block of land can be described by a combination of these three characteristics (e.g. A md XXX). Using these criteria lands were classified into five categories *i.e.* very suitable, suitable, moderately suitable, marginally suitable and unsuitable for cultivation of tea (Table 3).

Table 2. Criteria used for land suitability classification

Land character	Class of land	Value	Limitation
Land slope	A - gently undulating plain	02 - 04%	none
	B - undulating to rolling	04 - 16%	none to minor
	C - hilly terrain	16 - 30%	minor
	D - steep terrain	30 - 60%	moderate
	E - very steep terrain	> 60%	severe
Soil depth	d - deep	> 90 cm	none
	md - moderately deep	90 - 60cm	minor or moderate
	s - shallow	< 60 cm	severe
Rockiness	X	05 - 15%	none
	XX	15 - 30%	minor
	XXX	30 - 50%	moderate
	XXXX	> 50%	severe

The tea fields of the selected estates in the Ratnapura district were classified into different land suitability classes and separate maps were compiled for each estate. For the purpose of easy reference, different suitability classes were shown by different colours and their characteristics indicated.

Table 3. Land suitability classes

Class	Suitability	Limitations
01	very suitable	lands having no significant limitations for sustainable tea cultivation and will not require inputs above the acceptable level (e.g. Ad, Bd, Cd, Dd)
02	suitable	lands having one of the minor limitations for sustainable tea cultivation that will slightly reduce productivity and require more inputs than class 1 lands (e.g. Bdx, Ddx, Bmd,....)
03	moderately suitable	lands having some limitations for sustainable tea cultivation that will reduce productivity and increase required input level (e.g. Bdxx, Bmdx,....)
04	marginally suitable	lands having limitations which in aggregate are severe for sustainable tea cultivation. These limitations would reduce productivity and increase required input significantly (e.g. Cmdxx, Edxx,...)
05	not suitable	lands having limitations which cannot be corrected economically with the existing knowledge.

RESULTS AND DISCUSSION

The project was successfully completed within a period of 18 months from July 2003. During the project a large number of field visits were done covering the entire tea growing regions in the Ratnapura district after scrutinizing the aerial photographs and other basic information. Land suitability assessments were also carried out on the selected estates using the described criteria. At the end of the project period, a series of tea maps of the Ratnapura district, as given below, were produced and results were presented to the stakeholders.

- Tea map of Ratnapura district in 1:100,000 scale (Plate 1)
- Tea maps of Ratnapura, Balangoda and Kalawana regions in 1:50,000 scale
- Tea estates with AER in 1:100,000 and 1:250,000 scale (Plate 2)
- Tea estates with elevations (tea sector classification) in 1:250,000 scale (Plate 3)
- Tea productivity regions of Ratnapura district in 1:250,000 scale (Plate 4)
- Land Suitability Maps of 12 estates in 1:15,000 scale (Plate 5 for Hapugastenna)

Tea maps of Ratnapura district

According to the findings of this study, the total tea extent in the Ratnapura district (Plate 1) was 31,116 ha in 2002 which was previously reported as 26,120 ha. The tea small holdings, corporate estates, tea in home gardens and tea under rubber

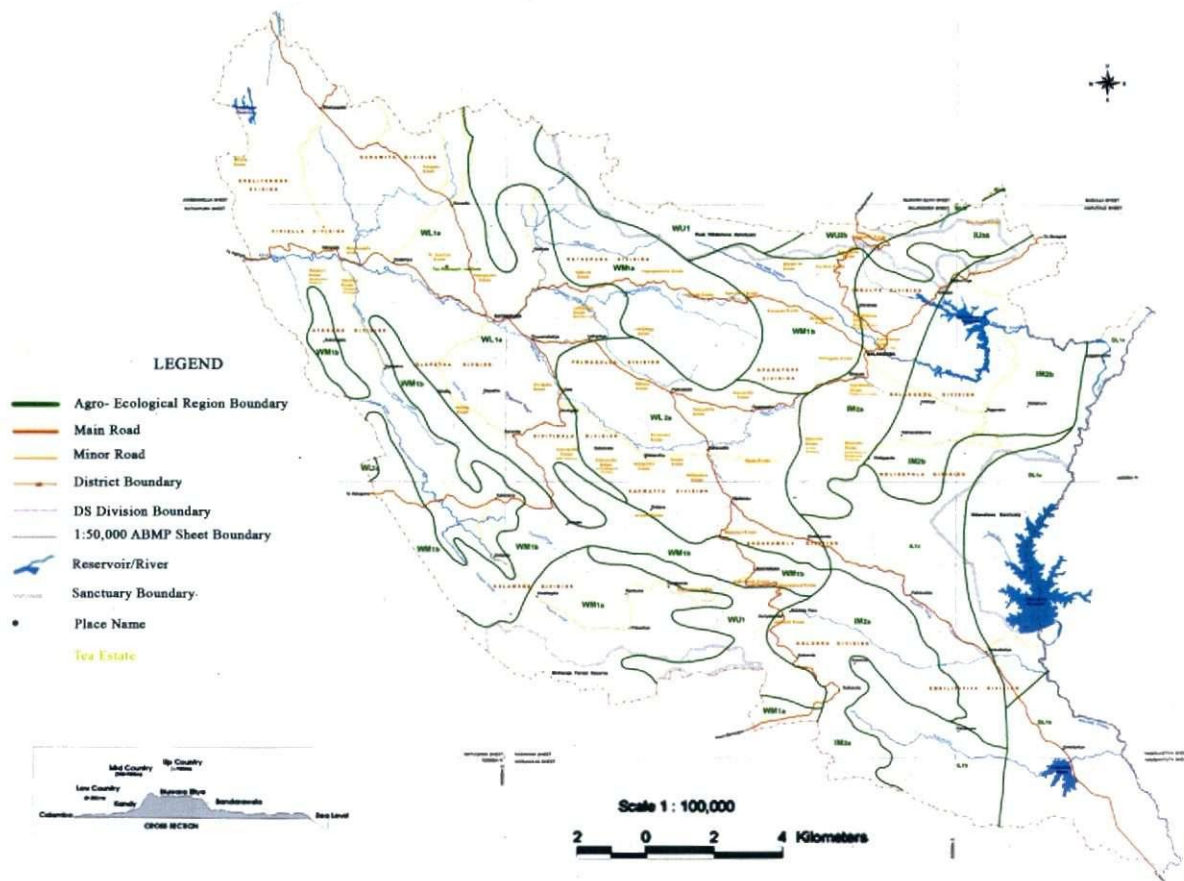


Plate 2. Agro ecological regions of Ratnapura district with special reference to tea growing areas

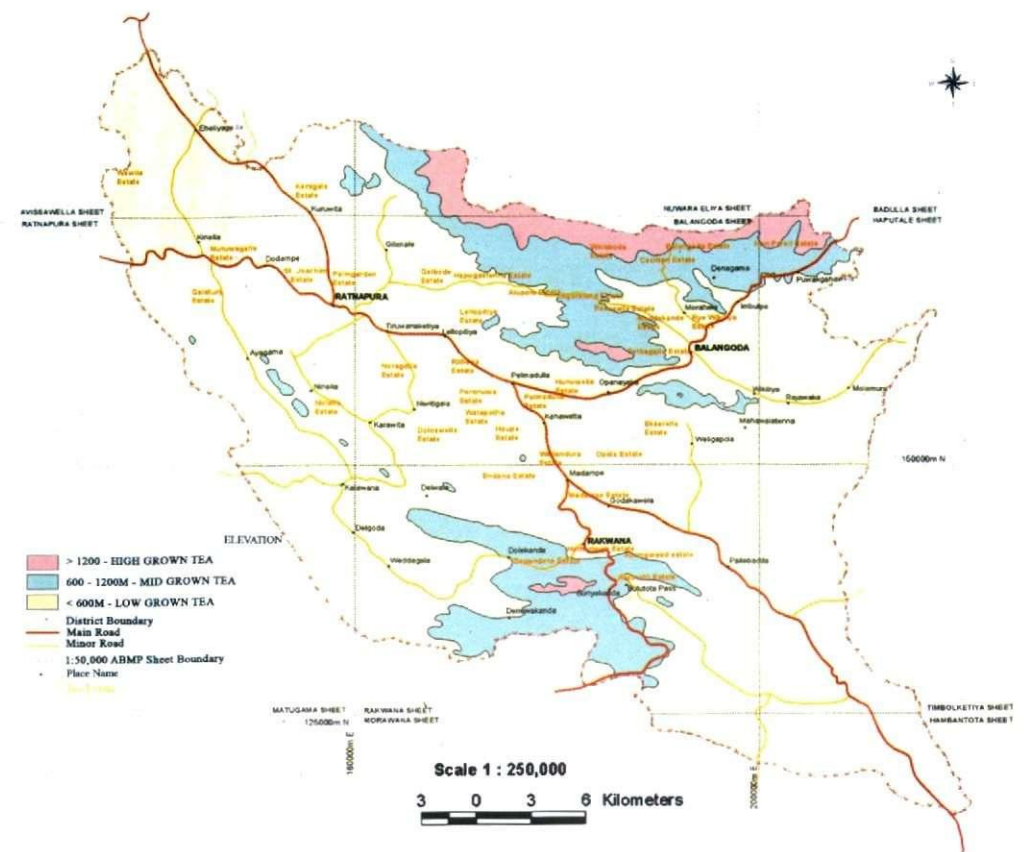


Plate 3. Elavation according to the tea sector classification of Ratnapura district

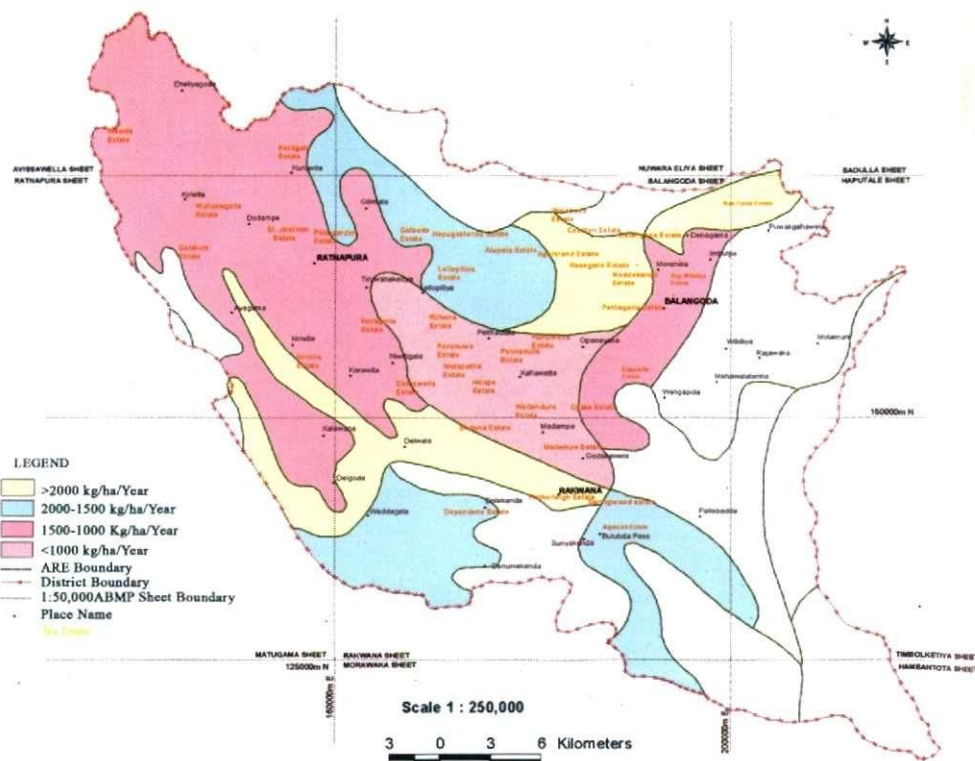


Plate 4. Tea productivity regions of Ratnapura district

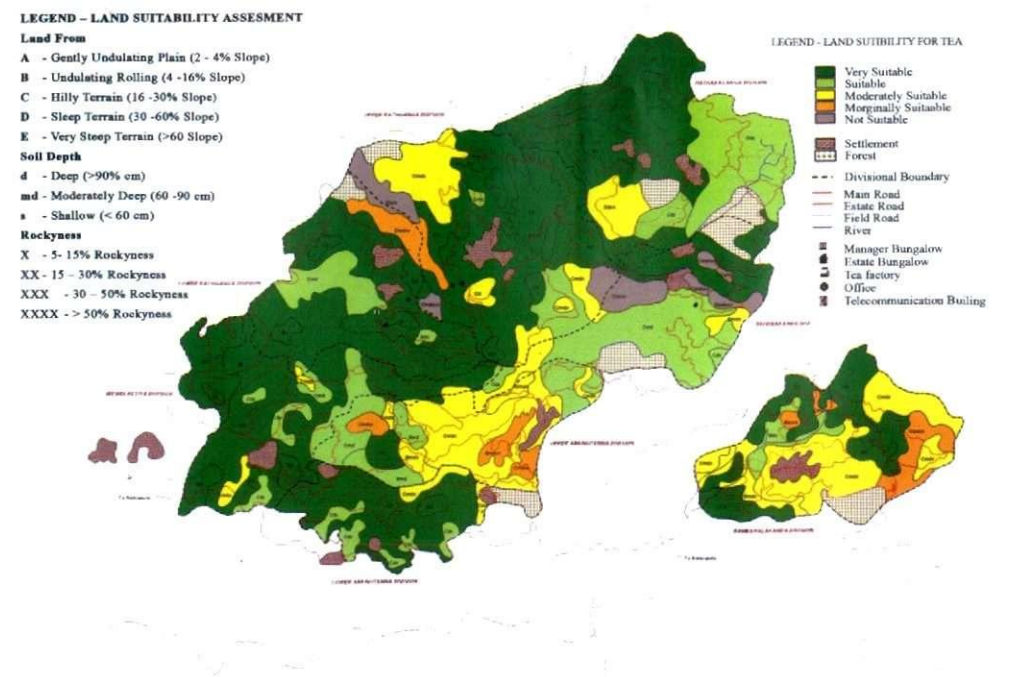


Plate 5. Land suitability map for tea (Hapugastenna Estate)

(intercropping) represented 70.5%, 24.0%, 4.9% and 0.45% of the total extent respectively. The increase in the extent of tea lands is mainly due to the expansion of smallholdings in the district. However, as per the recent census conducted by the Department of Census and Statistics in collaboration with the Tea Smallholdings Development Authority in 2005, the total extent of tea smallholdings in the Ratnapura district was 28,232 ha. In addition to the whole district map (1:100,000), individual maps for Ratnapura, Balangoda and Kalwana tea growing regions were separately prepared in 1:50,000 scale for clarity and easy reference.

Tea estates with AER and elevations

Environmental factors have profound effect on productivity and quality of tea. They vary from one region to the other. Usually, tea cultivation practices are planned taking into consideration the weather pattern in the region. The AER have been identified based on the elevation and the rainfall. In addition, tea sector use three elevation categories (tea sector classification) *i.e.* 0-600m *amsl* as Low country, 600-1200m *amsl* as Mid country and more than 1200 m *amsl* as Up country which are different from the AER. Some of the recommendations made by the Tea Research Institute of Sri Lanka are based on the tea sector classification. Therefore, separate maps were prepared showing tea estates under different AERs and the tea sector classification (Plate 2 and 3). Plates show that tea lands in the Ratnapura district are in AERs of WL1a, WL2a, WM1a, WM1b, WU2b, IM2a and IU3b. Moreover, the Ratnapura district has tea lands in all three elevations as per tea sector classification. However, the majority of tea lands were in the low elevation.

Tea productivity regions map

The Ratnapura district was divided into 4 productivity regions based on the average tea yield (productivity) of corporate sector estates (Plate 4). Detailed analysis of data had shown that each productivity region identified in this study closely represent particular AER as given in the Table 5. Accordingly, tea lands at higher elevations (WM) in the Ratnapura district are more productive than those at lower elevations (WL). This information can be used for identifying most suitable and productive regions for further expansion of tea cultivations and also for other investments such as replanting of tea. It also helps policy makers to diversify some of the unproductive lands into other crops such as timber or forest *etc.* The low productivity at lower elevations in Ratnapura district (WL) attributes to poor soil conditions and extreme environmental conditions prevailing in this region. Heavy rainfalls received in this region paves way for soil erosion. As a result, soil organic matter status of these soils is low. Besides, high ambient temperatures at low elevation aggravate the loss of organic matter. Dry weather condition during the first quarter of the year is more pronounced at lower elevations and is also responsible for lower productivity.

Land suitability maps of selected tea estates

After detailed soil investigations, the tea fields of 12 selected estates were classified into different land suitability classes and maps were compiled. In the maps, land suitability classes (Table 3) were identified by different colours and their characteristics indicated by a combination of letters (land management units) as described in the Table 2. Such a combination of legends helps stakeholders to easily identify the suitable blocks for tea cultivation and also the limiting factors if any (Plate 5). For instance, a block of land given "B md X" denotes that the slope of the land (4-16%) posing none to minor limitation, soil depth (60-90 cm) posing a minor to moderate limitation and rockiness (5-15%) posing no limitation for tea cultivation.

Table 4 shows the land management units under different land suitability classes. For an example, "Bd" comes under very suitable category while Bmd is categorized under suitable category due to the decrease in soil depth, which is considered a minor limitation. Further, it may become moderately suitable by the presence of rocks *viz.* BmdX. The BmdXX with a moderately deep soil and higher % of rocks is identified as marginally suitable land for tea. Finally, a land categorized as BmdXXX is not suitable for tea cultivation as both rockiness and soil depth impose moderate limitations.

The information and maps compiled by this study are available at the Tea Research Institute, Talawakelle and Low country Regional Centre, Ratnapura for the use of stakeholders. The results have also been conveyed to the respective tea estates for their reference. The information given in the maps can be used to identify more productive regions and tea lands for replanting, crop diversification, forestry and village expansion programmes *etc.* In addition, distribution and extent of tea lands, roads and streams *etc.* shown in these maps provide useful information for tea factory and other tea related infrastructure development programmes in the district. Growers can also improve the suitability of available lands for a selected crop by adopting appropriate agricultural measures relevant to the limitations indicated. Hence, findings of the present study are very useful for enhancing the productivity and profitability of tea lands in the Ratnapura

Table 4. Land management units in each category of land suitability class

Class	Land management units
01. very suitable	Ad, Bd, Cd, Dd
02. suitable	Bmd, BdX, Cmd, CdX, Dmd, DdX
03. moderately suitable	BmdX, BdXX, CmdX, CdXX, DmdX, DdXX, Ed
04. marginally suitable	BmdXX, CmdXX, DmdXX, EdX, Emd
05. not suitable	BmdXXX, CdXXX, CmdXXX, CsX, CsXX, DmdXXX, Ds, DsX-XXXX, EmdX, EmdXX-XXXX, Es, EsXX-XXXX

Table 5. AER under different productivity regions of tea

Productivity Region	Yield (made tea kg/ha/yr)	AER
01	>2000	WM1(b)
02	2000-1500	WM1(a)
03	1500-1000	WL1(a)
04	<1000	WL2(a)

district and harnessing maximum returns for investments. Similar studies are also planned for other tea growing districts in the Low country.

CONCLUSIONS

The present study revealed that the total tea extent in the Ratnapura district in 2002 was 31,116 ha of which the most productive estates are located at higher elevations (WM). About 75% of the tea extent in the Ratnapura district consists of small holdings. The corporate sector estates in the Ratnapura district had tea lands with varying degrees of limitations for tea cultivation which should be considered in future replanting and other field development programmes.

ACKNOWLEDGEMENTS

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