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LAND RESOURCE INVENTORY SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS FOR WATERSHED PLANNING AND DEVELOPMENT

RANTUR (4D4A3G1e) MICRO WATERSHED

Shirahatti Taluk, Gadag District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

The ICAR-National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS&LUP), Nagpur, a premier Institute of the Indian Council of Agricultural Research (ICAR), was set up during 1976 with the objective to prepare soil resource maps at national, state and district levels and to provide research inputs in soil resource mapping and its applications, land evaluation, land use planning, land resource management, and database management using GIS for optimising land use on different kinds of soils in the country.

The Bureau has been engaged in carrying out soil resource survey, agro-ecological and soil degradation mapping at the country, state and district levels for qualitative assessment and monitoring the soil health towards viable land use planning. The research activities have resulted in identifying the soil potentials and problems, and the various applications of the soil surveys with the ultimate objective of sustainable agricultural development. The Bureau has the mandate to correlate and classify soils of the country and maintain a National Register of all the established soil series. The Institute is also imparting in-service training to staff of the soil survey agencies in the area of soil survey, land evaluation and soil survey interpretations for land use planning. The Bureau in collaboration with Panjabrao Krishi Vidyapeeth, Akola is running post-graduate teaching and research programme in land resource management, leading to M.Sc. and Ph.D. degrees.

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PREFACE

In Karnataka, as in other Indian States, the livelihoods of rural people are intertwined with farming pursuits. Thechallenges in agriculture are seriously threatening the livelihood of a large number of farmers as they have been practicing farming in contextual factors beyond their control. Climatic factors are the most important ones and have become much more significant in recent times due to rapid climate changes induced by intensive anthropogenic activities affecting our ecosystem in multiple ways. Climate change has become the reality, it is happening and efforts to evolve and demonstrate climate resilient technologies have become essential. Due to the already over stressed scenario of agrarian sector, the climate change is resulting in manifold increase in the complexities, pushing the rural mass to face more and more unpredictable situations. The rising temperatures and unpredictable rainfall patterns are going to test seriously the informed decisions farmers have to make in order to survive in farming and sustain their livelihood.

It is generally recognized that impacts of climate change shall not be uniform across the globe. It is said that impact of climate change is more severe in South Asia. Based on the analysis of meteorological data, it is predicted that in India, there will be upward trend in mean temperature, downward trend in relative humidity, annual rainfall and number of wet days in a year. Also, in general, phenomena like erratic monsoon, spread of tropical diseases, rise in sea levels, changes in availability of fresh water, frequent floods, droughts, heat waves, storms and hurricanes are predicted. Each one of these adverse situations are already being experienced in various parts of India and also at the global level. Decline in agricultural productivity of small and marginal farmers becoming more vulnerable is already witnessed.

In Karnataka, more than 60 per cent of the population live in rural areas and depend on agriculture and allied activities for their livelihood. Though the state has achieved significant progress in increasing the yield of many crops, there is tremendous pressure on the land resources due to the growing and competing demands of various land uses. This is reflected in the alarming rate of land degradation observed. Already more than 50 per cent of the area is affected by various forms of degradation. If this trend continues, the sustainability of the fragile ecosystem will be badly affected. The adverse effects of change in the climatic factors are putting additional stress on the land resources and the farmers dependent on this.

The natural resources (land, water and vegetation) of the state need adequate and constant care and management, backed by site-specific technological interventions and investments particularly by the government. Detailed database pertaining to the nature of the land resources, their constraints, inherent potentials and suitability for various land based rural enterprises, crops and other uses is a prerequisite for preparing location-specific action plans, which are in tune with the inherent capability of the resources. Any effort to evolve climate resilient technologies has to be based on the baseline scientific database. Then only one can expect effective implementation of climate resilient technologies, monitor the progress, make essential review of the strategy, and finally evaluate the effectiveness of the implemented programs. The information available at present on the land resources of the state are of general nature and useful only for general purpose planning. Since the need of the hour is to have site-specific information suitable for farm level planning and detailed characterization and delineation of the existing land resources of an area into similar management units is the only option.

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of for Rantur microwatershed in Shirahatti Taluk, Gadag District, Karnataka" for integrated development was taken up in collaboration with the State Agricutural Universities, IISC, KSRSAC, KSNDMC as Consortia partners. The project provides detailed land resource information at cadastral level (1:7920 scale) for all the plots and socio-economic status of farm households covering thirty per cent farmers randomely selected representing landed and landless class of farmers in the micowatershed. The project report with the accompanying maps for the microwatershed will provide required detailed database for evolving effective land use plan, alternative land use options and conservation plans for the planners, administrators, agricutural extention personnel, KVK officials, developmental departments and other land users to manage the land resources in a sustainable manner.

It is hoped that this database will be useful to the planners, administrators and developmental agencies working in the area in not only for formulating location specific developmental schemes but also for their effective monitoring at the village/watershed level.

Nagpur **S.K. SINGH**

Date: 10.05.2016 Director, ICAR - NBSS&LUP, Nagpur

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The land resource inventory of Rantur microwatershed was conducted using village cadastral maps and IRS satellite imagery on 1:7920 scale. The false colour composites of IRS imagery were interpreted for physiography and these physiographic delineations were used as base for mapping soils. The soils were studied in several transects and a soil map was prepared with phases of soil series as mapping units. Random checks were made all over the area outside the transects to confirm and validate the soil map unit boundaries. The soil map shows the geographic distribution and extent, characteristics, classification and use potentials of the soils in the microwatershed.

The present study covers an area of 670 ha in Shirahatti taluk of Gadag district, Karnataka. The climate is semiarid and categorized as drought prone with an average annual rainfall of 633 mm of which about 363 mm is received during south –west monsoon, 165 mm during north-east and the remaining 105 mm during the rest of the year. An area of about 96 per cent is covered by soils, four per cent by rock lands, water bodies, settlements and others. The salient findings from the land resource inventory are summarized briefly below.

- The soils belong to 18 soil series and 46 soil phases (management units) and 9 land management units.
- The length of crop growing period is about 150 days starting from the 3rd week of June to 1st week of October.
- From the master soil map, several interpretative and thematic maps like land capability, soil depth, surface soil texture, soil gravelliness, available water capacity, soil slope and soil erosion were generated.
- Soil fertility status maps for macro and micronutrients were generated based on the surface soil samples collected at every 250 m grid interval.
- Land suitability for growing major agricultural and horticultural crops were assessed and maps showing the degree of suitability along with constraints were generated.
- About 96 per cent area is suitable for agriculture and 4% is not suitable for agriculture.
- About 58 per cent of the soils are moderately shallow (50-75 cm) to shallow (25-50 cm) and about 38 per cent are moderately deep to very deep soils.
- About 56 per cent of the area has loamy soils, 31 per cent clayey soils and 9 per cent sandy soils has at the surface..
- About 12 per cent of the area has non-gravelly, 57 per cent gravelly soils (15-35 % gravel) and 27 per cent very gravelly (35- 60%) to extremely gravelly (60-80%) soils.
- About 29 per cent medium (101-150 mm/m), 67 per cent low (51-100 mm/m) to very low (<50mm/m) in available water capacity.

- *About 77 per cent area has very gently sloping (1-3%), 18 per cent has nearly level (0-1%) and 1 per cent gently sloping (3-5%) lands.*
- *An area of about 44 per cent has soils that are slightly eroded (e1) and 52 per cent moderately eroded (e2).*
- *An area of about 17 per cent has that are neutral (pH 6.0-6.5), 33 per cent moderately alkaline (pH 7.8 to 8.4), 20 per cent strongly alkaline (pH 8.4 to 9.0) and 24 per cent slightly alkaline (pH 8.4-9.0).*
- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm-1indicating that the soils are non-saline.*
- *About 35 per cent of the soils are medium (0.5-0.75%), 11 per cent high (>0.75%) and low (<0.5%) in about 50 per cent*
- *An area of about 75 per cent low (<23 kg/ha) and 21 per cent medium (23-57 kg/ha) in available phosphorus.*
- *About 76 per cent medium (145-337 kg/ha) and 20 per cent high (>337 kg/ha) in available potassium.*
- *Available sulphur is medium (10-20 ppm) in about 57 per cent area, 8 per cent high (>20ppm) and about 31 per cent area is low (<10 ppm).*
- *Available boron is low (0.5 ppm) in about 52 per cent, medium (0.5-1.0 ppm) in 44 per cent area and high (>1.0 ppm) in <1 per cent area.*
- *Available iron is deficient in about 38 per cent and sufficient in 58 per cent area.*
- *Available zinc is deficient in about 89 per cent area and sufficient in 7 per cent area.*
- *Available manganese and copper are sufficient in all the soils.*
- *The land suitability for 23 major crops grown in the microwatershed were assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, price and finally the demand and supply position.*

Land suitability for various crops in the microwatershed

Crop	Suitability Area in ha (%)			Crop	Suitability Area in ha (%)	
	Highly suitable (S1)	Moderately suitable (S2)			Highly suitable (S1)	Moderately suitable (S2)
Sorghum	118 (18)	204 (30)		Sapota	57 (8)	160 (24)
Maize	96 (14)	204(30)		Jackfruit	7 (1)	112 (17)
Cotton	119(18)	203(30)		Jamun	7 (1)	112(17)
Sunflower	119 (18)	168(25)		Musambi	7 (1)	112(17)
Onion	141 (21)	159(24)		Lime	7 (1)	112(17)
Groundnut	113 (17)	365(54)		Cashew	7 (1)	174 (26)
Chilli	136 (20)	186(28)		Custard apple	119 (18)	420(62)
Sugarcane	119 (18)	111(17)		Amla	119(18)	420 (62)
Pomegranate	119 (18)	119 (18)		Tamarind	7(1)	112(17)
Tomato	190 (22)	191(28)		Marigold	190 (28)	194 (29)
Guava	70 (10)	140 (21)		Chrysanthemum	190 (28)	194 (29)
Mango	7 (1)	112(17)				

Apart from the individual crop suitability, a proposed crop plan has been prepared for the 9 identified LUCs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fibre and horticulture crops.

- *Maintaining soil-health is vital to crop production and conserve soil and land resource base for maintaining ecological balance and to mitigate climate change. For this, several ameliorative measures have been suggested to these problematic soils like saline/alkali, highly eroded, sandy soils etc.,*
- *Soil and water conservation treatment plan has been prepared that would help in identifying the sites to be treated and also the type of structures required.*
- *As part of the greening programme, several tree species have been suggested to be planted in marginal and submarginal lands, field bunds and also in the hillocks, mounds and ridges that would help in supplementing the income, provide fodder and fuel and generate lot of biomass. This would help in maintaining an ecological balance and also help in mitigating the climate change.*

Chapter 1

INTRODUCTION

Soil being a vital natural resource on whose proper use depends the life supporting systems of a country and the socio-economic development of its people. Soils provide food, fodder, fibre and fuel for meeting the basic human and animal needs. With the ever increasing growth in human and animal population, the demand on soil for more food and fodder production is on the increase. The area available for agriculture is about 51 per cent of the total geographical area and more than 60 per cent of the people are still dependant on agriculture for their livelihood. However, the capacity of a soil to produce is limited and the limits to the production are set by its intrinsic characteristics, agro climatic setting, and use and management. There is therefore, tremendous pressure on land and water resources, which is causing decline in soil-health and stagnation in productivity. The soils have been degrading at an estimated rate of one million hectares per year and ground water levels have been receding at an alarming rate resulting in decline in the ground water resource. Further, land degradation has emerged as a serious problem which has already affected about 38 lakh ha of cultivated area in the State. Soil erosion alone has degraded about 35 lakh ha. Almost all the uncultivated areas are facing various degrees of degradation, particularly soil erosion. Salinity and alkalinity has emerged as a major problem in more than 3.5 lakh ha in the irrigated areas of the State. Nutrient depletion and declining factor productivity is common in both rainfed and irrigated areas. The degradation is continuing at an alarming rate and there appears to be no systematic effort among the stakeholders to contain this process. In recent times, an aberration of weather due to climate change phenomenon has added another dimension leading to unpredictable situations to be tackled by the farmers.

In this critical juncture, the challenge before us is not only to increase the productivity per unit area which is steadily declining and showing a fatigue syndrome, but also to prevent or at least reduce the severity of degradation. If the situation is not reversed at the earliest, then the sustainability of the already fragile crop production system and the overall ecosystem will be badly affected in the state. Added to this, every year there is a significant diversion of farm lands and water resources for non-agricultural purposes. Thus, developing strategies to slow down the degradation process or reclaim the soils to normal condition and ensure sustainability of production system are the major issues today. This demands a systematic appraisal of our soil and land resources with respect to their extent, geographic distribution, characteristics, behaviour and uses potential, which is very important for developing an effective land use and cropping systems for augmenting agricultural production on a sustainable basis.

The soil and land resource inventories made so far in Karnataka had limited utility because the surveys were of different types, scales and intensities carried out at different times with specific objectives. Hence, there is an urgent need to generate detailed site-specific farm level database on various land resources for all the villages/watersheds in a time bound manner that would help to protect the valuable soil and land resources and also to stabilize farm production. Therefore, the land resource inventory required for farm level planning is the one which investigates all the parameters which are critical for productivity *viz.,* soils, site characteristics (slope, erosion, gravelliness and stoniness), climate, water, topography, geology, hydrology, vegetation, crops, land use pattern, animal population, socio-economic conditions, infrastructure, marketing facilities and various schemes and developmental works of the government etc. From the data collected at farm level, the specific problems and potentials of the area can be identified and highlighted, conservation measures required for the area can be planned on a scientific footing, suitability of the area for various uses can be worked out and finally viable and sustainable land use options suitable for each and every land holding can be prescribed.

The Land Resource Inventory is basically done for identifying potential and problem areas, developing sustainable land use plans, estimation of surface run off and water harvesting potential, preparation of soil and water conservation plans, land degradation/desertification etc. The Bureau is presently engaged in developing an LRI methodology using high resolution satellite remote sensing data and Digital Elevation Model (DEM) data to prepare Landscape Ecological Units (LEU) map representing agro-ecosystem as a whole. The LEU is preferred over landform as the base map for LRI. LEU is the assemblage of landform, slope and land use. An attempt has already been made to upscale the soil resource information from 1:250000 and 1:50000 scale to the LEU map in Goa and other states.

The land resource inventory aims to provide site specific database for Rantur microwatershed in Shirahatti Taluk, Gadag District, Karnataka State for the Karnataka Watershed Development Department. The database was generated by using cadastral map of the village as a base along with high resolution IRS LISS IV and Cartosat-1 merged satellite imagery. Later, an attempt will be made to uplink this LRI data generated at 1:7920 scale under Sujala-III Project to the proposed Landscape Ecological units (LEUs) map.

The study was organized and executed by the ICAR- National Bureau of Soil Survey and Land Use Planning, Regional Centre, Bangalore under Generation of Land Resource Inventory Data base Component-1 of the Sujala-III Project funded by the World Bank.

Chapter 2

GEOGRAPHICAL SETTING

2.1 Location and Extent

The Rantur Microwatershed (Nilogal Subwatershed) is located in the central part of northern Karnataka in Shirahatti Taluk, Gadag District, Karnataka State (Fig.2.1). It comprises of parts of Belhatti, Devihal, Chikkasavanur and Machinahalli villages. It lies between 15^0 05'and 15^0 07' North latitudes and $75^0$36'and $75^0$39' East longitudes and covers an area of 670 ha. It is about 60 km south of Gadag and is surrounded by Chabbi village on the north, Belhatti village in the south, Devihal village on the west and Rantur village on the eastern side.

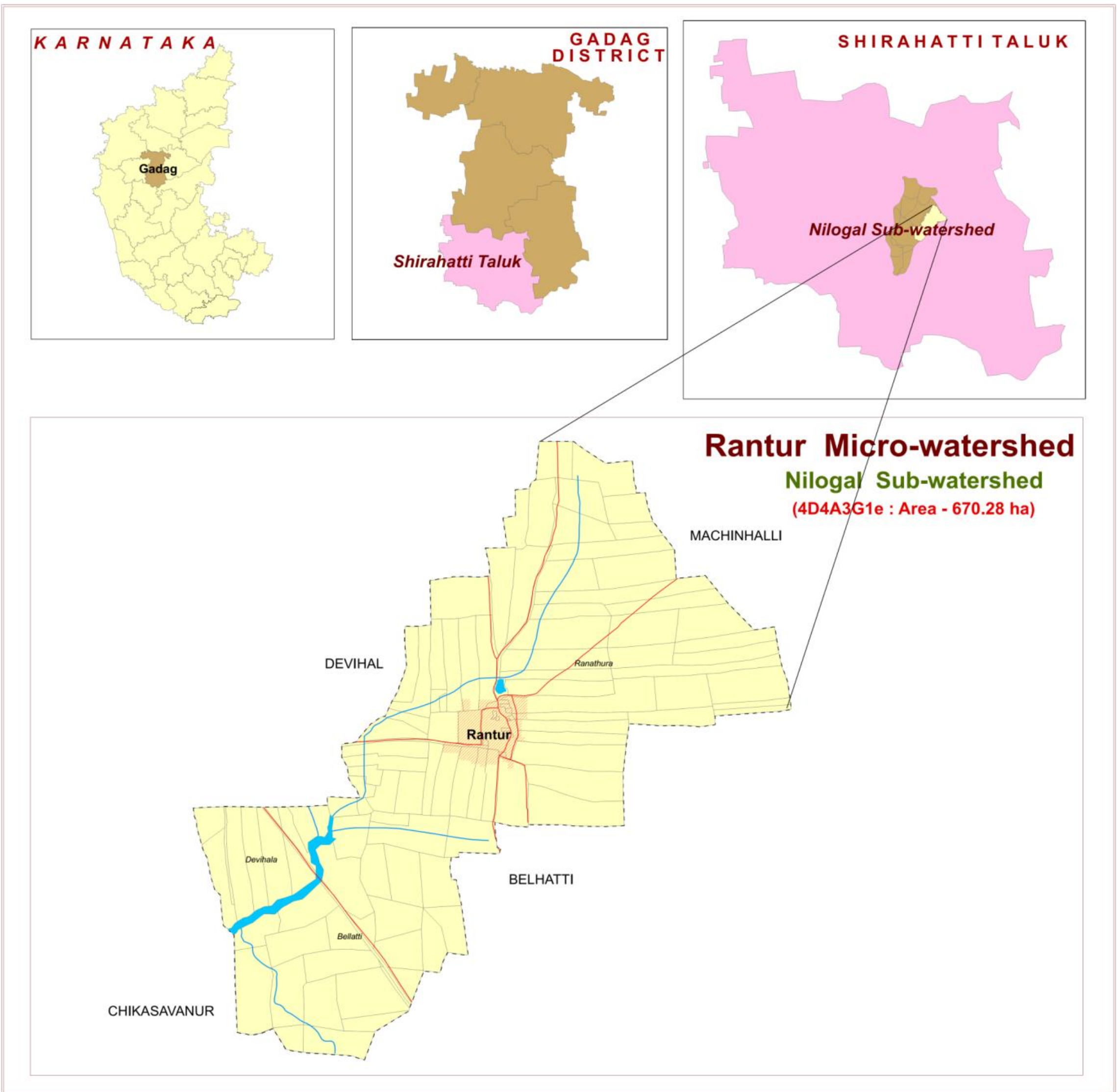


Fig.2.1 Location map of Rantur Microwatershed

2.2 Geology

Major rock formation observed in the microwatershed is granite and gneiss and gadag schist (Fig.2.2a & 2.2b). Granite and gneiss are essentially pink to gray and rocks are coarse to medium grained. Schist are formed with thick coating of Banded Ferrugenous Quartzite and ridges have capping of Banded Ferrugenous Quartzite (BFQ), whereas side slopes near the streams are dominated by schist. They are fine grained and show a distinct weathering pattern similar to that of basalt. The gray granite gneisses are highly weathered, fractured and fissured upto a depth of about 10 m. Due to fine texture of gadag schist, the soils formed from these rocks are mostly clayey in nature. The presence of iron rich banded ferrugenous quartzite is responsible for the dark red color of the soils observed in the microwatershed.

Fig.2.2a Granite and granite gneiss rocks

Fig.2.2b Gadag Schist rocks

2.3 Physiography

Physiographically, the area has been identified as granite gneiss landscape based on geology. The microwatershed area has been further divided into mounds/ridges, summits, side slopes and very gently sloping uplands based on slope and its relief features. The elevation ranges from 573 to 616 m in the gently sloping uplands. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

The area is drained by several small seasonal streams that join Dodd Halla along its course. Though, it is not a perennial one, during rainy season it carries large quantities of rain water. The microwatershed has only few small tanks which are not able to store the water flowing during the rainy season. Due to this, the ground water recharge is very much affected in the villages. This is reflected in the failure of many bore wells in the villages. If the available rain water is properly harnessed by constructing tanks and recharge structures at appropriate places in the village, then the drinking and irrigation needs of the entire area can be easily met. The drainage network is dendritic to sub parallel.

2.5 Climate

The district falls under semiarid tract of the state and is categorized as drought - prone with average annual rainfall of 633 mm (Table 2.1). Maximum of 363 mm precipitation takes place during south–west monsoon period from June to September, north-east monsoon contributes about 165 mm and prevails from October to early December and the remaining 105 mm takes place during the rest of the year. The winter season is from December to February. During April and May, the temperatures reach up to 42°C and in December and January, the temperatures will go down to 16°C. Rainfall distribution is shown in Figure 2.3. The average Potential Evapo Transpiration (PET) is 137 mm and varies from a low of 109 mm in December to 182 mm in the month of May. The PET is always higher than precipitation in all the months except in the month of October. Generally, the Length of crop Growing Period (LGP) is 150 days and starts from 3rd week of June to third week of November.

Table 2.1 Mean Monthly Rainfall, PET, 1/2 PET at Shirahatti Taluk, Gadag District

Sl.No.	Months	Rainfall	PET	1/2 PET
1	January	0.80	122.20	61.10
2	February	1.50	131.40	65.70
3	March	15.20	172.00	86.00
4	April	30.10	178.80	89.40
5	May	57.60	182.00	91.00
6	June	87.10	146.20	73.10
7	July	79.90	130.80	65.40
8	August	87.80	130.80	65.40
9	September	108.70	123.20	61.60
10	October	121.00	113.10	56.55
11	November	36.00	112.70	56.35
12	December	7.80	108.70	54.35
TOTAL		633.50	137.65	

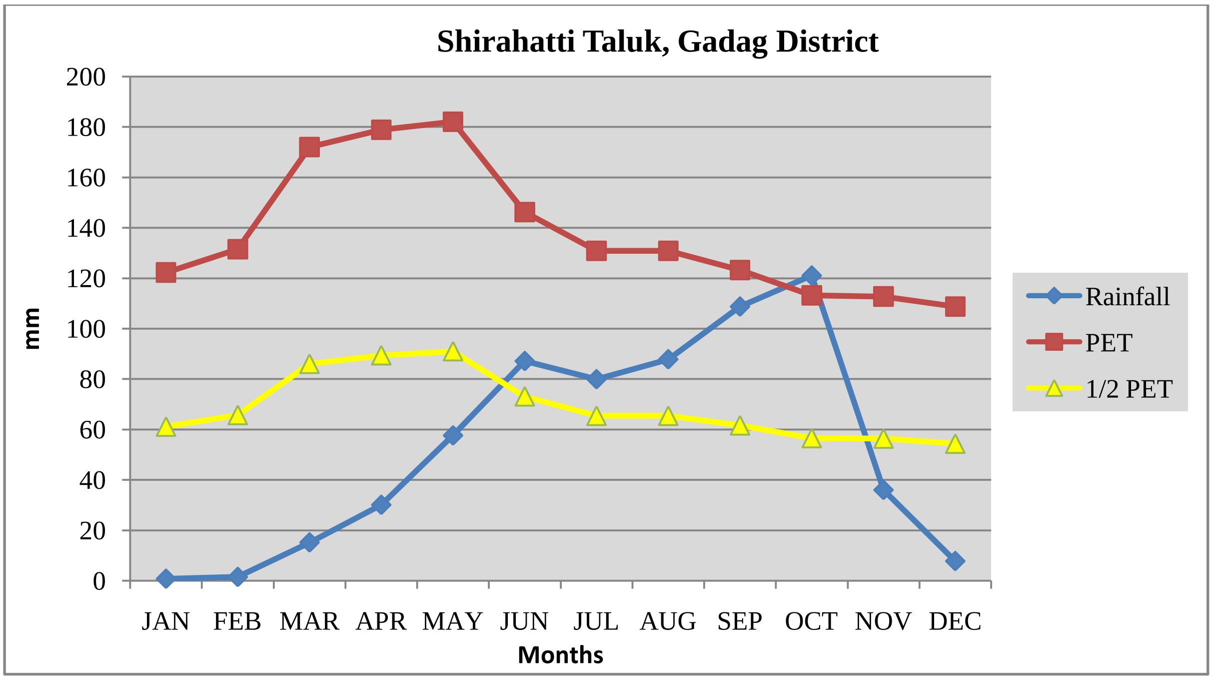


Fig. 2.3 Rainfall distribution in Shirahatti Taluk, Gadag District

2.6 Natural Vegetation

The natural vegetation is sparse comprising few tree species, shrubs and herbs. The mounds, ridges and bouldery areas occupy very sizeable areas which are under thin to moderately thick forest vegetation. Still, there are some remnants of the past forest cover which can be seen in patches in some ridges and hillocks in the microwatershed.

Apart from the continuing deforestation, the presence of large population of goats, sheep and other cattle in the micowatershed is causing vegetative degradation of whatever little vegetation left in the area. The uncontrolled grazing has left no time for the regeneration of the vegetative cover. This leads to the accelerated rate of erosion on the hill slopes, resulting in the formation of deep gullies in the foot slopes and eventually resulting in the heavy siltation of few tanks and reservoirs in the microwatershed.

2.7 Land Utilization

About 77 per cent area (Table 2.2) in Shirahatti taluk is cultivated at present and about 14 per cent of the area is sown more than once. An area of about 17 per cent is currently barren. Forests occupy a small area of about 1.6 per cent and the tree cover is in a very poor state. Most of the mounds, ridges and bouldery areas have very poor vegetative cover. Major crops grown in the area are sorghum, maize, cotton, safflower, sunflower, red gram, horse gram, onion, mulberry, sugarcane, Bengal gram and groundnut. While carrying out land resource inventory, the land use/land cover particulars are collected from all the survey numbers and a current land use map of the microwatershed is prepared. The current land use map prepared shows the arable and non-arable lands, other land uses and different types of crops grown in the area. The current land use map of Rantur Microwatershed is presented in Fig.2.4.

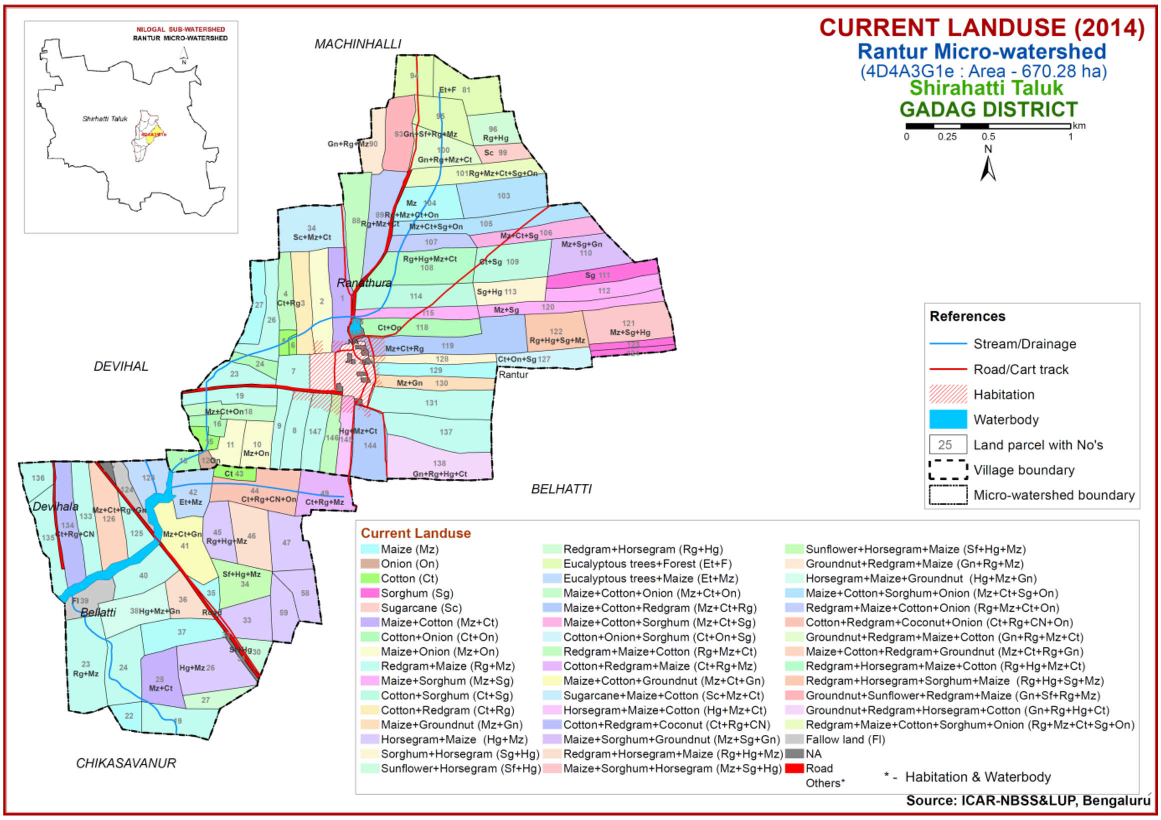


Fig.2.4 Current Land Use – Rantur Microwatershed

Simultaneously, enumeration of existing wells (bore wells and open wells) and other soil water conservation structures in the microwatershed is made and their location in different survey numbers is located on the cadastral map. Map showing the location of wells, soil conservation structures and other water bodies in Rantur Microwatershed is given Fig.2.5.

Table 2.2 Land Utilization in Shirahatti Taluk

Sl.No.	Agricultural land use	Area (ha)	Per cent
1	Total cultivated area	85004	77.0
2	Cultivable wasteland	291	0.26
3	Pasture land	1054	1.0
4	Forest area	1749	1.6
5	Area sown more than once	15366	14.0
6	Current Barren	18302	16.7
7	Total geographical area	109751	

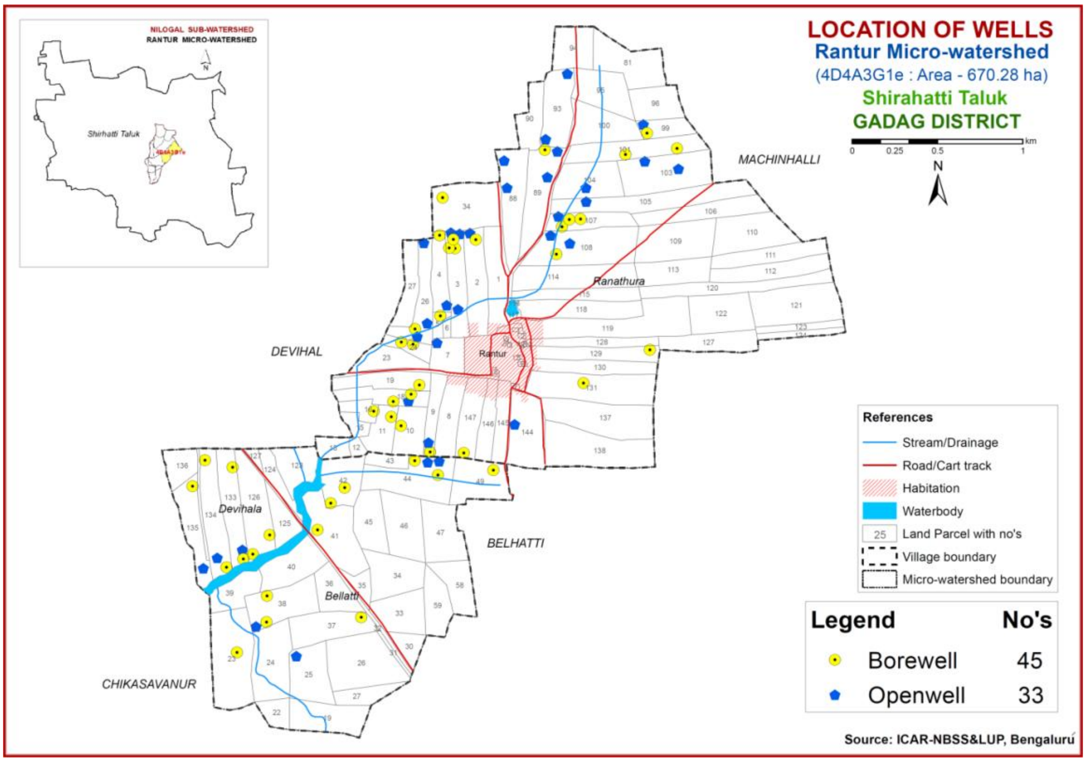


Fig.2.5 Location of Wells and conservation structures- Rantur Microwatershed

Fig. 2.6 Different crops and cropping systems in Rantur Microwatershed

Chapter 3

SURVEY METHODOLOGY

The purpose of land resource inventory is to delineate similar areas (soil series and phases), which respond or expected to respond similarly to a given level of management. This was achieved in Rantur Microwatershed by the detailed study of all the soil characteristics (depth, texture, color, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.) and site (slope, erosion, drainage, occurrence of rock fragments etc.) and followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units and showing their extent and geographic distribution on the microwatershed cadastral map. The detailed soil survey at 1:7920 scale was carried out in 670 ha area. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.*, 2015) which is briefly described below.

3.1 Base Maps

The detailed survey of the land resources occurring in the microwatershed was carried out by using digitized cadastral map as a base. The cadastral map shows field boundaries with their survey numbers, location of tanks, streams and other permanent features of the area (Fig. 3.1). Apart from the cadastral map, remote sensing data products from Cartosat-1 and LISS IV merged at the scale of 1:7920 were used in conjunction with the cadastral map to identify the geology, landscapes, landforms and other surface features. The imagery helped in the identification and delineation of boundaries between hills, uplands and lowlands, water bodies, forest and vegetated areas, roads, habitations and other cultural features of the area (Fig.3.2).The cadastral map was overlaid on the satellite imagery (Fig.3.3) that helps to identify the parcel boundaries and other permanent features. Apart from cadastral maps and images, toposheets of the area (1:50,000 scale) were used for initial traversing, identification of geology, landscape, landforms, drainage features, present land use and also for selection of transects in the microwatershed.

3.2 Image Interpretation for Physiography

False Colour Composites (FCC) of Cartosat-I and LISS-IV merged satellite data covering the microwatershed area was visually interpreted using image interpretation elements and all the available collateral data with local knowledge. The delineated physiographic boundaries were transferred on to a cadastral map overlaid on satellite imagery. Physiographically, the area has been identified as schist landscape and is divided into landforms such as ridges, mounds and uplands based on slope. They were further subdivided into physiographic/ image interpretation units based on image characteristics. The image interpretation legend for Physiography is given below.

Image Interpretation Legend for Physiography

G- Granite gneiss landscape

G1			Hills/ Ridges/ Mounds
	G11		Summits
	G12		Side slopes
		G121	Side slopes with dark grey tones
G2			Uplands
	G21		Summits
	G22		Gently sloping uplands
		G221	Gently sloping uplands, yellowish green (eroded)
		G222	Gently sloping uplands, yellowish white (severely eroded)
	G23		Very gently sloping uplands
		G231	Very gently sloping uplands, yellowish green
		G232	Very gently sloping uplands, medium green and pink
		G233	Very gently sloping uplands, pink and green (scrub land)
		G234	Very gently sloping uplands, medium greenish grey
		G235	Very gently sloping uplands, yellowish white (eroded)
		G236	Very gently sloping uplands, dark green
		G237	Very gently sloping uplands, medium pink (coconut garden)
		G238	Very gently sloping uplands, pink and bluish white (eroded)

S-Schist landscape

S1		Uplands
	S11	Summits, greenish blue
	S12	Side slopes, greenish grey
S2		Very gently sloping uplands
	S21	Very gently sloping uplands, greenish grey
	S22	Very gently sloping uplands, medium grey
	S23	Very gently sloping uplands, dark grey
	S24	Very gently sloping uplands, light green (scrub lands)
	S25	Very gently sloping uplands, grey and pink
	S26	Very gently sloping uplands, whitish grey (eroded)

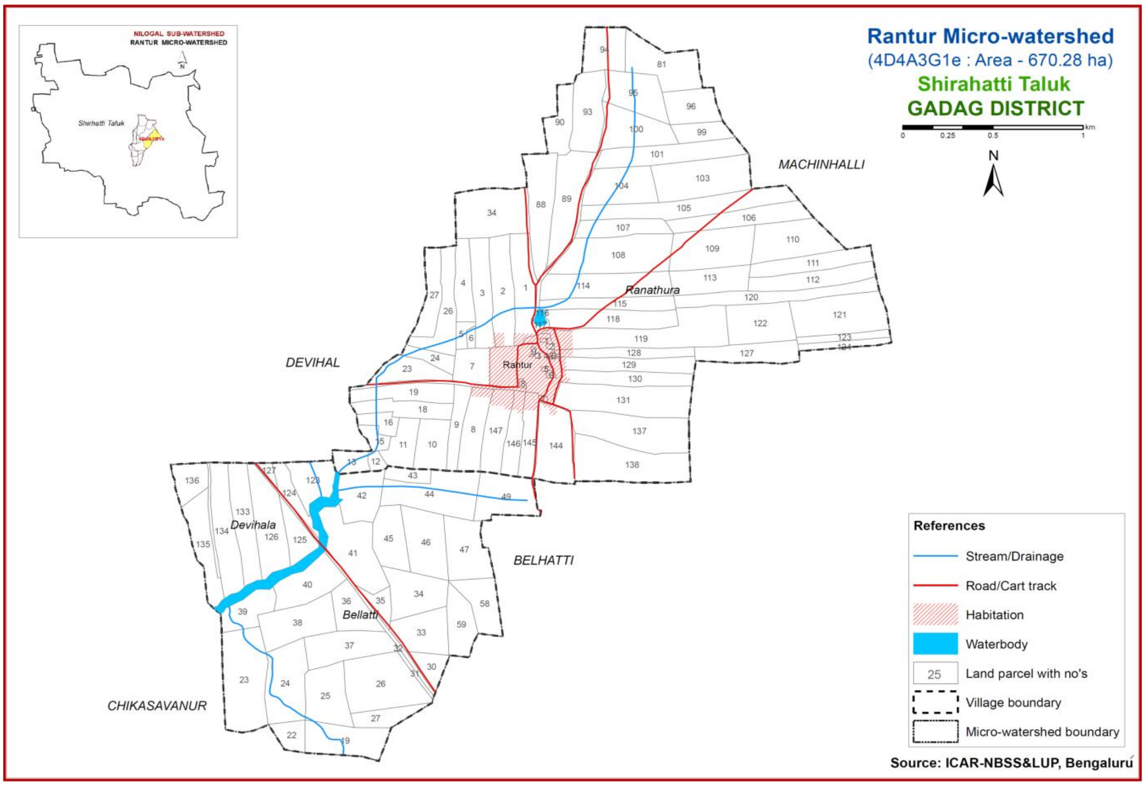


Fig 3.1 Scanned and Digitized Cadastral map of Rantur Microwatershed

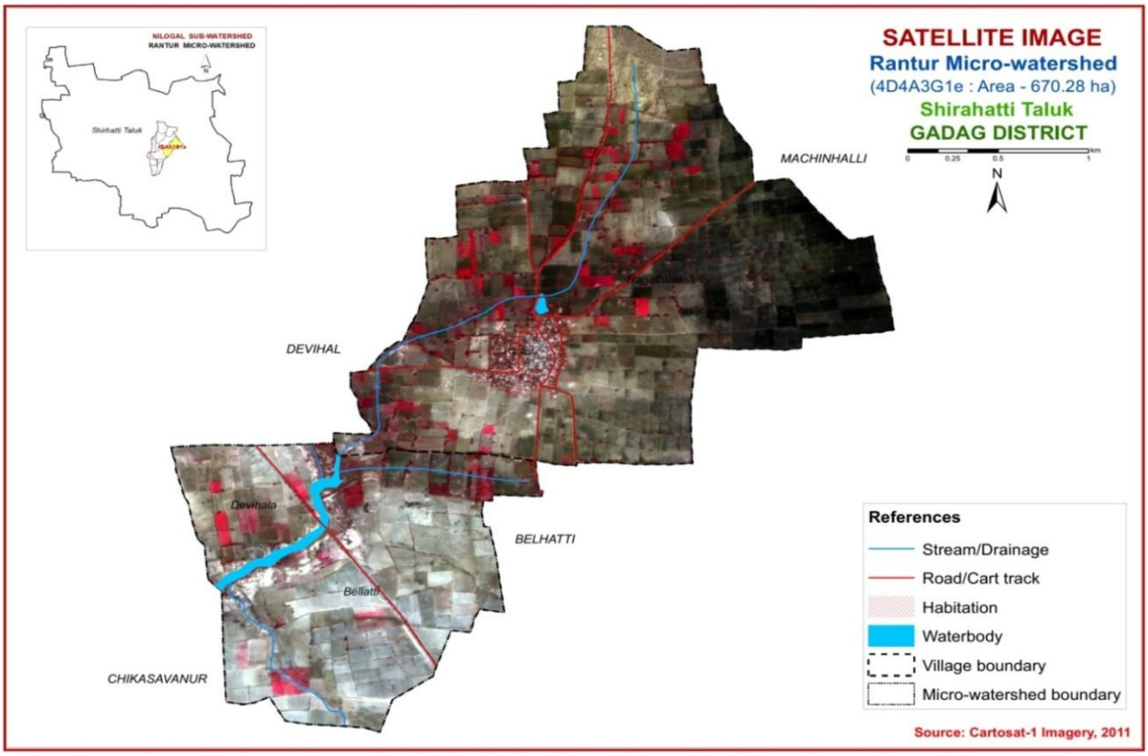


Fig.3.2 Satellite Image of Rantur Microwatershed

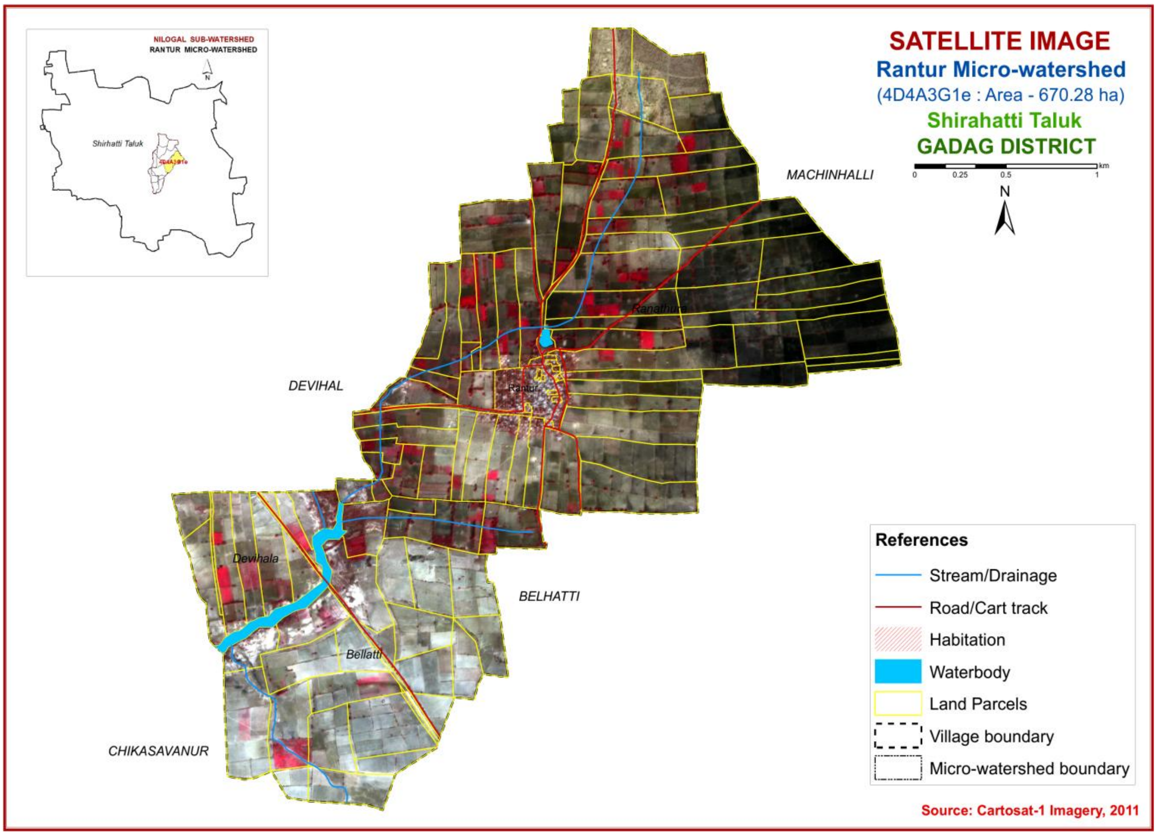


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Rantur Microwatershed

3.3 Field Investigation

The field boundaries and survey numbers given on the cadastral sheet were located on the ground by following permanent features like roads, cart tracks, nallas, streams, tanks etc., and wherever changes were noticed, they were incorporated on the microwatershed cadastral map. Preliminary traverse of the microwatershed was carried out with the help of cadastral map, imagery and toposheets. While traversing, landforms and physiographic units identified were checked and preliminary soil legend was prepared by studying soils at few selected places. Then, intensive traversing of each physiographic unit like hills, ridges and uplands was carried out. Based on the variability observed on the surface, transects were selected across the slope covering all the landform units in the microwatershed (Natarajan and Dipak Sarkar, 2010). In the selected transect, soil profiles were located at closely spaced intervals to take care of any change in the land features like break in slope, erosion, gravel, stones etc. In the selected sites, profiles (vertical cut showing the soil layers from surface to the rock) were opened upto 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all profile sites on a standard proforma as per the guidelines given in USDA Soil Survey Manual (Soil Survey Staff, 2012). Apart from the transect study, profiles were also studied at random, almost like in a grid pattern, outside the transect areas.

Based on the soil characteristics, the soils were grouped into different soil series. Soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management. Soil depth, texture, color, kind of horizon and horizon sequence, amount and nature of gravel present, nature of substratum etc, were used as the major differentiating characteristics for identifying soil series occurring in the area. The differentiating characteristics used for identifying the soil series are given in Table 3.1. Based on the above characteristics, 18 soil series were identified in Rantur Microwatershed.

Table 3.1 Differentiating Characteristics used for identifying Soil Series (Characteristics are of Series Control Section)

Soils of Granite Gneiss Landscape							
Sl.No	**Soil Series**	**Depth (cm)**	**Colour**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcareo-usness**
1	Chikkamegheri (CKM)	75-100	2.5YR2.5/3,3/4, 3/6	sc	-	Ap-Bt-Cr	-
2	Chikkasavanur (CSR)	25-50	7.5YR3/2,3/3,3/4	scl	<15	Ap-Bw-Cr	-
3	Gollarahatti (GHT)	75-100	2.5YR3/4,4/6	scl	15-35	Ap-Bt-Cr	-
4	Hooradhahalli (HDH)	75-100	2.5YR2.5/4,3/4, 3/6	scl-sc	>35	Ap-Bt-Cr	-
5	Honnenahalli (HNH)	50-75	7.5YR3/3,4/3 10YR3/3	sc	-	Ap-Bw-Cr	-
6	Harve (HRV)	25-50	2.5YR3/6 5YR4/4	scl	>35	Ap-Bt-Cr-	-
7	Kutegoudanahundi (KGH)	50-75	7.5YR3/2	scl	15-35	Ap-Bt-Cr	-
8	Kaggalipura (KGP)	25-50	2.5YR2.5/4	scl-sc	15-35	Ap-Bt-Cr	-
9	Kanchikere (KKR)	75-100	10YR3/3,4/2,5/2 7.5YR3/1,3/2,5/2	cl-sc	-	Ap-Bw-BC-Cr	-
10	Kumchahalli (KMH)	100-150	2.5YR3/4, 3/6	scl-sc	<15	Ap-Bt-Cr	-
11	Kanchanahalli (KNH)	25-50	2.5YR3/4	sc	<15	Ap-Bt-Cr	-
12	Kethanapura (KTP)	50-75	2.5YR3/4, 3/6	scl	15-35	Ap-Bt-Cr	-
13	Lakkur (LKR)	50-75	2.5YR3/4, 3/6	scl-sc	40-60	Ap-Bt-Bc-Cr	-
14	Mukhadahalli (MKH)	50-75	2.5YR3/4 5YR3/3,3/4,4/3, 5/4,6/6	scl	>35	Ap-Bt-Cr	-
15	Muradi (MRD)	>150	2.5YR3/6, 4/6,5/6, 5/8	scl-sc	-	Ap-Bt	-
16	Thammadahalli (TDH)	50-75	2.5YR2.5/4,3/6	sc-c	-	Ap-Bt-Cr	-
17	Vaddarahalli (VDH)	100-150	7.5YR3/2,3/3,3/4	sc-c	-	Ap-Bt-Cr	-
Soils Schist Landform							
18	Jelligeri (JLG)	75-100	7.5YR2.5/2,3/1, 3/2,3/3 10YR2/1,2/2,3/1	c	-	Ap-Bw-Cr	-

3.4 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected from farmer's fields (111 samples) for fertility status (major and micronutrients) at 250 m grid interval were analyzed in the laboratory (Katyal and Rattan, 2003). By linking the soil fertility data to the survey numbers through GIS, soil fertility maps were generated using kriging method for the microwatershed.

3.5 Finalization of Soil Maps

The area under each soil series was further separated into soil phases and their boundaries delineated on the cadastral map based on the variations observed in the texture of the surface soil, slope, erosion, presence of gravel, stoniness etc. A soil phase is a subdivision of soil series based mostly on surface features that affect its use and management.

The soil mapping units are shown on the map (Fig.3.4) in the form of symbols. During the survey about 34 soil profile pits, few minipits and a few auger bores representing different landforms occurring in the microwatershed were studied. All the profile locations are indicated on the village cadastral map in the form of a triangle. In addition to the profile study, spot observations in the form of minipits, road cuts, terrace cuts etc., were studied to validate the soil boundaries on the soil map.

The soil map shows the geographic distribution of 45 mapping units representing 18 soil series occurring in the microwatershed. The soil map unit (soil legend) description is presented in Table 3.2.

The soil phase map (management units) shows the distribution of 45 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one phase will have similar management needs and they have to be treated accordingly.

The 46 soil phases identified and mapped in the microwatershed were regrouped into 9 Land Management Units (LMU's) for the purpose of preparing a proposed crop plan for sustained development of the microwatershed. The database (soil phases) generated under LRI was utilized for identifying Land Management Units (LMUs) based on the management needs. One or more than one soil site characteristic having influence on the management have been chosen for identification and delineation of LMUs. For Rantur Microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LMUs. The land management units are expected to behave similarly for a given level of management.

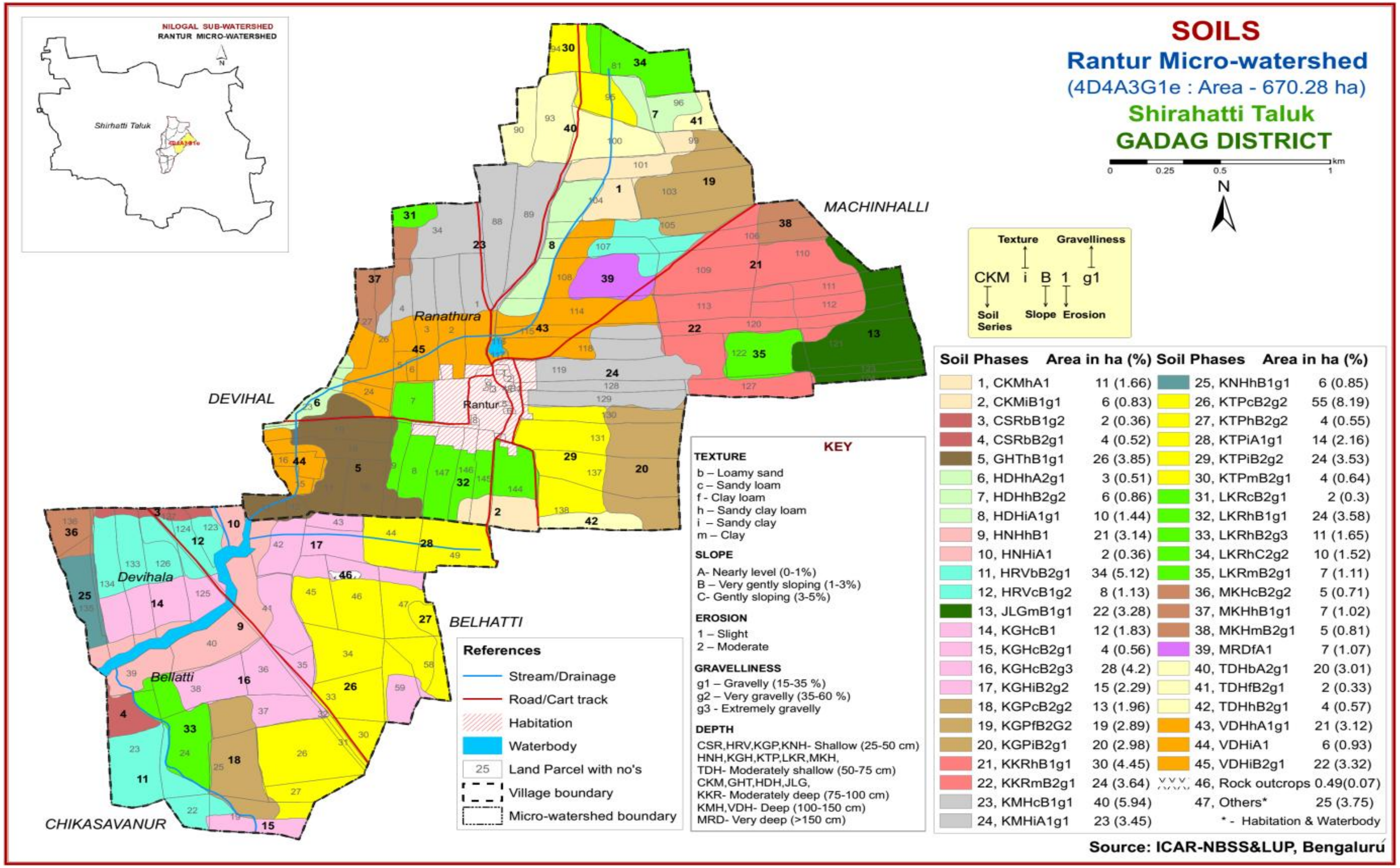


Fig 3.4 Soil Phase or Management Units- Rantur Microwatershed

Table 3.2 Soil map unit description of Rantur Microwatershed (Soil Legend)

Sl. No.	Soil Series	Soil Phases	Mapping Unit description	Area in ha (%)
SOILS OF GRANITE GNEISS LANDSCAPE				
	CKM	Chikkamegheri soils are moderately deep (75-100 cm), well drained, have dark brown to dark reddish brown sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation		**16.70 (2.49)**
1		CKMhA1	Sandy clay loam surface, slope 0-1%, slight erosion	11.12 (1.66)
2		CKMiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	5.58 (0.83)
	CSR	Chikkasavanur soils are shallow (25-50 cm), well drained, have dark brown to light yellowish brown sandy clay to clay soils occurring on very gently sloping uplands under cultivation		**5.91 (0.88)**
3		CSRbB1g2	Loamy sand surface, slope 1-3%, slight erosion, very gravelly (35-60 %)	2.41 (0.36)
4		CSRbB2g1	Loamy sand surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	3.50 (0.52)
	GHT	Gollarahatti soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation		**25.78 (3.82)**
5		GHThB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	25.78 (3.82)
	HDH	Hooradhahalli soils are moderately deep (75-100 cm), well drained, have red to dark red and reddish brown gravelly sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation		**18.87 (2.81)**
6		HDHhA2g1	Sandy clay loam surface, slope 0-1%, moderate erosion, gravelly (15-35 %)	3.45 (0.51)
7		HDHhB2g2	Sandy clay loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	5.77 (0.86)
8		HDHiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35 %)	9.65 (1.44)
	HNH	Honnenahalli soils are moderately deep (50-75 cm), well drained, have brown to dark brown clay soils occurring on nearly level to very gently sloping lowlands under cultivation		**23.48 (3.50)**
9		HNHhB1	Sandy clay loam surface, slope 1-3%, slight erosion	21.06 (3.14)
10		HNHiA1	Sandy clay surface, slope 0-1%, slight erosion	2.42 (0.36)
	HRV	Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils occurring on very gently to moderately sloping uplands under cultivation		**41.85 (6.25)**

11		HRVbB2g1	Loamy sand surface, slope 1-3%, moderate erosion, gravelly (15-35%)	34.29 (5.12)
12		HRVcB1g2	Sandy loam surface, slope 1-3%, slight erosion, very gravelly (35-60 %)	7.56 (1.13)
	JLG	Jelligeri soils are moderately deep (75-100 cm), moderately well drained, very dark brown to dark brown and black cracking clay soils occurring on very gently sloping uplands under cultivation		**22.01 (3.28)**
13		JLGmB1g1	Clay surface, slope 1-3%, slight erosion, gravelly (15-35 %)	22.01 (3.28)
	KGH	Kutegoudanahundi soils are moderately shallow (50 - 75 cm), well drained, have brown to dark brown loamy sand to sandy loam soils occurring on very gently to gently sloping uplands under cultivation		**59.52 (8.88)**
14		KGHcB1	Sandy loam surface, slope 1-3%, slight erosion	12.26 (1.83)
15		KGHcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	3.73 (0.56)
16		KGHcB2g3	Sandy loam surface, slope 1-3%, moderate erosion, extremely gravelly (60-80 %)	28.16 (4.20)
17		KGHiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	15.37 (2.29)
	KGP	Kaggalipura soils are shallow (25 - 50 cm), well drained, have brown to dark reddish brown sandy clay loam to sandy clay soils occurring on very gently sloping uplands under cultivation		**52.44 (7.83)**
18		KGPcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60 %)	13.12 (1.96)
19		KGPfB2g2	Clay loam surface, slope 1-3%, moderate erosion, very gravelly (35-60 %)	19.35 (2.89)
20		KGPiB2g1	Sandy clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	19.97 (2.98)
	KKR	Kanchikere soils are moderately deep (75-100 cm), well drained, have dark brown to very dark brown clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation		**54.18 (8.09)**
21		KKRhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	29.80 (4.45)
22		KKRmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	24.38 (3.64)
	KMH	Kumchahalli soils are deep (100-150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation		**62.93 (9.39)**
23		KMHcB1g1	Sandy loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	39.82 (5.94)
24		KMHiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35 %)	23.11 (3.45)

	KNH	Kanchanahalli soils are shallow (25 -50 cm), well drained, have dark reddish brown sandy clay soils occurring on very gently sloping uplands under cultivation		**5.68 (0.85)**
25		KNHhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	5.68 (0.85)
	KTP	Kethanapura soils are moderately shallow (50-75 cm), well drained, have dark reddish brown gravelly sandy loam soils occurring on very gently to gently sloping uplands under cultivation		**100.92 (15.07)**
26		KTPcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60 %)	54.88 (8.19)
27		KTPhB2g2	Sandy clay loam surface, slope 1-3%, moderate erosion, very gravelly (35-60 %)	3.65 (0.55)
28		KTPiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35 %)	14.45 (2.16)
29		KTPiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	23.65 (3.53)
30		KTPmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	4.29 (0.64)
	LKR	Lakkur soils are moderately shallow (50-75 cm), well drained, have reddish brown to dark red gravelly sandy clay loam to sandy clay red soils occurring on nearly level to gently and moderately sloping uplands under cultivation		**54.7 (8.16)**
31		LKRcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	2.03 (0.30)
32		LKRhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	23.99 (3.58)
33		LKRhB2g3	Sandy clay loam surface, slope 1-3%, moderate erosion, extremely gravelly (60-80 %)	11.05 (1.65)
34		LKRhC2g2	Sandy clay loam surface, slope 3-5 %, moderate erosion, very gravelly (35-60 %)	10.18 (1.52)
35		LKRmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	7.45 (1.11)
	MKH	Mukhadahalli soils are moderately shallow (50-75 cm), well drained, have dark brown to reddish brown gravelly sandy clay loam soils occurring on very gently to gently sloping uplands under cultivation		**16.96 (2.54)**
36		MKHcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60 %)	4.74 (0.71)
37		MKHhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35 %)	6.82 (1.02)
38		MKHmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	5.40 (0.81)
	MRD	Muradi soils are very deep (>150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to gently sloping uplands under cultivation		**7.15 (1.07)**

39		MRDfA1	Clay loam surface, slope 0-1%, slight erosion	7.15 (1.07)
	TDH	Thammadahalli soils are moderately shallow (50 – 75 cm), well drained, have brown to very dark brown and dark reddish brown sandy loam to clay loam soils occurring on nearly level to gently sloping uplands under cultivation		**26.17 (3.91)**
40		TDHbA2g1	Loamy sand surface, slope 0-1%, moderate erosion, gravelly (15-35 %)	20.15 (3.01)
41		TDHfB2g1	Clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	2.21 (0.33)
42		TDHhB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	3.81 (0.57)
	VDH	Vaddarahalli soils are deep (100 - 150 cm), well drained, have dark reddish brown to dark brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation		**49.40 (7.37)**
43		VDHhA1g1	Sandy clay loam surface, slope 0-1%, slight erosion, gravelly (15-35 %)	20.94 (3.12)
44		VDHiA1	Sandy clay surface, slope 0-1%, slight erosion	6.20 (0.93)
45		VDHiB2g1	Sandy clay surface, slope 1-3%, moderate erosion, gravelly (15-35 %)	22.26 (3.32)
46		Rock lands, rocky and bouldery		0.49 (0.07)
47	Others	Habitation and water body		25.14 (3.75)

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Rantur Microwatershed is provided in this chapter. The microwatershed area has been identified as Schist Landscape based on geology. In all, 18 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. In schist landscape, soil formation is dominantly influenced by the parent material, climate and relief.

A brief description of each of the 18 soil series identified and soil phases (management units) mapped under each series (Fig. 3.4) are furnished below. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristic that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

4.1 Soils of Granite Gneiss and Schist Landscape

In this landscape, 18 soil series are identified and mapped. Of these, Kethanapura (KTP) soil series occupies maximum area of about 101 ha (15%) and Kumchahalli (KMH) 63 ha (9%) area. The brief description of each soil series and number of phases identified in the microwatershed are given below. The mapping unit description (Soil Legend) of the phases identified and mapped under each series given in Table 3.2.

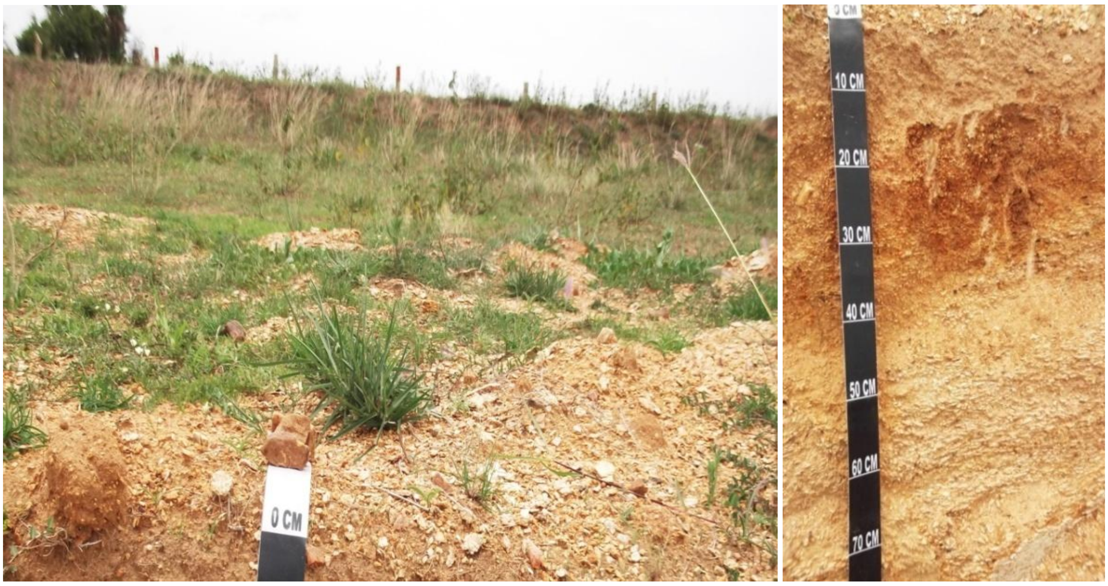
4.1.1 Chikkamegheri (CKM) Series: Chikkamegheri soils are moderately deep (75-100 cm), well drained, have dark brown to dark reddish brown and red sandy clay soils. They have developed from granite gneiss and occur on nearly level to very gently sloping uplands. The Chikkamegheri series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Rhodic Paleustalfs.

The thickness of the solum ranges from 76 to 100 cm. The thickness of A horizon ranges from 11 to 24 cm. Its colour is in 7.5 YR, 5YR and 2.5 YR hue with value 2 to 4 and chroma 3 to 6. The texture varies from sandy clay loam to sandy clay with 10 to 15 per cent gravel. The thickness of B horizon ranges from 65 to 86 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 3 to 6. Its texture is dominantly sandy clay. The available water capacity is medium (100-150 mm/m). Two phases identified and mapped.

Landscape and soil profile characteristics of Chikkamegheri (CKM) Series

4.1.2 Chikkasavanur (CSR) Series: Chikkasavanur soils are shallow (25-50 cm), well drained, have dark brown to light yellowish brown sandy clay to clay soils. They have developed from granite gneiss and occur on very gently sloping uplands. The Chikkasavanur series has been tentatively classified as a member of the fine-loamy, mixed, isohyperthermic family of Typic Haplustepts.

The thickness of the solum ranges from 32 to 49 cm. The thickness of A horizon ranges from 12 to 23 cm. Its colour is in 7.5 YR and 10 YR hue with value 2.5 to 4 and chroma 3 to 6. The texture varies from sandy loam to clay with 10 to 20 per cent gravel. The thickness of B horizon ranges from 16 to 32 cm. Its colour is in 7.5 YR and 5 YR hue with value 3 and chroma 2 to 4. Its texture is sandy clay loam with gravel content of < 15 per cent. The available water capacity is low (50-100 mm/m). Two phases identified and mapped.



Landscape and soil profile characteristics of Chikkasavanur (CSR) Series

4.1.3 Gollarahatti (GHT) Series: Gollarahatti soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red sandy clay loam to clay soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands. The Gollarahatti series has been tentatively classified as a member of the fine-loamy, mixed, isohyperthermic family of Typic Haplustalfs.

The thickness of the solum ranges from 78 to 98 cm. The thickness of A horizon ranges from 12 to 18cm. Its colour is in 5 YR and 2.5 YR hue with value 3 to 4 and chroma 4 to 6. Texture varies from loamy sand to sandy clay with 15 to 35 per cent gravel. The thickness of B horizon ranges from 66 to 81cm. Its colour is in 2.5 YR hue with value 3 to 4 and chroma 4 to 6. Texture is sandy clay loam to clay with 15 to 35 per cent gravel. The available water capacity is medium (100-150 mm/m). Only one phase was identified and mapped.

Landscape and soil profile characteristics of Gollarahatti (GHT) Series

4.1.4 Hooradhahalli (HDH) Series: Hooradhahalli soils are moderately deep (75-100 cm), well drained, have red to dark red and reddish brown gravelly sandy clay loam to clay soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands. The Hooradhahalli series has been tentatively classified as a member of the loamy-skeletal, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 76 to 100 cm. The thickness of A horizon ranges from 11 to 19 cm. Its colour is in 5 YR and 2.5 YR hue with value 3 to 4 and chroma 3 to 6. The texture varies from loamy sand to sandy clay with 15 to 50 per cent gravel. The thickness of B horizon varies from 65 to 83 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 4 to 6. Texture is sandy clay loam to sandy clay with 35 to 50 per cent gravel. The available water capacity is low (50-100mm/m). Three phases identified and mapped.

Landscape and soil profile characteristics of Hooradhahalli (HDH) Series

4.1.5 Honnenahalli (HNH) Series: Honnenahalli soils are moderately deep (50 to 75 cm), well drained, have brown to dark brown clayey soils. They have developed from alluvium and occur on nearly level to very gently sloping lowlands. The Honnenahalli series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Haplustepts.

The thickness of the solum ranges from 52 to 74 cm. The thickness of A horizon ranges from 17 to 21 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 and chroma 3 to 4. The texture varies from sandy clay loam to sandy loam with 5 to 10 per cent gravel. The thickness of B horizon ranges from 45 to 72 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 and chroma 3 to 4. Its texture is sandy clay. The available water capacity is medium (100-150 mm/m). Two phase were identified and mapped.

Landscape and soil profile characteristics of Honnenahalli (HNH) Series

4.1.6 Harve (HRV) Series: Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils. They have developed from granite gneiss and occur on very gently to moderately sloping uplands. The Harve series has been tentatively classified as a member of the loamy- skeletal, mixed, isohyperthermic family of Typic Haplustalfs.

The thickness of the solum ranges from 28 to 48 cm. The thickness of A horizon ranges from 12 to 17 cm. Its colour is in 5YR and 2.5 YR hue with value 3 to 4 and chroma 4 to 6. The texture varies from loamy sand to sandy loam with 20 to 60 per cent gravel. The thickness of B horizon ranges from 16 to 32 cm. Its colour is in 2.5 YR and 5 YR hue with value 3 to 4 and chroma 4 to 6. Its texture is sandy clay loam with gravel content of 35 to 50 per cent. The available water capacity is very low (<50mm/m). Two phases were identified and mapped.

Landscape and soil profile characteristics of Harve (HRV) Series

4.1.7 Kutegoudanahundi (KGH) Series: Kutegoudanahundi soils are moderately shallow (50-75 cm), well drained, have brown to dark brown loamy sand to sandy loam soils. They have developed from granite gneiss and occur on very gently to gently sloping uplands. The Kutegoudanahundi series has been tentatively classified as a member of the fine-loamy, mixed, isohyperthermic family of Typic Haplustalfs.

The thickness of the solum ranges from 50 to 74 cm. The thickness of A horizon ranges from 12 to 22 cm. Its colour is in 7.5 YR and 10 YR hue with value and chroma 3 to 4. The texture varies from loamy sand to sandy loam with 15 to 30 per cent gravel. The thickness of B horizon ranges from 40 to 62 cm. Its colour is in 7.5 YR hue with value and chroma 3 to 4. Its texture is sandy clay loam with gravel content of 15 to 35 per cent. The available water capacity is medium (100-150 mm/m). Four phases were identified and mapped.

Landscape and soil profile characteristics of Kutegoudanahundi (KGH) Series

4.1.8 Kaggalipura (KGP) Series: Kaggalipura soils are shallow (25-50 cm), well drained, have brown to dark reddish brown sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on very gently sloping uplands. The Kaggalipura series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 7 to 19 cm. The thickness of A horizon ranges from 12 to 17 cm. Its colour is in 7.5 YR, 5YR and 2.5 YR hue with value 2.5 to 4 and chroma 2 to 6. The texture varies from sandy clay loam to sandy clay with 10 to 25 per cent gravel. The thickness of B horizon ranges from 28 to 50 cm. Its colour is in 2.5 YR hue with value 2.5 and chroma 4. Its texture is sandy clay with gravel content of 15 to 35 per cent. The available water capacity is low (50-100 mm/m). Three phases were identified and mapped.

Landscape and soil profile characteristics of Kaggalipura (KGP) Series

4.1.9 Kanchikere (KKR) Series: Kanchikere soils are moderately deep (75-100 cm), well drained, have dark brown to very dark brown clay loam to sandy clay soils. These soils are developed from weathered granite gneiss and occur on very gently to gently sloping uplands. The Kanchikere series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Haplustepts.

The thickness of the solum ranges from 76 to 100 cm. The thickness of A horizon ranges from 11 to 20 cm. Its colour is in 7.5YR and 10 YR hue with value 3 to 5 and chroma 3 to 4. Texture varies from loamy sand to sandy clay. The thickness of B horizon ranges from 63 to 82 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 to 5 and chroma 1 to 3. Texture is clay loam to sandy clay. The available water capacity is medium (100-150 mm/m). Two phases were identified and mapped.

Landscape and soil profile characteristics of Kanchikere (KKR) Series

4.1.10 Kumchahalli (KMH) Series: Kumchahalli soils are deep (100-150cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on nearly level to very gently sloping uplands. The Kumchahalli series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 102 to 150 cm. The thickness of A horizon ranges from 11 to 23 cm. Its colour is in 5 YR and 2.5 YR hue with value 2.5 to 3 and chroma 3 to 6. The texture is dominantly sandy clay. The thickness of B horizon ranges from 95 to 132 cm. Its colour is in 2.5 YR hue with value 3 and chroma 4 to 6. Its texture is dominantly sandy clay. The available water capacity is high (150-200 mm/m). Two phases were identified and mapped.

Landscape and soil profile characteristics of Kumchahalli (KMH) Series

4.1.11 Kanchanahalli (KNH) Series: Kanchanahalli soils are shallow (25 -50 cm), well drained, have dark reddish brown sandy clay soils. They have developed from granite gneiss and occur on very gently sloping uplands. The Kanchanahalli series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 28 to 48 cm. The thickness of A horizon ranges from 12 to 18 cm. Its colour is in 5YR and 2.5 YR hue with value 3 and chroma 4 to 6. The texture varies from sandy clay loam to sandy clay with 10 to 15 per cent gravel. The thickness of B horizon ranges from 16 to 38 cm. Its colour is in 2.5 YR hue with value 3 to 4 and chroma 4 to 6. Its texture is sandy clay with gravel content of < 15 per cent. The available water capacity is low (50-100 mm/m). Only one phase was identified and mapped.

Landscape and soil profile characteristics of Kanchanahalli (KNH) Series

4.1.12 Kethanapura (KTP) Series: Kethanapura soils are moderately shallow (50-75cm), well drained, have dark reddish brown gravelly sandy loam soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands. The Kethanapura series has been tentatively classified as a member of the fine-loamy, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 53 to 72 cm. The thickness of A horizon ranges from 11 to 16 cm. Its colour is in 5YR and 2.5 YR hue with value 3 to 4 and chroma 3 to 6. The texture varies from loamy sand to sandy clay loam with 15 to 40 per cent gravel. The thickness of B horizon varies from 41 to 56 cm. Its colour is in 2.5 YR hue with value 3 to 4 and chroma 4 to 6. Texture is dominantly sandy clay loam with 15 to 35 per cent gravel. The available water capacity is medium (100-150 mm/m). Five phases identified and mapped.

Landscape and soil profile characteristics of Kethanapura (KTP) Series

4.1.13 Lakkur (LKR) Series: Lakkur soils are moderately shallow (50-75cm), well drained, have reddish brown to dark red gravelly sandy clay loam to sandy clay red soils. They have developed from granite gneiss and occur on nearly level to very gently and gently sloping uplands. The Lakkur series has been tentatively classified as a member of the clayey-skeletal, mixed, isohyperthermic family of Typic Rhodustalfs.

The thickness of the solum ranges from 51 to 74 cm. The thickness of A horizon ranges from 12 to 18 cm. Its colour is in 5YR and 2.5 YR hue with value 3 to 4 and chroma 4 to 6. The texture varies from loamy sand to sandy clay loam with 15 to 50 per cent gravel. The thickness of B horizon ranges from 39 to 58 cm. Its colour is in 2.5 YR hue with value 3 to 4 and chroma 4 to 6. Texture varies from sandy clay loam to sandy clay with 40 to 60 per cent gravel. The available water capacity is low (50-100 mm/m). Five phases were identified and mapped.

Landscape and soil profile characteristics of Lakkur (LKR) Series

4.1.14 Mukhadahalli (MKH) Series: Mukhadahalli soils are moderately shallow (50-75 cm), well drained, have dark brown to reddish brown gravelly sandy clay loam soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands. The Mukhadahalli series has been tentatively classified as a member of the loamy-skeletal, mixed, isohyperthermic family of Typic Haplustalfs.

The thickness of the solum ranges from 51 to 72 cm. The thickness of A horizon ranges from 12 to 17 cm. Its colour is in 5 YR and 7.5 YR hue with value 3 to 4 and chroma 2 to 4. The texture varies from loamy sand to sandy loam with 20 to 45 per cent gravel. The thickness of B horizon ranges from 40 to 68 cm. Its colour is in 2.5 YR and 5 YR hue with value and chroma 3 to 6. Texture is sandy clay loam to sandy clay with 35 to 50 per cent gravel. The available water capacity is low (50-100 mm/m). Three phases were identified and mapped.

Landscape and soil profile characteristics of Mukhadahalli (MKH) Series

4.1.15 Muradi (MRD) Series: Muradi soils are very deep (>150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to gently sloping uplands under cultivation.

The thickness of the solum is >150 cm. The thickness of A horizon ranges from 15 to 30 cm thick. Its colour is in hue 7.5 YR, value 3 and chroma 3. The texture is dominantly gravelly clay loam. The thickness of B horizon ranges from 45--160 cm. The colour of the B horizon in hue 2.5 YR value 2 to 5 and chroma 6 to 8. The texture is sandy clay to sandy clay loam. The available water capacity is medium (101-150 mm/m). Only one phase was identified and mapped.

Landscape Soil Profile Characteristics of Muradi (MRD) Series

4.1.16 Thammadahalli (TDH) Series: Thammadahalli soils are moderately shallow (50-75cm), well drained, have brown to very dark brown and dark reddish brown sandy loam to clay loam soils. They have developed from granite gneiss and occur on nearly level to gently sloping uplands. The Thammadahalli series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Rhodic Paleustalfs.

The thickness of the solum ranges from 54 to 75 cm. The thickness of A horizon ranges from 11 to 19 cm. Its colour is in 7.5 YR, 5YR and 2.5 YR hue with value 2.5 to 4 and chroma 2 to 6. The texture varies from sandy loam to clay loam with 10 to 20 per cent gravel. The thickness of B horizon ranges from 43 to 60 cm. Its colour is in 2.5 YR hue with value 3 and chroma 4 to 6. Its texture is sandy clay loam to sandy clay. The available water capacity is medium (100-150 mm/m). Three phases were identified and mapped.

Landscape and soil profile characteristics of Thammadahalli (TDH) Series

4.1.17 Vaddarahalli (VDH) Series: Vaddarahalli soils are deep (100-150 cm), well drained, have dark reddish brown to dark brown clay soils. They have developed from granite gneiss and occur on nearly level to very gently sloping uplands. The Vaddarahalli series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Haplustalfs.

The thickness of the solum ranges from 106 to 148 cm. The thickness of A horizon ranges from 13 to 23 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 and chroma 3 to 4. The texture varies from sandy loam to clay. The thickness of B horizon ranges from 95 to 132 cm. Its colour is in 7.5 YR and 5 YR hue with value 3 to 4 and chroma 2 to 4. Its texture is sandy clay to clay. The available water capacity is high (150-200 mm/m). Three phases identified and mapped.

Landscape and soil profile characteristics of Vaddarahalli (VDH) Series

4.2 Soils of Schist Landscape

In this landscape, only one soil series are identified and mapped. The mapping unit description (Soil Legend) of the phases identified and mapped under each series given in Table 3.2.

4.2.1 Jelligeri (JLG) Series: Jelligeri soils are moderately deep (75-100 cm), moderately well drained, very dark brown to dark brown and black cracking clay soils. They have developed from schist and occur on very gently sloping uplands. The Jelligeri series has been tentatively classified as a member of the fine, smectitic, isohyperthermic family of Vertic Haplustepts.

The thickness of the solum ranges from 78 to 98 cm. The thickness of A horizon ranges from 15 to 20 cm. Its colour is in hue 10 YR and 7.5 YR with value 2 to 3 and chroma 1 to 3. Its texture is dominantly clay. The thickness of B horizon ranges from 63 to 78cm. Its colour is in hue 10 YR and 7.5 YR with value 2 to 3 and chroma 1 to 3. Its texture is dominantly clay. The available water capacity is high (150-200 mm/m).Only one phase was identified and mapped.

Landscape and soil profile characteristics of Jelligeri (JLG) Series

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

The most important soil and site characteristics that affect the land use and conservation needs of an area are land capability, soil depth, soil texture, coarse fragments, available water capacity, soil slope, soil erosion, soil reaction etc. These are interpreted from the data base generated through land resource inventory and several thematic maps are generated. These would help in identifying the areas suitable for growing crops and, soil and water conservation measures and structures needed thus helping to maintain good soil health for sustained crop production. The various thematic maps generated are described below.

5.1 Land Capability Classification

Land capability classification is an interpretative grouping of soil map units (soil phases) mainly based on inherent soil characteristics, external land features and environmental factors that limit the use of land for agriculture, pasture, forestry, or other uses on a sustained basis (IARI, 1971). The land and soil characteristics used to group the land resources in an area into various land capability Classes, subclasses and units are

Land characteristics: Slope, erosion, drainage, rock outcrops.

Climate: Total rainfall and its distribution, and length of crop growing period.

The land capability classification system is divided into land capability classes, subclasses and units based on the level of information available. Eight land capability classes are recognized. They are

Class I: They are very good lands that have no limitations or very few limitations that restrict their use.

Class II: They are good lands that have minor limitations and require moderate conservation practices.

Class III: They are moderately good lands that have severe limitations that reduce the choice of crops or that require special conservation practices.

Class IV: They are fairly good lands that have very severe limitations that reduce the choice of crops or that require very careful management.

Class V: Soils in these lands are not likely to erode, but have other limitations like wetness that are impractical to remove and as such not suitable for agriculture, but suitable for pasture or forestry with minor limitations.

Class VI: The lands have severe limitations that make them generally unsuitable for cultivation, but suitable for pasture or forestry with moderate limitations.

Class VII: The lands have very severe limitations that make them unsuitable for cultivation, but suitable for pasture or forestry with major limitations.

Class VIII: Soil and other miscellaneous areas (rock lands) that have very severe limitations that nearly preclude their use for any crop production, but suitable for wildlife, recreation and wind mills.

The land capability subclasses are recognised based on the dominant limitations observed within a given land capability class. The subclasses are designated by adding a lower case letter like ‘e’, ‘w’, ‘s’, or ‘c’ to the class numeral. The subclass “e” indicates that the main hazard is risk of erosion, “w” indicates drainage or wetness as a limitation for plant growth, “s” indicates shallow soil depth, coarse or heavy textures, calcareousness, salinity/alkalinity or gravelliness and “c” indicates limitation due to climate.

The land capability subclasses have been further subdivided into land capability units based on the kinds of limitations present in each subclass. Ten land capability units are used in grouping the soil map units. They are stony or rocky (0), erosion hazard (slope, erosion) (1), coarse texture (sand, loamy sand, sandy loam) (2), fine texture (cracking clay, silty clay) (3), slowly permeable subsoil (4), coarse underlying material (5), salinity/alkali (6), stagnation, overflow, high ground water table (7), soil depth (8) and fertility problems (9). The capability units thus identified have similar soil and land characteristics that respond similarly to a given level of management. The soils of the microwatershed have been classified upto land capability subclass level.

The 46 soil map units identified in the Rantur microwatershed are grouped under 4 land capability classes and 9 land capability subclasses. An area (96 %) in the microwatershed is suitable for agriculture and 4 % is not suitable for agriculture (Fig. 5.1).

Good cultivable lands (Class II) cover a small area of about 60 per cent and are distributed in all parts of the micowatershed with minor problems of soil, wetness and erosion. Moderately good cultivable lands (Class III) cover a maximum area of about 22 per cent and are distributed in the western, northern, central and northeastern part of the microwatershed with moderate problems of erosion, wetness and soil. The fairly good cultivable lands (Class IV) cover very small area of about 14 per cent and are distributed in the southwestern, eastern and northeastern part of the microwatershed. They have severe limitations of erosion and soil. The class VIII lands occupy very negligible area in the microwatershed. They are rock lands and not suitable for agriculture but well suited for as habitat for wildlife, recreation and installation of wind mills.

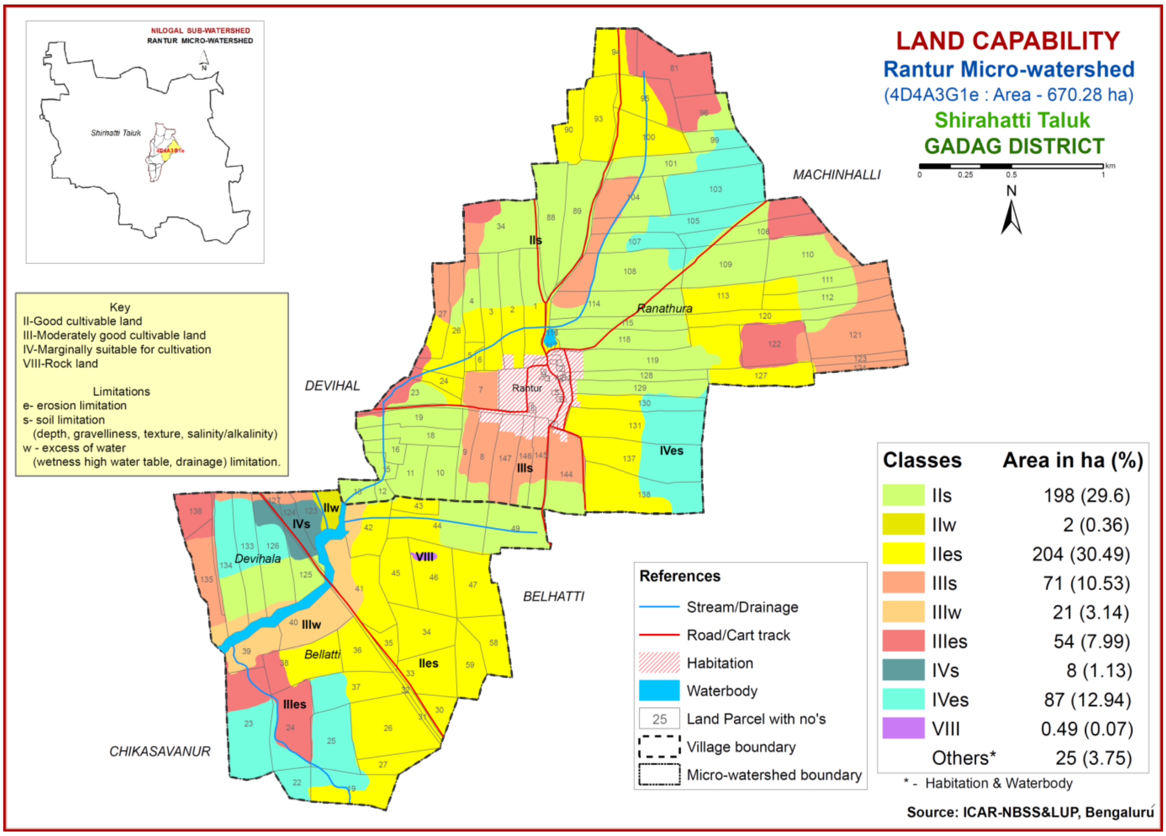


Fig. 5.1 Land Capability map of Rantur Microwatershed

5.2 Soil Depth

Soil depth refers to the depth of the soil occurring above the parent material or hard rock. The depth of the soil determines the effective rooting depth for plants and in accordance with soil texture, mineralogy and gravel content, the capacity of the soil column to hold water and nutrient availability. Soil depth is one of the most important soil characteristic that is used in differentiating soils into different soil series. The soil depth classes used in identifying soils in the field are very shallow (<25 cm), shallow (25-50 cm), moderately shallow (50-75 cm), moderately deep (75-100 cm), deep (100-150 cm) and very deep (>150 cm). They were used to classify the soils into different depth classes and a soil depth map was generated (Fig. 5.2).

Moderately shallow soils (50-75 cm) occupy maximum area of about 282 ha (42%) and occur in all parts of the microwatershed. Shallow (25-50 cm) soils occupy an area of about 106 ha (16%) and are distributed in the southwestern, eastern and northeastern part of the microwatershed. An area of about 138 ha (20%) is moderately deep (75-100 cm) and are distributed in the western, central and northeastern part of the microwatershed. Very deep (>150 cm) soils occupy a small area of about 7 ha (1%) and are distributed in small patch in the central part of the microwatershed.

The most problem lands with a maximum area of about 388 ha (58%) having moderate shallow 50-75 cm) and shallow (25-50 cm) rooting depth occur in major part of the microwatershed. They are not suitable for growing agricultural crops but well suited for pasture, forestry or other recreational purposes. Occasionally, short duration crops may be grown if rainfall is normal. The most productive soils cover 247 ha (39%) that are moderately deep to very deep (75->150 cm) and have potential for growing both annual and perennial crops.

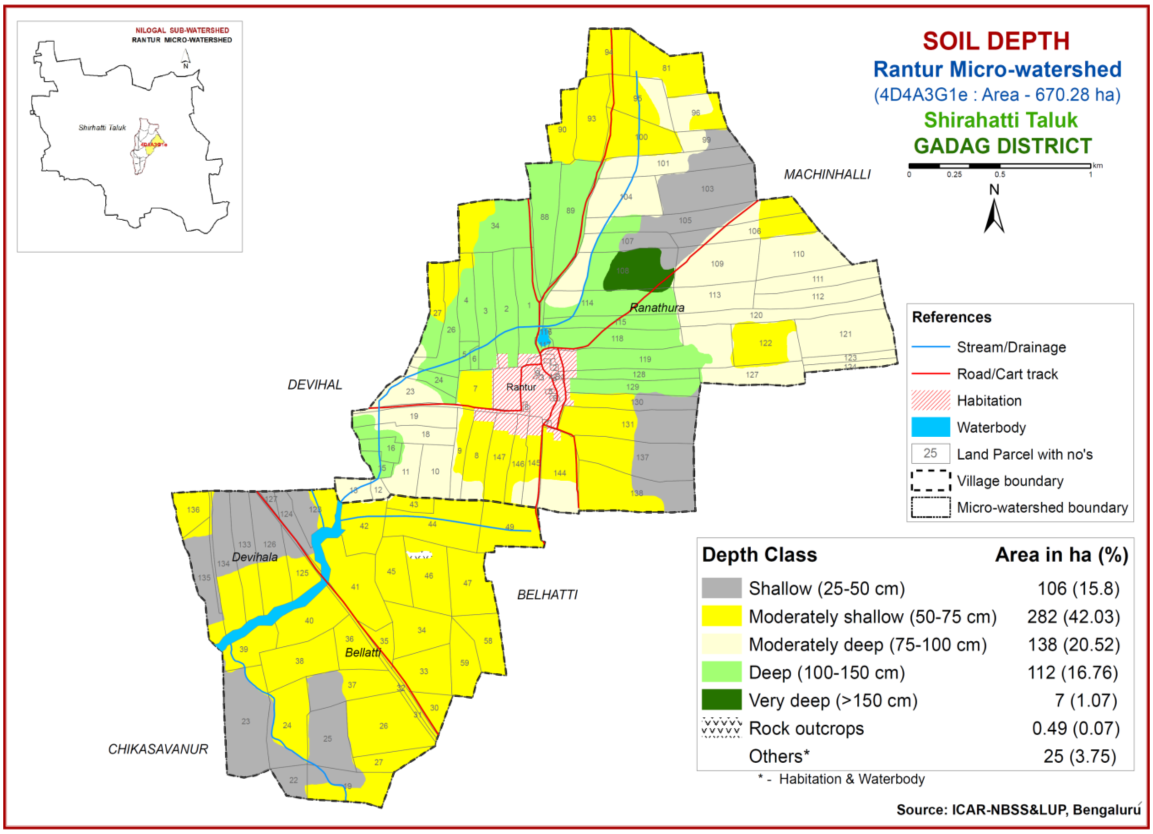


Fig. 5.2 Soil Depth map of Rantur Microwatershed

5.3 Surface Soil Texture

Texture is an expression to indicate the coarseness or fineness of the soil as determined by the relative proportion of primary particles of sand, silt and clay. It has a direct bearing on the structure, porosity, adhesion and consistence. The surface layer of a soil to a depth of about 25 cm is the layer that is most used by crops and plants. The surface soil textural class provides a guide to understanding soil-water retention and availability, nutrient holding capacity, infiltration, workability, drainage, physical and chemical behaviour, microbial activity and crop suitability.

Maximum area of 378 ha (56%) has soils that are loamy at the surface and are distributed in all parts of the microwatershed. Clay soils occupy an area of about 207 ha (31%) and occur in southern western, central and eastern part of the microwatershed. An area of about 60 ha (9%) occupy sandy soils at the surface and are distributed in northwestern and central part of the microwatershed (Fig. 5.3).

The most productive lands (87%) with respect to surface soil texture are the loamy and clayey soils that have high potential for soil-water retention and availability, and nutrient retention and availability, but have problems of drainage, infiltration, workability and other physical problems.

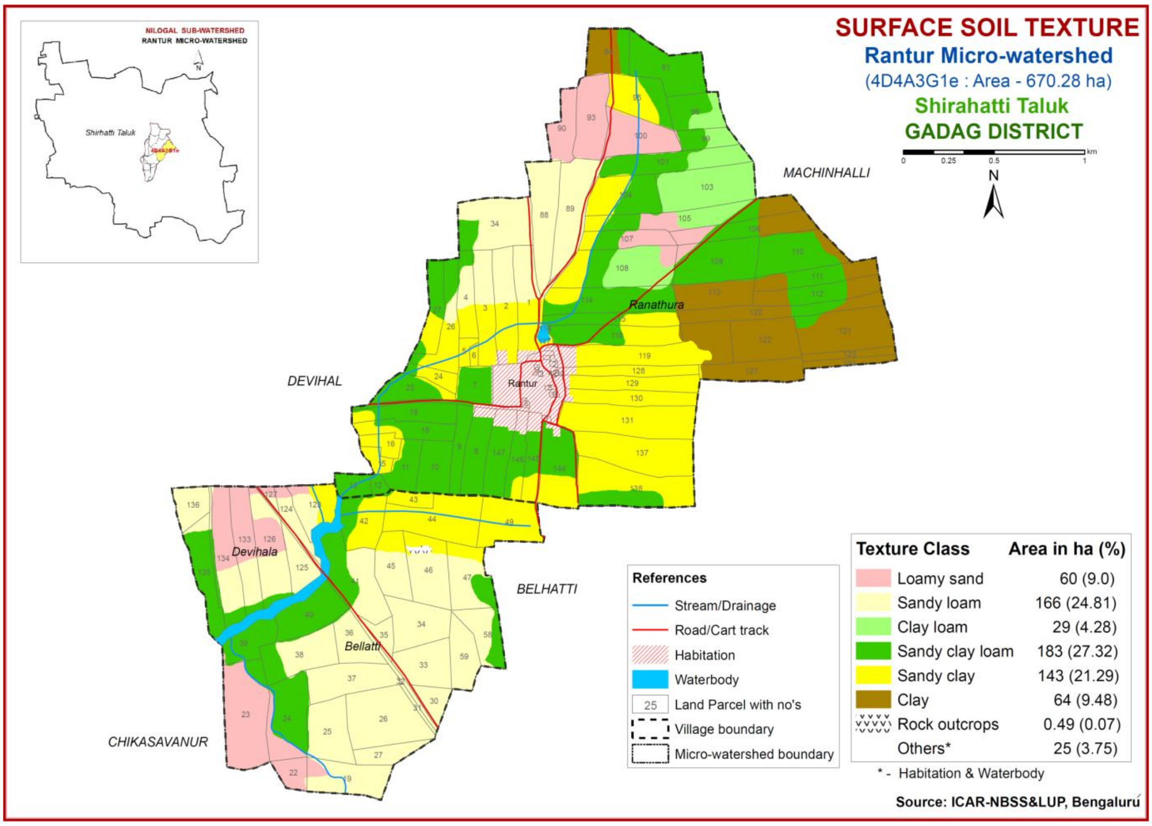


Fig. 5.3 Surface Soil Texture map of Rantur Microwatershed

5.4 Soil Gravelliness

Gravel is the term used for describing coarse fragments between 2 mm and 7.5 cm diameter and stones for those between 7.5 cm and 25 cm. The presence of gravel and stones in soil reduces the volume of soil responsible for moisture and nutrient storage, drainage, infiltration and runoff and hinders plant growth by impeding root growth and seedling emergence, intercultural operations and farm mechanization.

About 141 ha (21%) area in the microwatershed has soils that are very gravelly (35-60%) and are distributed in the northern, central, western and south-eastern part of the microwatershed (Fig. 5.4). Maximum area of 385 ha (57%) is covered by gravelly (15-35%) soils and are distributed in all parts of the microwatershed. The soils that are non-gravelly (<15%) cover an area of about 80 ha (12%) are distributed in the southwestern and northeastern part of the microwatershed.

The most productive lands with respect to gravelliness are found to be 12%. They are non-gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops. The problem soils (21%) that are very gravelly (35-60%) where only short duration crops can be grown.

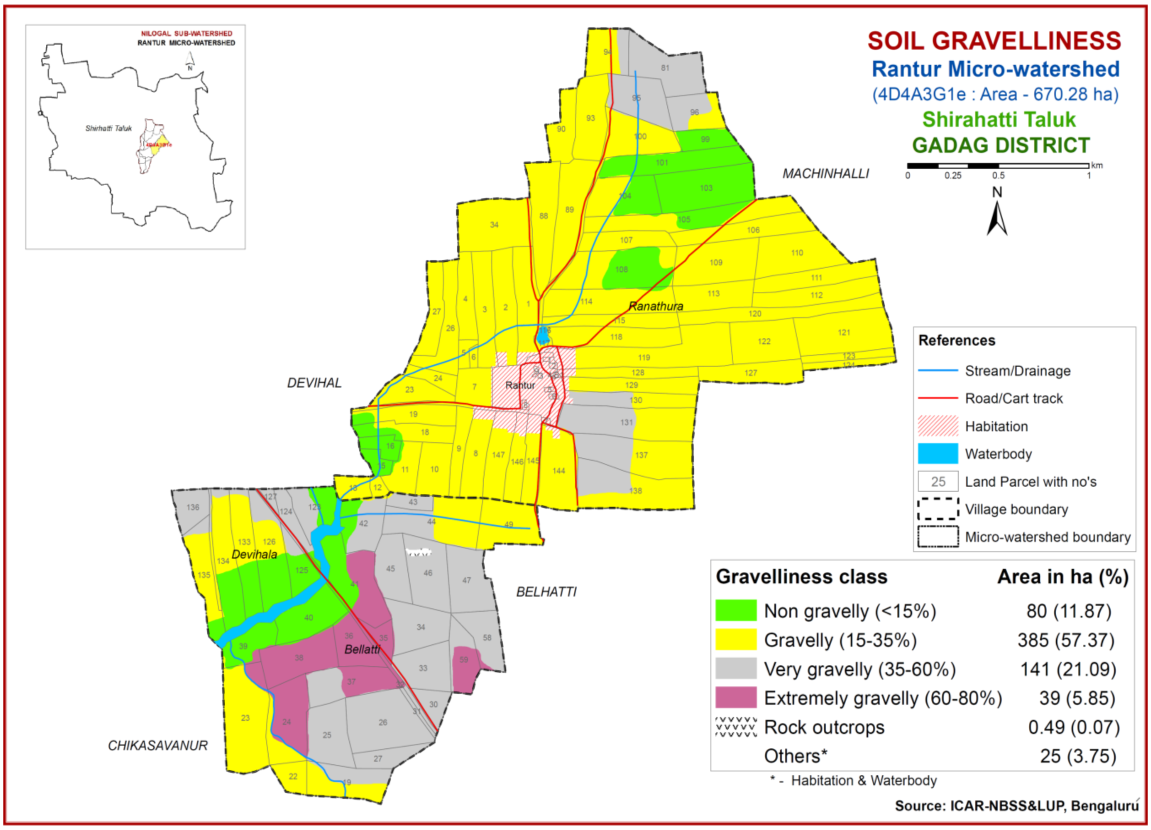


Fig. 5.4 Soil Gravelliness map of Rantur Microwatershed

5.5 Available Water Capacity

The soil available water capacity (AWC) is estimated based on the ability of the soil column to retain water between the tensions of 0.33 and 15 bar in a depth of 100 cm or the entire solum if the soil is shallower. The AWC of the soils (soil series) as estimated by considering the soil texture, mineralogy, soil depth and gravel content (Sehgal *et al.*, 1990) and accordingly the soil map units were grouped into five AWC Classes *viz,* very low (<50 mm/m), low (50-100 mm/m), medium (100-150 mm/m), high (150-200 mm/m) and very high (>200 mm/m) and using these values, an AWC map was generated (Fig. 5.5).

An area of about 196 ha (29%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and are distributed in the northeastern, southwestern and eastern parts of the microwatershed. Major area of about 253 ha (38%) has soils that are low (51-100 mm/m) in available water capacity and are distributed in the northern, south-eastern and western part of the microwatershed. An area of about 196 ha (29%) area is medium (101-150 mm/m) in available water capacity and are distributed in the eastern, central and northwestern part of the microwatershed.

An area of 449 ha (67%) in the microwatershed has soils that are problematic with regard to available water capacity. Here, only short or medium duration crops can be grown and the probability of crop failure is very high. These areas are best put to other alternative uses.

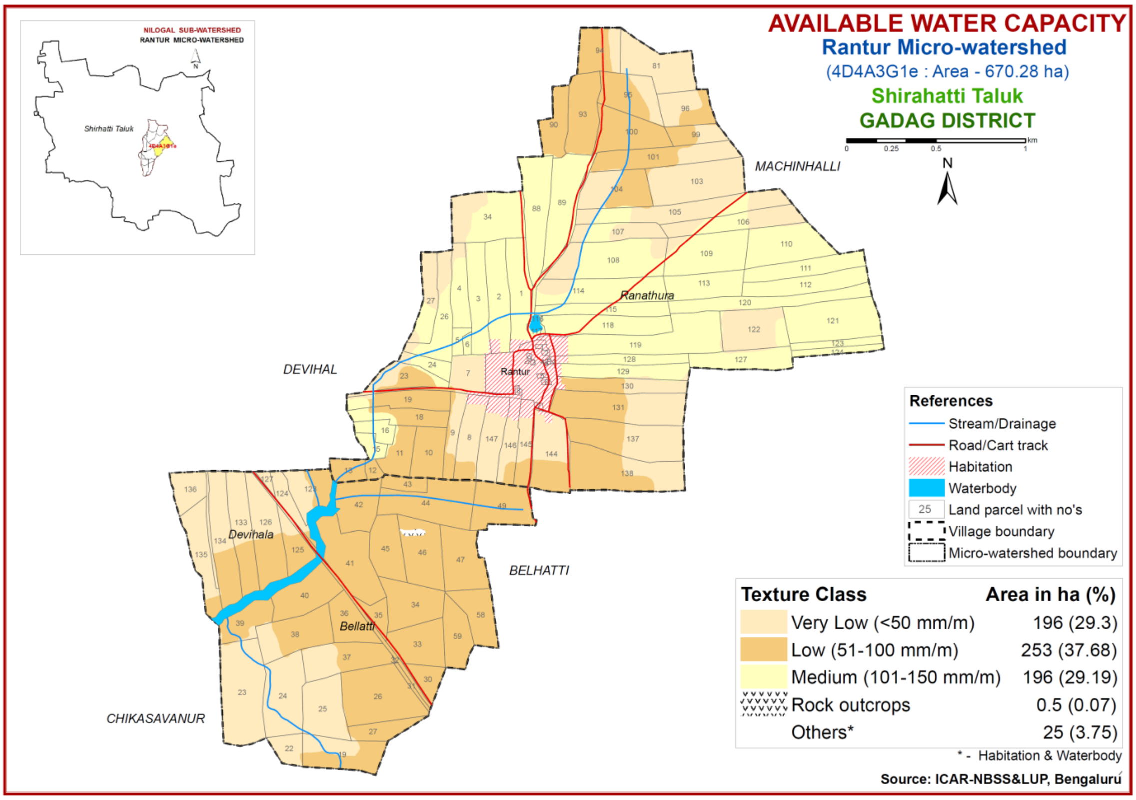


Fig. 5.5 Soil Available Water Capacity map of Rantur Microwatershed

5.6 Soil Slope

Soil slope refers to the inclination of the surface of the land. It is defined by gradient, shape and length, and is an integral feature of any soil as a natural body. Slope is considered important in soil genesis, land use and land development. The length and gradient of slope influences the rate of runoff, infiltration, erosion and deposition. The soil map units were grouped into four slope classes and a slope map was generated showing the area extent and geographic distribution of different slope classes in the microwatershed (Fig. 5.6).

An area of about 516 ha (77%) falls under very gently sloping (1-3% slope) lands and is distributed in all parts of the microwatershed. Nearly level (0-1%) lands occupy an area of about 119 ha (18%) and occur in the western, south-eastern, central and northwestern part of the microwatershed. A very small area of about 10 ha (1%) falls under gently sloping (3-5%) and are distributed in northern part of the microwatershed.

In these areas, all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

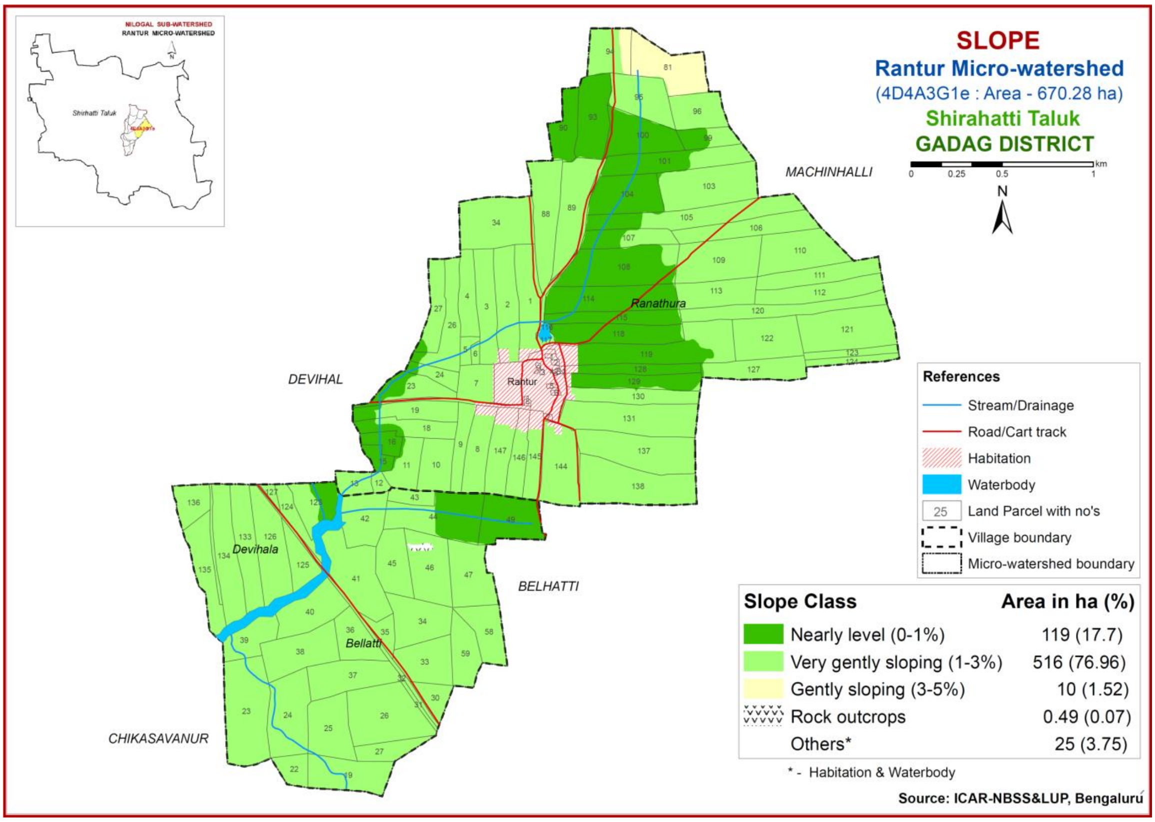


Fig. 5.6 Soil Slope map of Rantur Microwatershed

5.7 Soil Erosion

Soil erosion refers to the wearing away of the earth's surface by the forces of water, wind and ice involving detachment and transport of soil by raindrop impact. It is used for accelerated soil erosion resulting from disturbance of the natural landscape by burning, excessive grazing and indiscriminate felling of forest trees and tillage, all usually by man. The erosion classes showing an estimate of the current erosion status as judged from field observations in the form of rills, gullies or a carpet of gravel on the surface are recorded. Four erosion classes, viz, slight erosion (e1), moderate erosion (e2), severe erosion (e3) and very severe erosion (e4) are recognized. The soil map units were grouped into different erosion classes and soil erosion map generated. The area extent and their spatial distribution in the microwatershed is given in Figure 5.7.

Soils that are moderately eroded (e2 class) cover major area of about 347 ha (52%) in the microwatershed. They are distributed in all part of the microwatershed. Slightly eroded (e1 class) soils cover an area of about 298 ha (44%) and are distributed in southwestern, northwestern, central and eastern parts of the microwatershed.

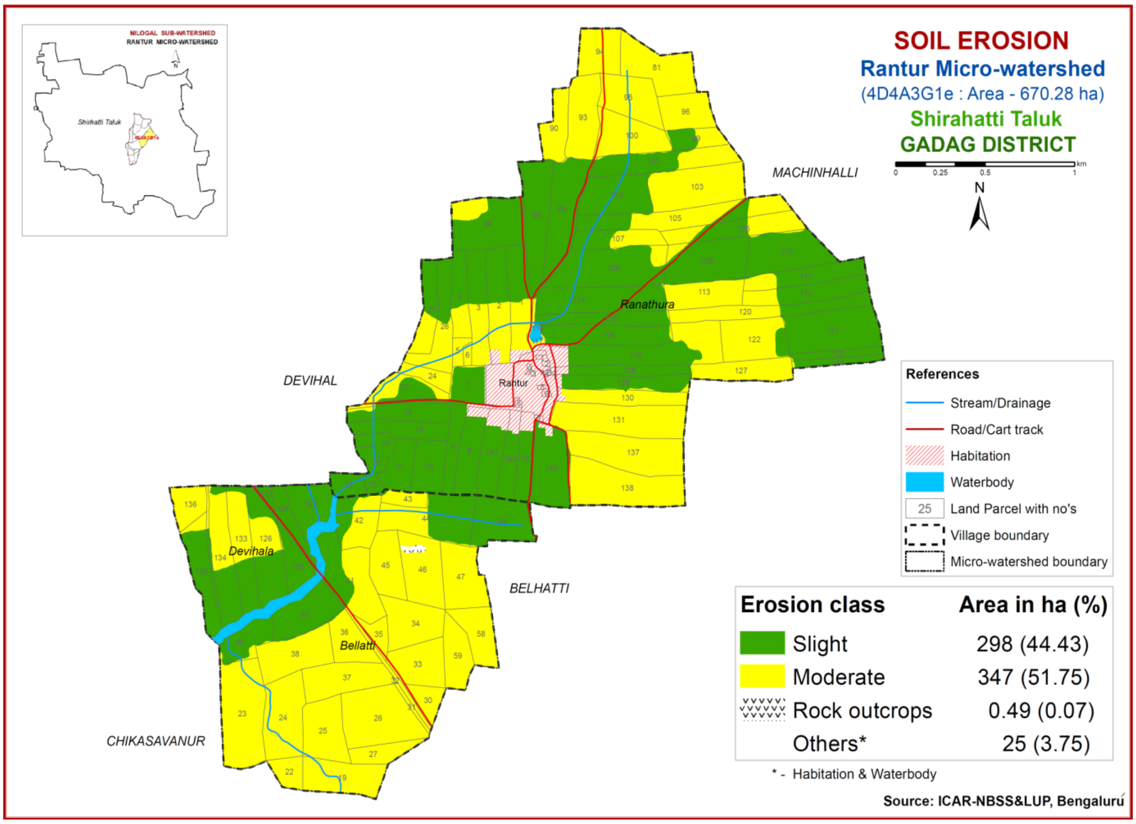


Fig. 5.7 Soil Erosion map of Rantur Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status as the area is characterised by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected from the grid points (one soil sample at every 250 m grid interval) all over the microwatershed through land resource inventory in the year 2014 were analysed for pH, EC, organic carbon, available phosphorus and potassium and for micronutrients like zinc, boron, copper, iron and manganese, and secondary nutrient sulphur.

Soil fertility data generated has been assessed and individual maps for all the nutrients for the microwatershed have been generated using kriging method under GIS. The village/survey number wise fertility data for the microwatershed is given in Appendix-II.

6.1 Soil Reaction (pH)

The soil analysis of the Rantur microwatershed for soil reaction (pH) showed that major area of about 219 ha (33%) is moderately alkaline (pH 7.8-8.4) and are distributed in the western, northeastern, south-eastern and central part of the microwatershed and 162 ha (24%) is under slightly alkaline (pH 7.3-7.8) and are distributed in northwestern, northeastern, eastern and southern part of the microwatershed. An area of about 133 ha (20%) is under strongly alkaline (pH 8.4-9.0) and is distributed in the northeastern, central and western part of the microwatershed. An area of about 116 ha (17%) is neutral (6.5-7.3) and are distributed in the northern, eastern and southwestern part of the microwatershed (Fig.6.1). A very small area of about 14 ha (2%) is slightly acidic and distributed in the western and central part of the microwatershed.

6.2 Electrical Conductivity (EC)

The Electrical Conductivity of the soils of the entire microwatershed area is <2 dSm^{-1} (Fig 6.2) and as such soils are non-saline.

6.3 Organic Carbon

The soil organic carbon (an index of available Nitrogen) content of the microwatershed is medium (0.5-0.75%) covering an area of about 238 ha (35%) and is distributed in the western, northeastern and southern part of the microwatershed. Major area of 334 ha (50%) is low (<0.5%) in organic carbon content and is distributed in the all parts of the microwatershed. An area of about 73 ha (11%) is high (>0.75%) in organic carbon content and occur in the northeastern and northwestern part of the microwatershed (Fig.6.3).

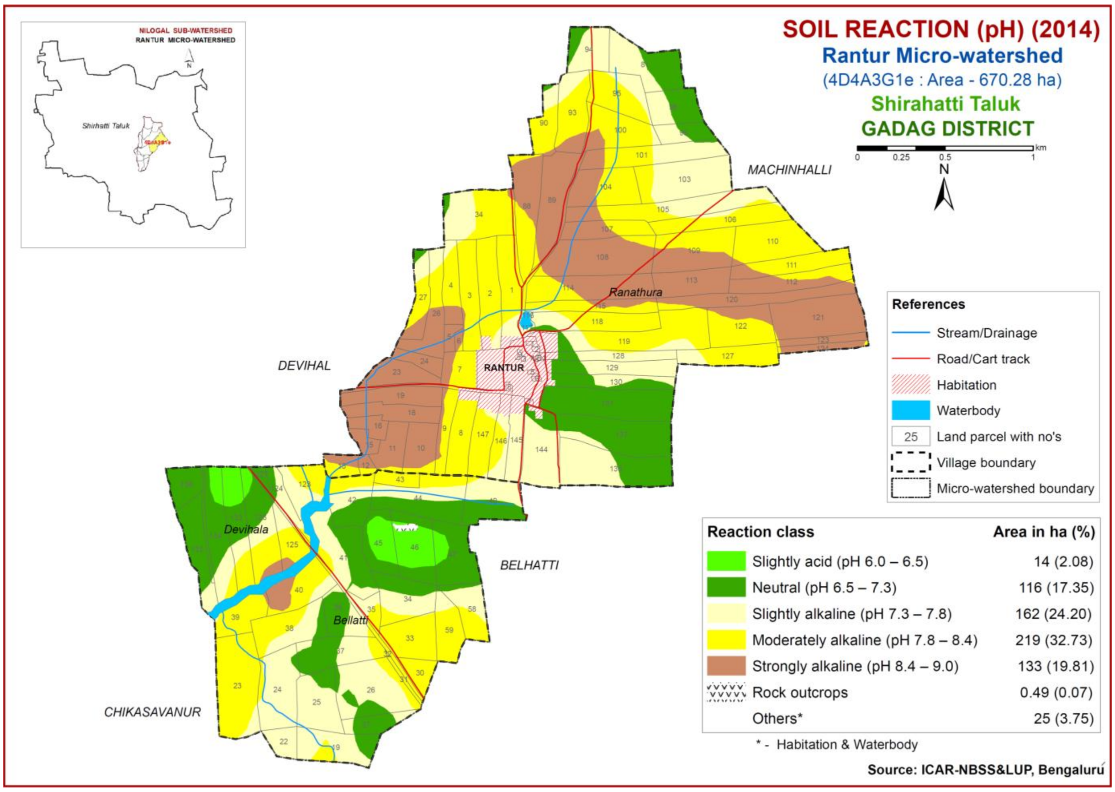


Fig.6.1 Soil Reaction (pH) map of Rantur Microwatershed

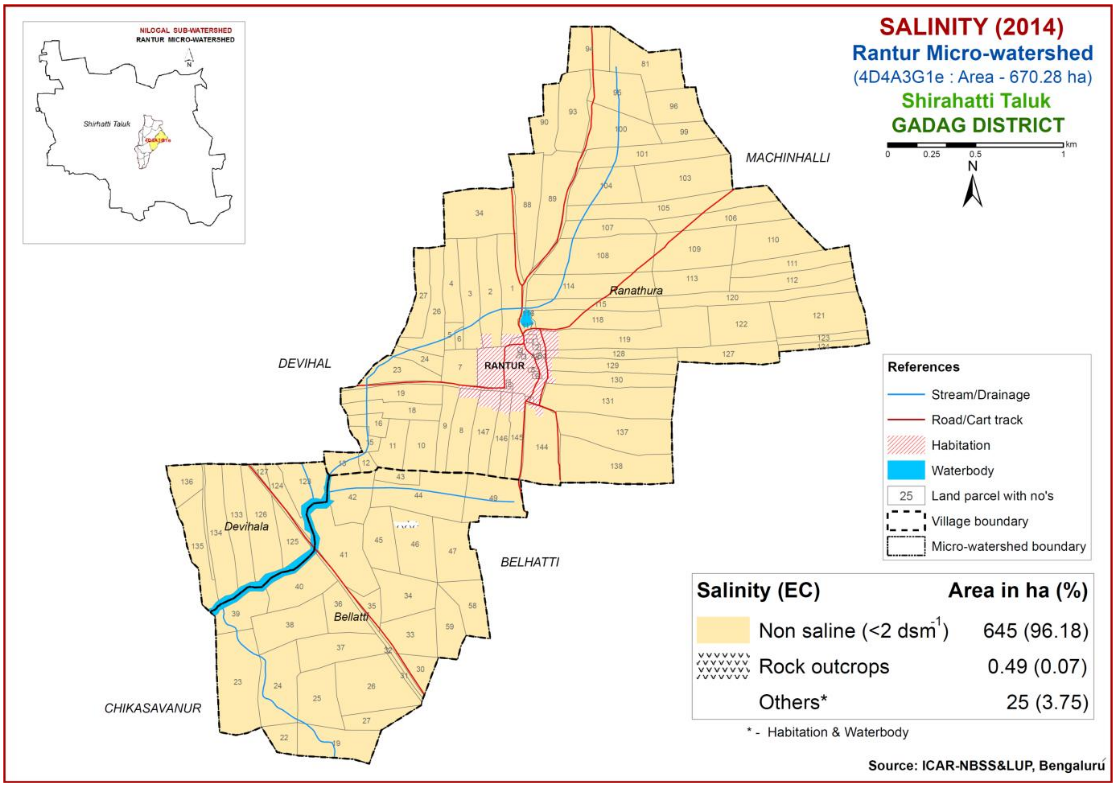


Fig.6.2 Electrical Conductivity (EC) map of Rantur Microwatershed

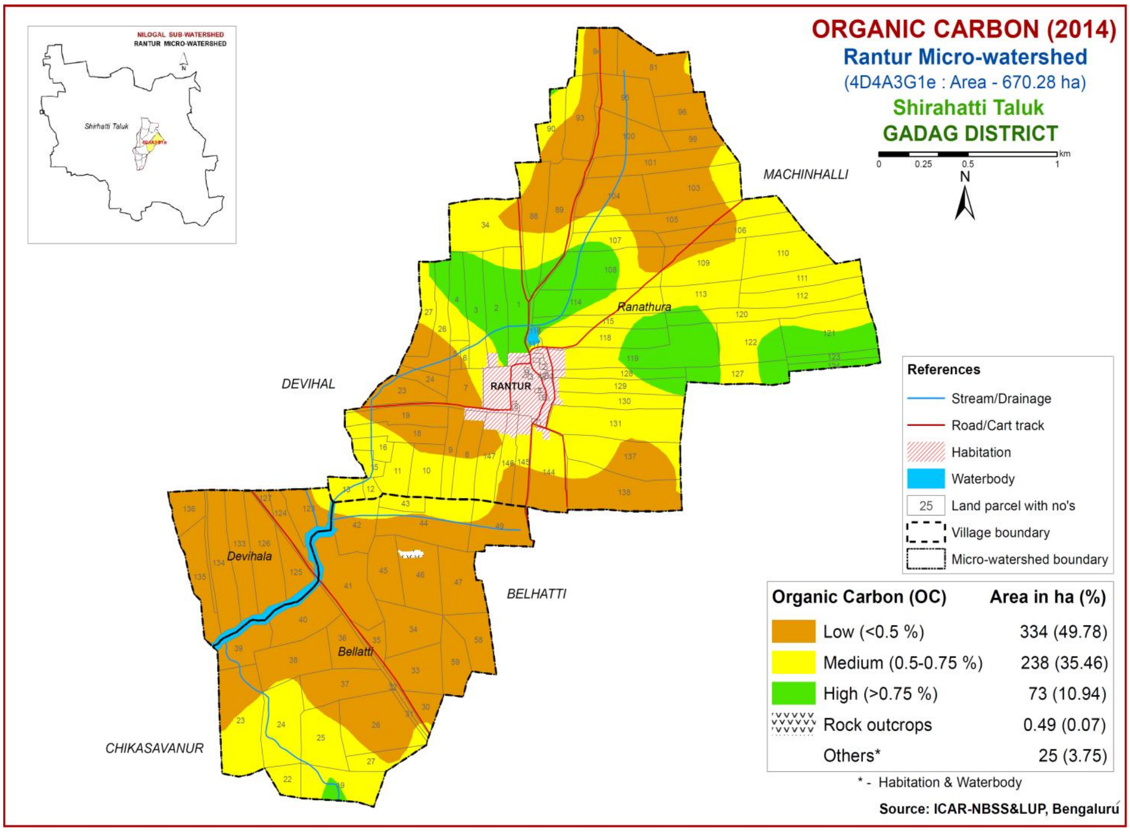


Fig.6.3 Soil Organic Carbon map of Rantur Microwatershed

6.4 Available Phosphorus

Available phosphorus content is low (<23 kg/ha) in maximum area of about 504 ha (75%) and occur in all parts of the microwatershed area. An area of about 140 ha (21%) is medium (23-57 kg/ha*)* and are distributed in the northwestern, central and south-eastern part of the microwatershed (Fig 6.4).

6.5 Available Potassium

Available potassium content is medium (145-337 kg/ha) in maximum area of about 512 ha (76%) and is distributed in all parts of the microwatershed (Fig.6.5). An area of 133 ha (20%) is high (>337 kg/ha) and is distributed in the northern part of the microwatershed.

6.6 Available Sulphur

Maximum area of about 382 ha (57%) is medium (10-20 ppm) in available sulphur and is distributed in all parts of the microwatershed followed by 210 ha (31%) is low in available sulphur and distributed in the western, south-eastern and northeastern part of the microwatershed. An area of about 53 ha (8%) is high (>20 ppm) in available sulphur and are distributed in small patches in the central and western part of the microwatershed (Fig.6.6).

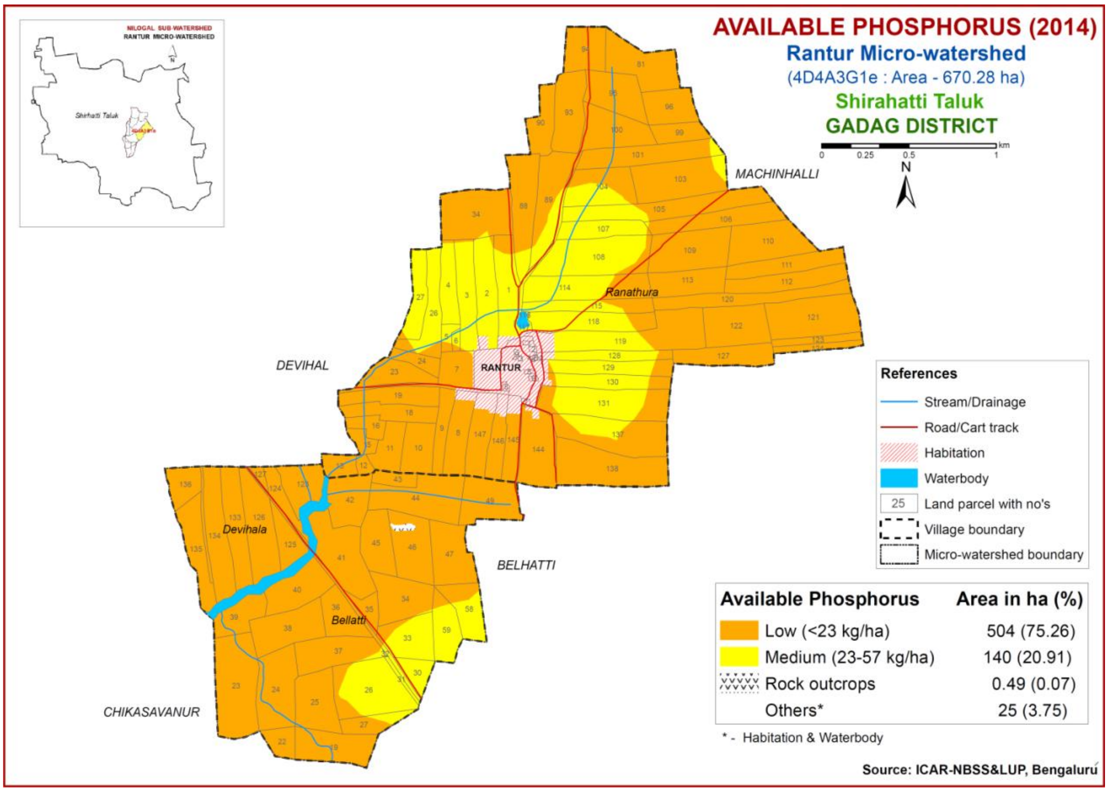


Fig.6.4 Soil Available Phosphorus map of Rantur Microwatershed

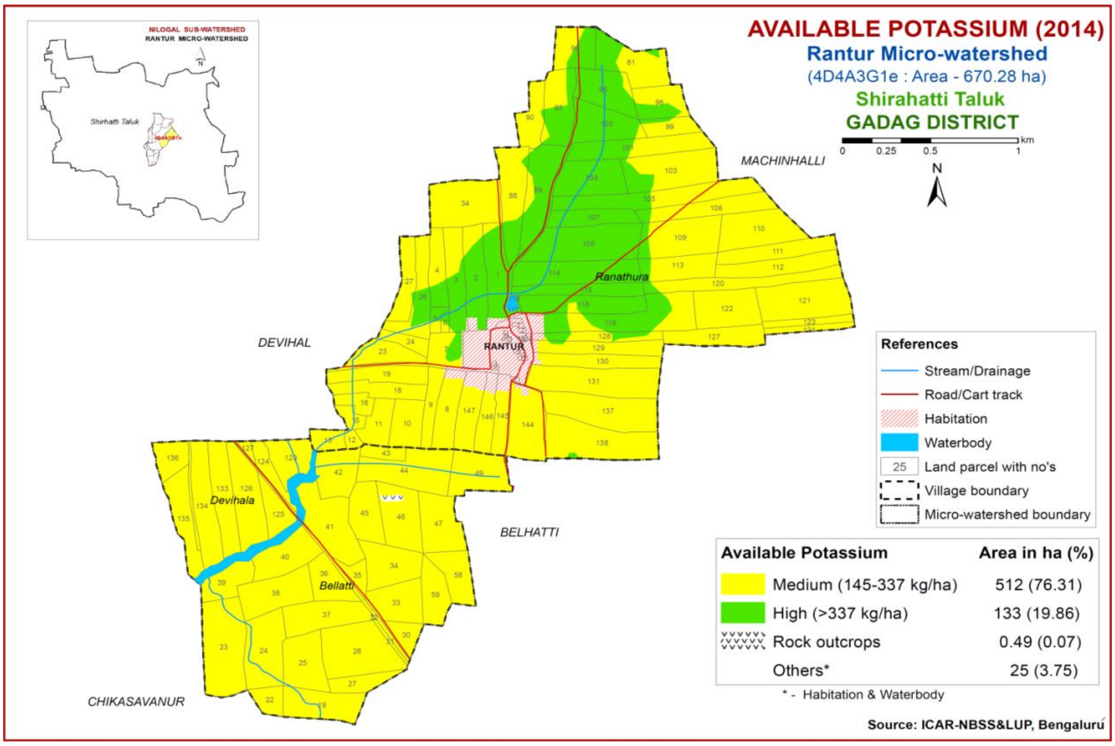


Fig.6.5 Soil Available Potassium map of Rantur Microwatershed

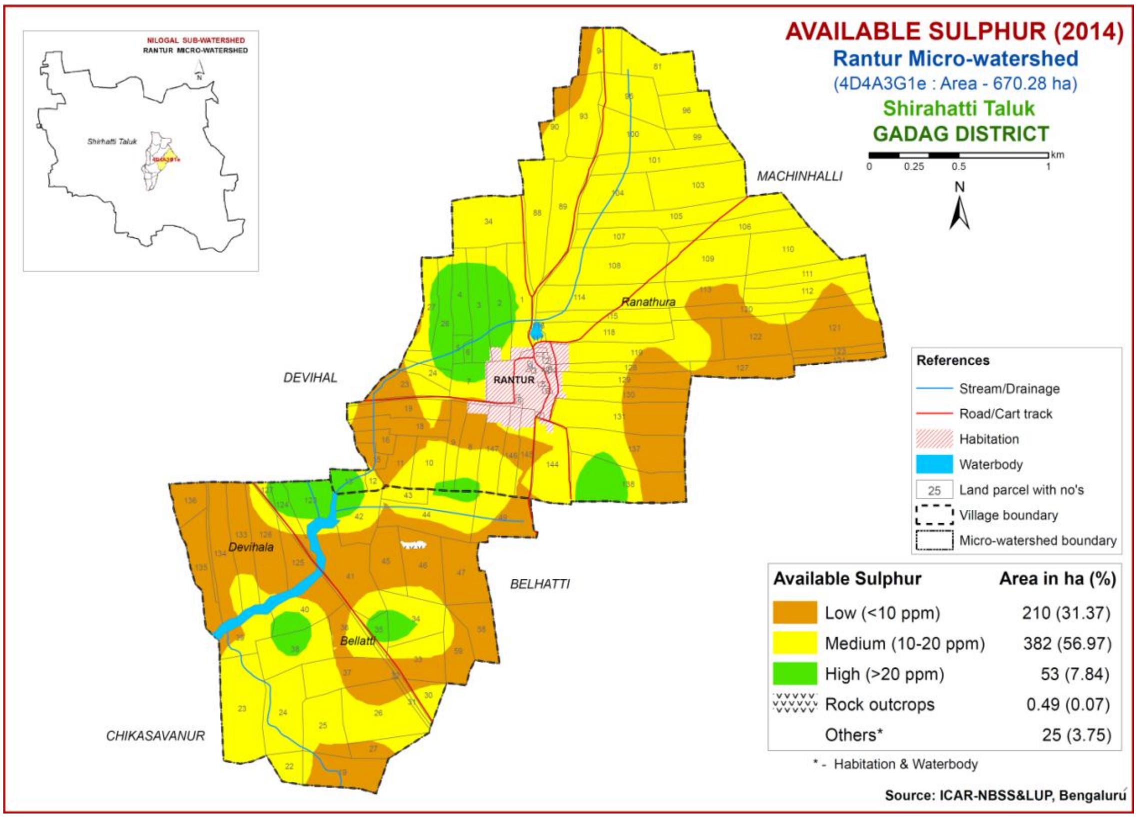


Fig.6.6 Soil Available Sulphur map of Rantur Microwatershed

6.7 Available Boron

Available boron content is medium (0.5-1.0 ppm) in an area of 294 ha (44%) in the microwatershed and is distributed in the southern, western and central part of the microwatershed. Maximum area of about 349 ha (52%) is low (<0.5 ppm) in available boron and is distributed all parts of the microwatershed (Fig.6.7). Available boron is high (>1.0 ppm) in a very small area of about 2 ha (<1%) and is distributed in the western part of the microwatershed.

6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in maximum area of 388 ha (58%) and is distributed in all parts of the microwatershed. About 257 ha (38%) area is deficient (<4.5 ppm) in available iron content and is distributed in the central, northwestern and south-eastern part of the microwatershed (Fig 6.8).

6.9 Available Manganese

Available manganese content is sufficient (>1.0 ppm) in the entire microwatershed area (Fig 6.9).

6.10 Available Copper

Available copper content is sufficient (>0.2 ppm) in the entire microwatershed area (Fig 6.10).

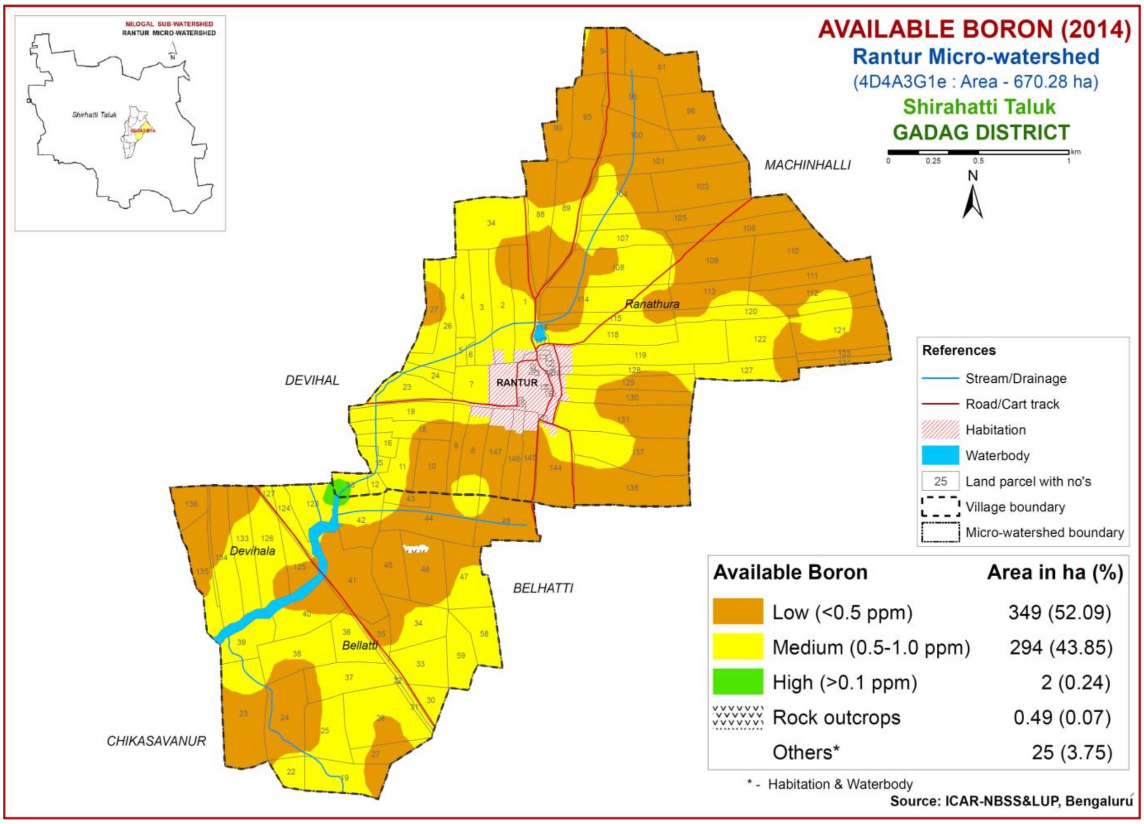


Fig.6.7 Soil Available Boron map of Rantur Microwatershed

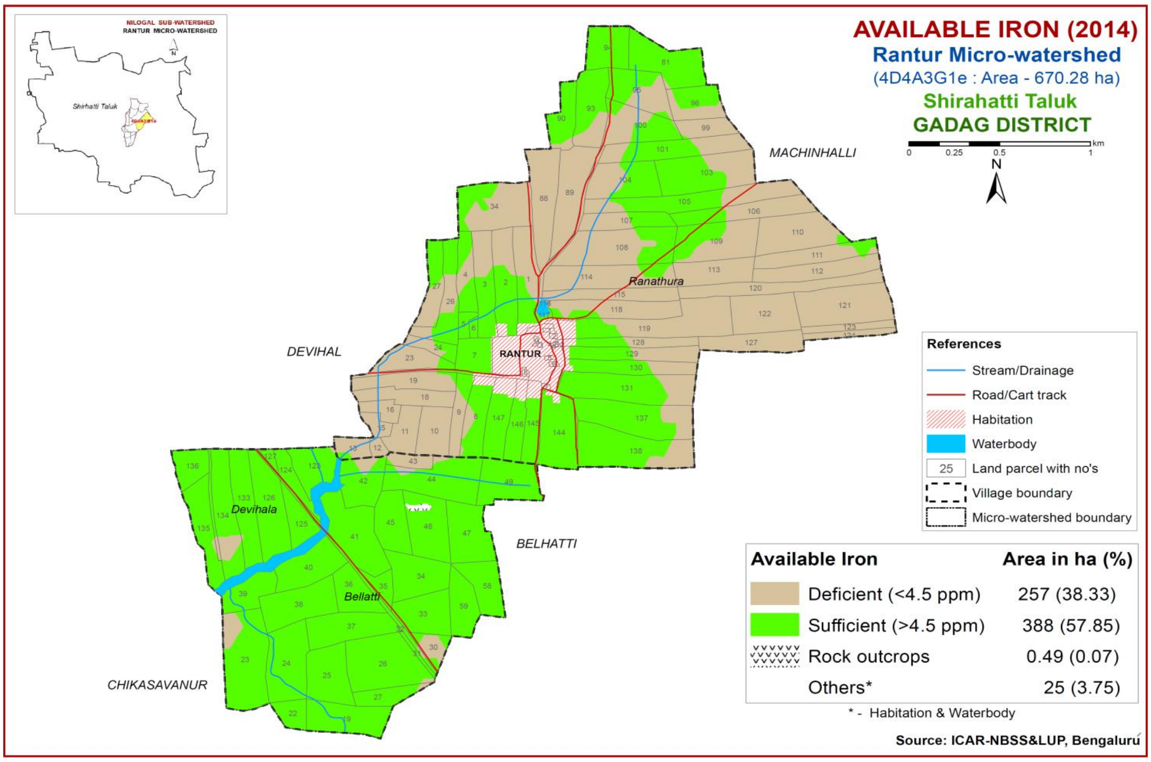


Fig.6.8 Soil Available Iron map of Rantur Microwatershed

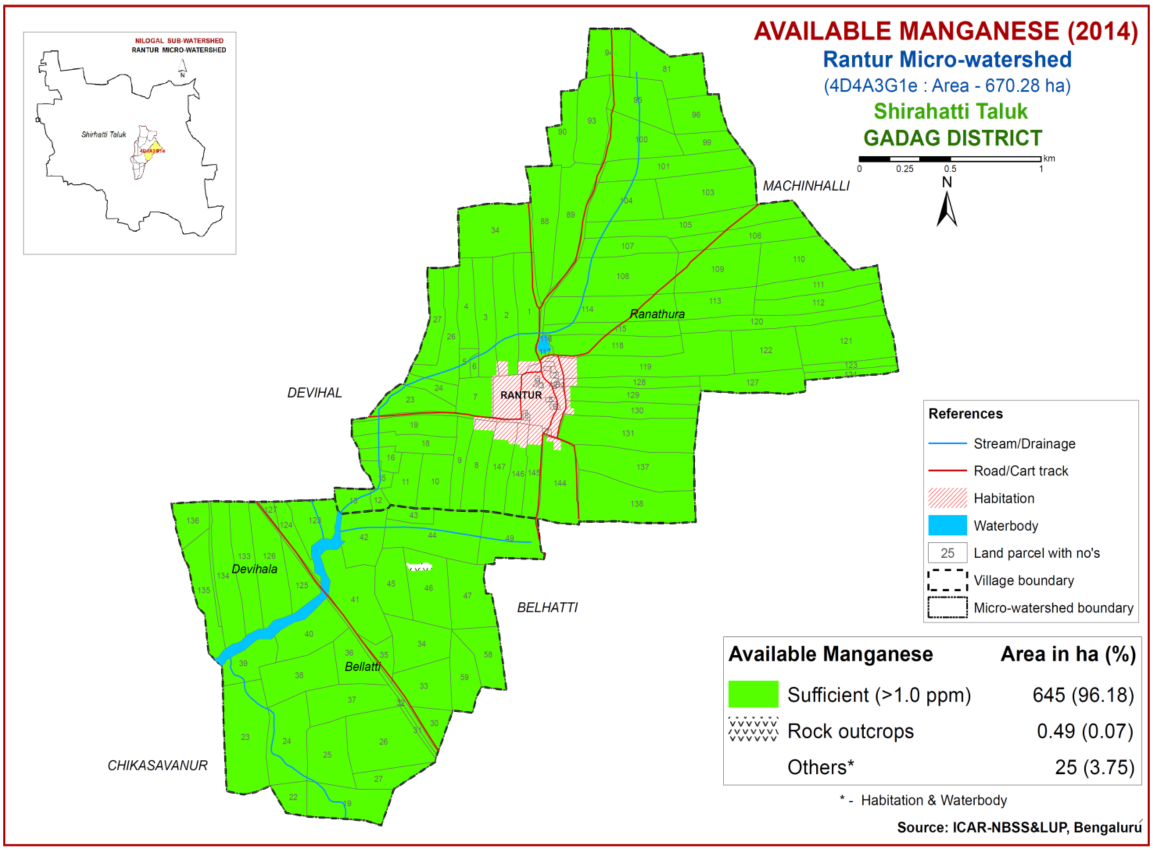


Fig.6.9 Soil Available Manganese map of Rantur Microwatershed

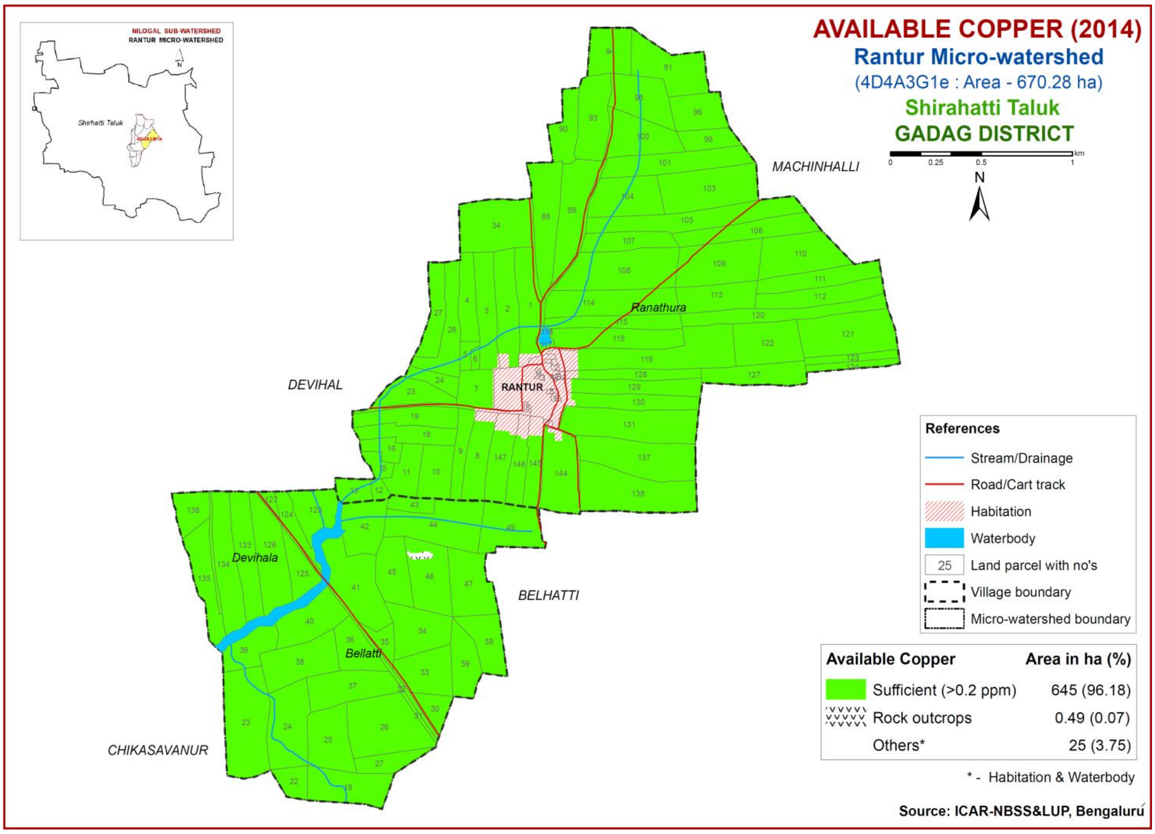


Fig.6.10 Soil Available Copper map of Rantur Microwatershed

6.11 Available Zinc

Available zinc content is deficient (<0.6 ppm) in an area of 599 ha (89%) and are distributed in all parts of the microwatershed area (Fig 6.11). An area of about 45 ha (7%) is sufficient (>0.6ppm) in iron content and occur in the central part of the microwatershed area.

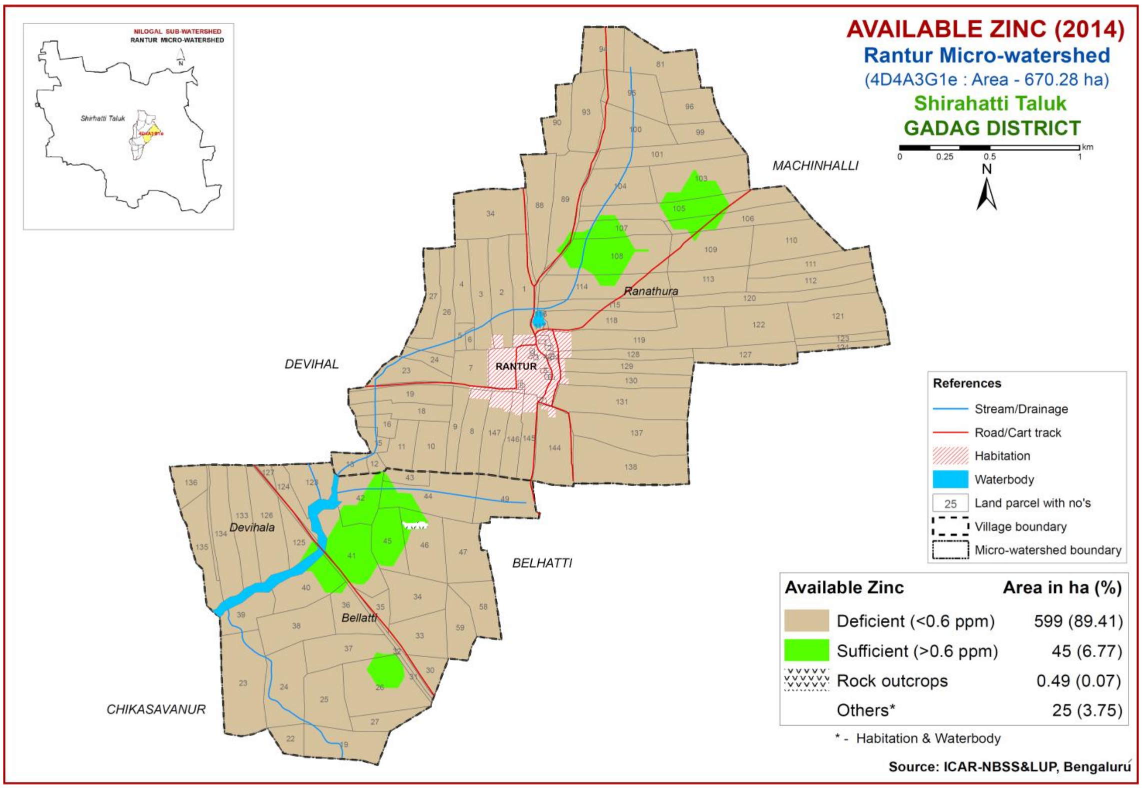


Fig.6.11 Soil Available Zinc map of Rantur Microwatershed

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Rantur Microwatershed were assessed for their suitability for growing food, fodder, fibre and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S- Suitable and Order N- Not suitable. The orders have classes, subclasses and units. Order-S has three classes, class S1- Highly Suitable, class S2- Moderately Suitable and class S3- Marginally Suitable. Order N has two classes, N1- Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, 'z' for calcareousness and 'w' for drainage. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable land with the limitations of soil depth and erosion is designated as S2re. For the microwatershed, the soil mapping units were evaluated and classified up to subclass level.

Using the above criteria, the soil map units of the microwatershed were evaluated and land suitability maps for 23 major agricultural and horticultural crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-III.

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

Sorghum is one of the major crops grown in Karnataka in an area of 10.47 lakh ha in Bijapur, Gulbarga, Raichur, Bidar, Belgaum, Dharwad, Bellary, Chitradurga, Mysore and Chamarajanagar districts. The crop requirements for growing sorghum (Table 7.2) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing sorghum was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure. 7.1.

Highly suitable (Class S1) land occupy an area of about 118 ha (18%) for growing sorghum and occur in the western, central and northeastern part of the microwatershed. An area of about 204 ha (30%) is moderately suitable (Class S2) for growing sorghum and are distributed in the northern, southern, central and south-eastern part of the microwatershed.

Table 7.1 Soil-Site Characteristics of Rantur Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drainage Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC	ESP	CEC [Cmol (p+)kg-1]	BS (%)
					Sur-face	Sub-surface	Surface (%)	Sub surface (%)								
CKMhA1	633	150	WD	75-100	scl	sc	-	-	100-150	0-1	slight					
CKMiB1g1	633	150	WD	75-100	sc	sc	15-35	-	100-150	1-3	slight					
CSRbB1g2	633	150	WD	25-50	ls	scl	35-60	<15	50-100	1-3	slight					
CSRbB2g1	633	150	WD	25-50	ls	scl	15-35	<15	50-100	1-3	moderate					
GHThB1g1	633	150	WD	75-100	scl	scl	15-35	15-35	100-150	1-3	slight					
HDHhA2g1	633	150	WD	75-100	scl	scl-sc	15-35	>35	50-100	0-1	moderate					
HDHhB2g2	633	150	WD	75-100	scl	scl-sc	35-60	>35	50-100	1-3	moderate					
HDHiA1g1	633	150	WD	75-100	sc	scl-sc	15-35	>35	50-100	0-1	slight					
HNHhB1	633	150	WD	50-75	scl	sc	-	-	100-150	1-3	slight					
HNHiA1	633	150	WD	50-75	sc	sc	-	-	100-150	0-1	slight					
HRVbB2g1	633	150	WD	25-50	ls	scl	15-35	>35	<50	1-3	moderate					
HRVcB1g2	633	150	WD	25-50	sl	scl	35-60	>35	<50	1-3	slight					
JLGmB1g1	633	150	WD	75-100	c		15-35			1-3	slight					
KGHcB1	633	150	WD	50-75	sl	scl	-	15-35	100-150	1-3	slight					
KGHcB2g1	633	150	WD	50-75	sl	scl	15-35	15-35	100-150	1-3	moderate					
KGHcB2g3	633	150	WD	50-75	sl	scl	60-80	15-35	100-150	1-3	moderate					
KGHiB2g2	633	150	WD	50-75	sc	scl	35-60	15-35	100-150	1-3	moderate					
KGPcB2g2	633	150	WD	25-50	sl	scl-sc	35-60	15-35	50-100	1-3	moderate					
KGPfB2g2	633	150	WD	25-50	cl	scl-sc	35-60	15-35	50-100	1-3	moderate					
KGPiB2g1	633	150	WD	25-50	sc	scl-sc	15-35	15-35	50-100	1-3	moderate					
KKRhB1g1	633	150	WD	75-100	scl	cl-sc	15-35	-	100-150	1-3	slight					
KKRmB2g1	633	150	WD	75-100	c	cl-sc	15-35	-	100-150	1-3	moderate					
KMHcB1g1	633	150	WD	100-150	sl	scl-sc	15-35	<15	150-200	1-3	slight					
KMHiA1g1	633	150	WD	100-150	sc	scl-sc	15-35	<15	150-200	0-1	slight					
KNHhB1g1	633	150	WD	25-50	scl	sc	15-35	<15	50-100	1-3	slight					

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drainage Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC	ESP	CEC [Cmol (p+)kg-1]	BS (%)
					Sur-face	Sub-surface	Surface (%)	Sub surface (%)								
KTPcB2g2	633	150	WD	50-75	sl	scl	35-60	15-35	100-150	1-3	moderate					
KTPhB2g2	633	150	WD	50-75	scl	scl	35-60	15-35	100-150	1-3	moderate					
KTPiA1g1	633	150	WD	50-75	sc	scl	15-35	15-35	100-150	0-1	slight					
KTPiB2g2	633	150	WD	50-75	sc	scl	35-60	15-35	100-150	1-3	moderate					
KTPmB2g1	633	150	WD	50-75	c	scl	15-35	15-35	100-150	1-3	moderate					
LKRcB2g1	633	150	WD	50-75	sl	scl-sc	15-35	40-60	50-100	1-3	moderate					
LKRhB1g1	633	150	WD	50-75	scl	scl-sc	15-35	40-60	50-100	1-3	slight					
LKRhB2g3	633	150	WD	50-75	scl	scl-sc	60-80	40-60	50-100	1-3	moderate					
LKRhC2g2	633	150	WD	50-75	scl	scl-sc	35-60	40-60	50-100	3-5	moderate					
LKRmB2g1	633	150	WD	50-75	c	scl-sc	15-35	40-60	50-100	1-3	moderate					
MKHcB2g2	633	150	WD	50-75	sl	scl	35-60	>35	50-100	1-3	moderate					
MKHhB1g1	633	150	WD	50-75	scl	scl	15-35	>35	50-100	1-3	slight					
MKHmB2g1	633	150	WD	50-75	c	scl	15-35	>35	50-100	1-3	moderate					
MRDfA1	633	150	MWD	>150	cl		-	-	100-150	0-1	slight					
TDHbA2g1	633	150	WD	50-75	ls	sc-c	15-35	-	100-150	0-1	moderate					
TDHfB2g1	633	150	WD	50-75	ls	sc-c	15-35	-	100-150	1-3	moderate					
TDHhB2g1	633	150	WD	50-75	scl	sc-c	15-35	-	100-150	1-3	moderate					
VDHhA1g1	633	150	WD	100-150	scl	sc-c	15-35	-	150-200	0-1	slight					
VDHiA1	633	150	WD	100-150	sc	sc-c	-	-	150-200	0-1	slight					
VDHiB2g1	633	150	WD	100-150	sc	sc-c	15-35	-	150-200	1-3	moderate					

*Symbols and abbreviations are according to Field Guide for LRI under Sujala-III Project, Karnataka

They have minor limitations of gravelliness and rooting depth. Marginally suitable lands (Class S3) for growing sorghum occupy major area of about 283 ha (42%) and occur in all parts of the microwatershed with moderate limitations of gravelliness and rooting depth. A small area of about 39 ha (6%) is not suitable for growing sorghum and are distributed in the central and very small patch in the south-eastern part of the microwatershed with severe limitation of gravelliness.

Table 7.2 Crop suitability criteria for Sorghum

Crop requirement		Rating			
Soil –site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Slope	%	2-3	3-8	8-15	>15
LGP	Days	120-150	120-90	<90	
Soil drainage	Class	Well to mod. Well drained	imperfect	Poorly/excessively	V.poorly
Soil reaction	pH	6.0-8.0	5.5-5.9,8.1-8.5	<5.5,8.6-9.0	>9.0
Surface soil texture	Class	c, cl, sicl, sc	l, sil, sic	Sl, ls	S,fragmental skeletal
Soil depth	Cm	100-75	50-75	30-50	<30
Gravel content	% vol.	5-15	15-30	30-60	>60
Salinity (EC)	dSm^{-1}	2-4	4-8	8-10	>10
Sodicity (ESP)	%	5-8	8-10	10-15	>15

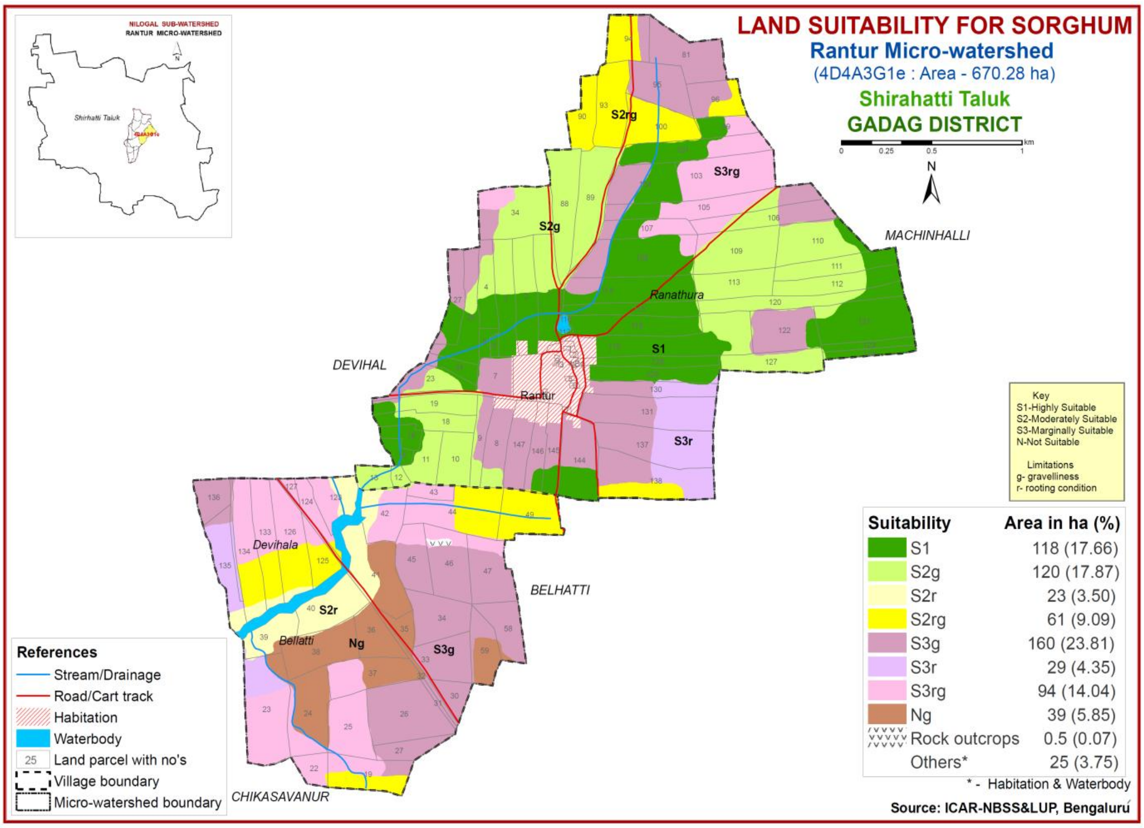


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

Maize is the most important food crop grown in an area of 13.37 lakh ha in almost all the districts of the State. The crop requirements for growing maize (Table 7.3) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing maize was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.2.

Table 7.3 Crop suitability criteria for Maize

Crop requirement		Rating			
Soil–site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Slope	%	<3	3.5	5-8	
LGP	Days	>100	100-80	60-80	
Soil drainage	Class	Well drained	Mod. to imperfectly	Poorly/excessively	V.poorly
Soil reaction	pH	5.5-7.5	7.6-8.5	8.6-9.0	
Surface soil texture	Class	l, cl, scl, sil	Sl, sicl, sic	C(s-s), ls	S,fragmental
Soil depth	Cm	>75	50-75	25-50	<25
Gravel content	% vol.	<15	15-35	35-50	>50
Salinity (EC)	dSm^{-1}	<1.0	1.0-2.0	2.0-4.0	
Sodicity (ESP)	%	<10	10-15	>15	

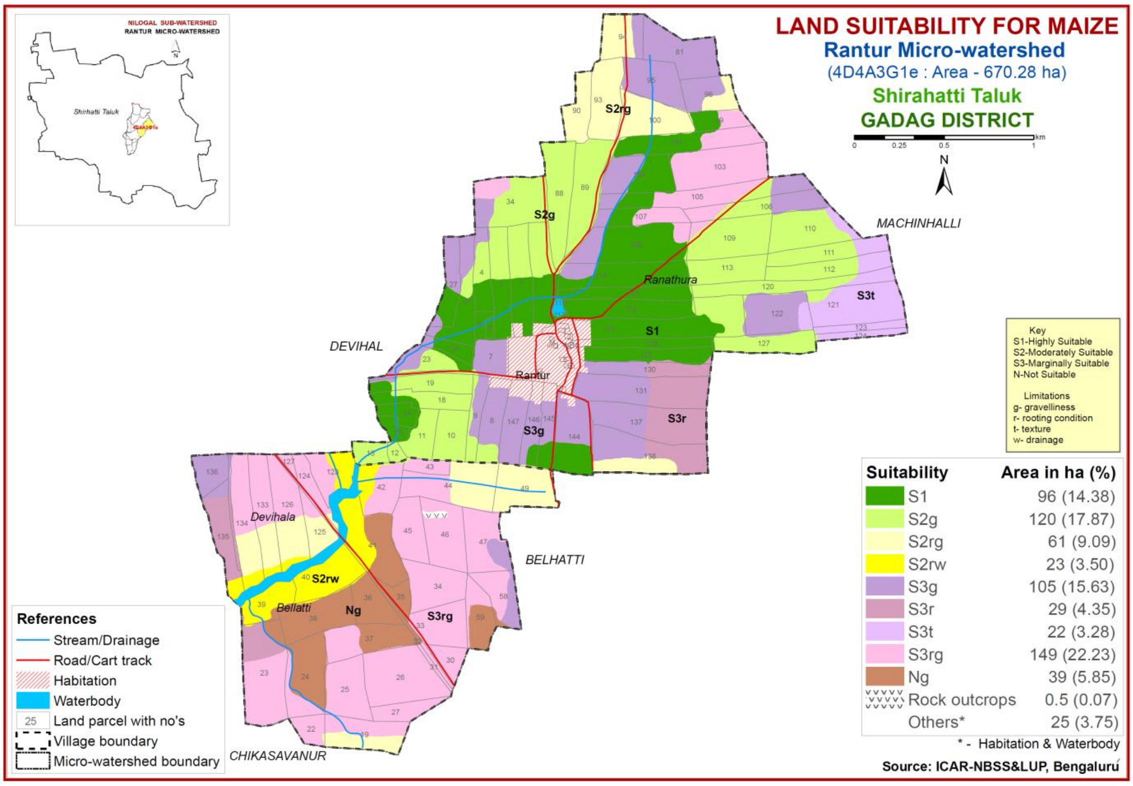


Fig. 7.2 Land Suitability map of Maize

An area of about 96 ha (14%) is highly suitable (Class S1) for growing maize and are distributed in the western, central and south-eastern part of the microwatershed.

Moderately suitable (Class S2) lands occupy an area of about 204 ha (30%) and are distributed in the western and northeastern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and wetness. Marginally suitable (Class S3) lands cover a maximum area of about 305 ha (45%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, rooting depth and texture. An area of about 39 ha (6%) is not suitable (Class N) for growing maize and distributed in the central and a very small patch in the south-eastern part of the microwatershed with severe limitation of gravelliness.

7.3 Land Suitability for Cotton (*Gossypium hirsutum*)

Cotton is the most important fibre crop grown in the State in about 6.6 lakh ha area in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and Chamarajanagar districts. The crop requirements for growing cotton (Table 7.4) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cotton was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.3.

Table 7.4 Crop suitability criteria for Cotton

Crop requirement		Rating			
Soil–site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Slope	%	1-2	2-3	3-5	>5
LGP	Days	180-240	120-180	<120	
Soil drainage	Class	Well to mod.well	Imperfectly drained	Poor some what excessive	Stagnant/ Excessive
Soil reaction	pH	6.5-7.5	7.6-8.0	8.1-9.0	>9.0>6.5
Surface soil texture	Class	Sic, c	Sicl, cl	Si,sil,sc,scl,l	Sl, s,ls
Soil depth	cm	100-150	60-100	30-60	<30
Gravel content	% vol.	<5	5-10	10-15	15-35
$CaCO_3$ in root zone	%	<3	3-5	5-10	10-20
Salinity (EC)	dSm^{-1}	2-4	4.0-8.0	8.0-12	>12
Sodicity (ESP)	%	5-10	10-20	20-30	>30

Highly suitable (Class S1) lands occupy an area of about 119 ha (18%) and are distributed in the central and northwestern part of the microwatershed. An area of about 203 ha (30%) has soils that are moderately suitable (Class S2) with minor limitations of rooting depth and gravelliness. They are distributed in the northern, northeastern, central, eastern and western part of the microwatershed. The marginally suitable (Class S3) lands cover a maximum area of about 282 ha (42%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 39 ha (6%) is not suitable (Class N) and occur in the central and very small patch in the south-eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

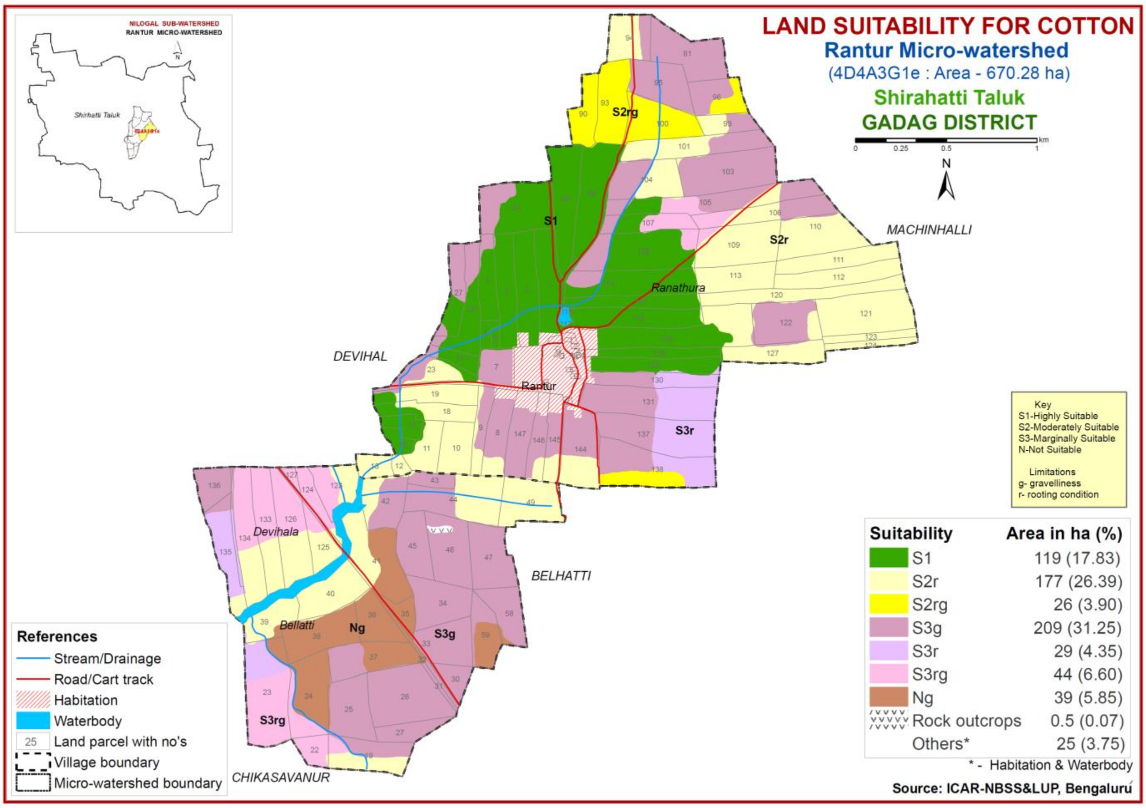


Fig. 7.3 Land Suitability map of Cotton

7.4 Land Suitability for Sunflower (*Helianthus annus*)

Sunflower is the most important oilseed crop grown in an area of 3.56 lakh ha in the State in all the districts. The crop requirements for growing sunflower (Table 7.5) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sunflower was generated (Fig. 7.4). The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Table 7.5.

Table 7.5 Land suitability criteria for Sunflower

Crop requirement		Rating			
Soil -site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Slope	%	<3	3-5	5-10	>10
LGP	Days	>90	80-90	70-80	<70
Soil drainage	Class	Well drained	Mod. well rained	imperfectly drained	Poorly drained
Soil reaction	pH	6.5-8.0	8.1-8.5 5.5-6.4	8.6-9.0; 4.5-5.4	>9.0 <4.5
Sub Surface soil texture	Class	l, cl, sil, sc	cl, sic, c,	c (>60%), sl	ls, s
Soil depth	cm	>100	75-100	50-75	<50
Gravel content	% vol.	<15	15-35	35-60	>60
Salinity (EC)	dsm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

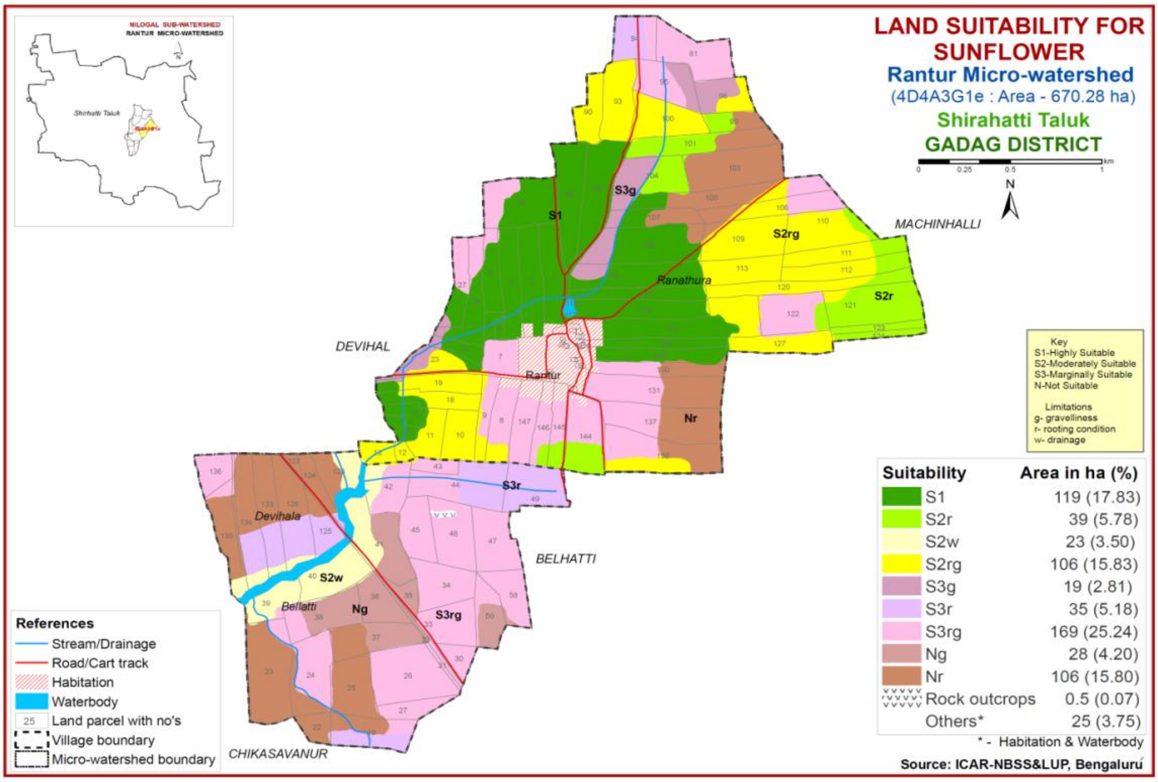


Fig. 7.4 Land Suitability map of Sunflower

Highly suitable (Class S1) lands occupy an area of about 119 ha (18%) for growing sunflower and occur in the northwestern and central part of the microwatershed. Moderately suitable (Class 2) lands occupy an area of about 168 ha (25%) and are distributed in the northern, northeastern, eastern and western part of the microwatershed with minor limitations of rooting depth, wetness and gravelliness. Maximum area of about 223 ha (33%) is marginally suitable (Class S3) and are distributed in all parts of the microwatershed. They have moderate limitations of rooting depth and rooting depth. An area of about 134 ha (20%) is not suitable (Class N) and occur in the southwestern, eastern and northeastern part of the microwatershed. They have severe limitations of rooting depth and gravelliness.

7.5 Land Suitability for Onion (*Allium cepa*)

Onion is the most important vegetable crop grown in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and Chamarajanagar districts. The crop requirements for growing onion (Table 7.6) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing onion was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.5.

Highly suitable (Class S1) lands occupy an area of about 141 ha (21%) for growing cotton and occur in the northwestern and northeastern part of the microwatershed. An area of about 159 ha (24%) has soils that are moderately suitable (Class S2) for growing onion with minor limitations of gravelliness, texture and rooting depth. They are distributed in the northern, western, central and eastern part of the microwatershed. The marginally suitable (Class S3) lands cover a maximum area of about 304 ha (45%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, rooting depth and texture. An area of about 39 ha (6%) is not suitable (Class N) and occur in the central and a very small patch in the south-eastern part of the microwatershed. They have severe limitation of gravelliness.

Table 7.6 Land suitability criteria for Onion

Crop requirement		Rating			
Soil –site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable (S2)**	**Marginally suitable(S3)**	**Not suitable (N)**
Mean temperature in growing season	^{0}C	20-30	30-35	35-40	>40
Slope	%	<3	3-5	5-10	>10
Soil drainage	Class	Well drained	Moderately /imperfectly	Poor drained	Very poorly drained
Soil reaction	pH	6.5-7.3	7.3-7.8,5.0-5.4	7.8-8.4 ,<5.0	>8.4
Surface soil texture	Class	scl, sil, sl	sc, sicl, c (red soil)	sc, c (black soil)	ls
Soil depth	cm	>75	50-75	25-50	<25
Gravel content	% vol.	<15	15-35	35-60	60-80
Salinity (ECe)	dsm^{-1}	<1.0	1.0-2.0	2.0-4.0	<4
Sodicity (ESP)	%	<5	5-10	10-15	>15

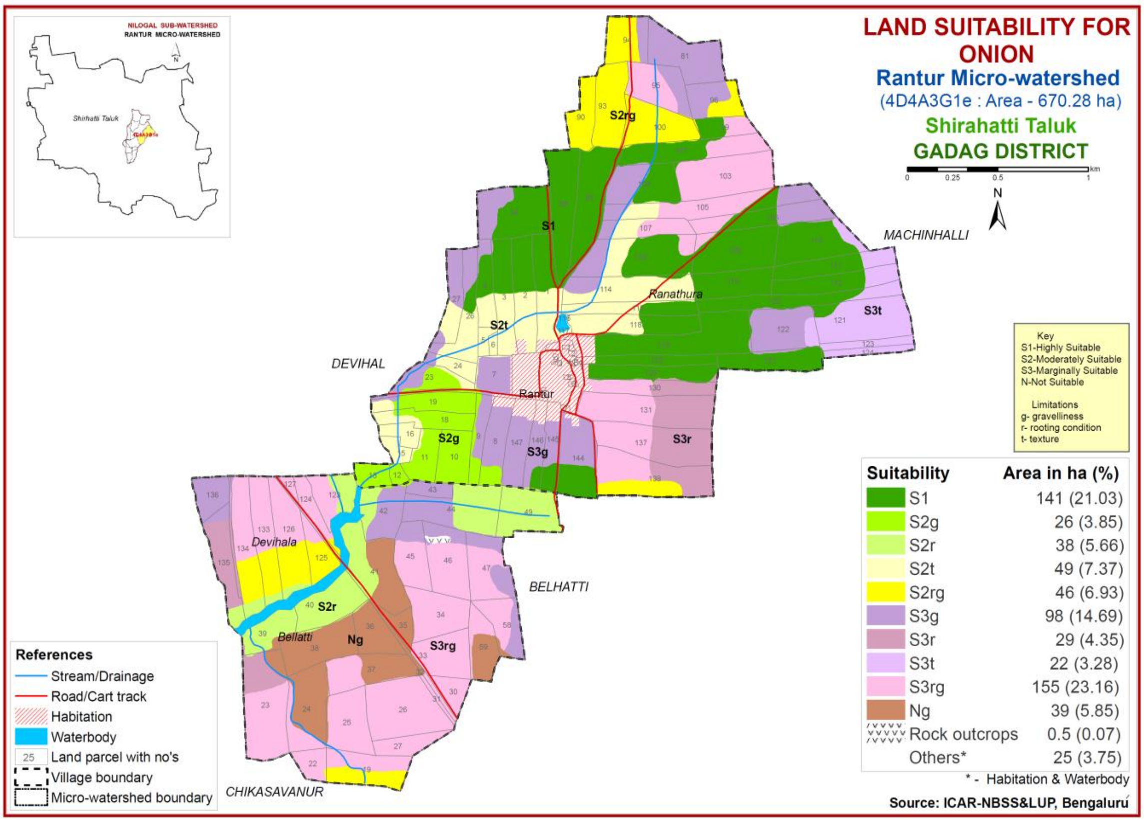


Fig. 7.5 Land Suitability map of Onion

7.6 Land Suitability for Groundnut (*Arachis hypogaea*)

Groundnut is one of the major oilseed crop grown in an area of 6.54 lakh ha in Karnataka in most of the districts either as rainfed or irrigated crop. The crop requirements for growing groundnut (Table 7.7) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing groundnut was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.6.

Table 7.7 Crop suitability criteria for Groundnut

Crop requirement		Rating			
Soil–site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Slope	%	<3	3-5	5-10	>10
LGP	Days	100-125	90-105	75-90	
Soil drainage	Class	Well drained	Mod. Well drained	Imperfectly drained	Poorly drained
Soil reaction	pH	6.0-8.0	8.1-8.5,5.5-5.9	>8.5,<5.5	
Surface soil texture	Class	l,cl,sil,sc,sicl	sc, sic, c,	s,ls,sl,c(>60%)	s,fragmental
Soil depth	cm	>75	50-75	25-50	<25
Gravel content	% vol.	<35	35-50	>50	
$CaCO_3$ in root zone	%	high	Medium	low	
Salinity (EC)	dSm^{-1}	<2.0	2.0-4.0	4.0-8.0	
Sodicity (ESP)	%	<5	5-10	>10	

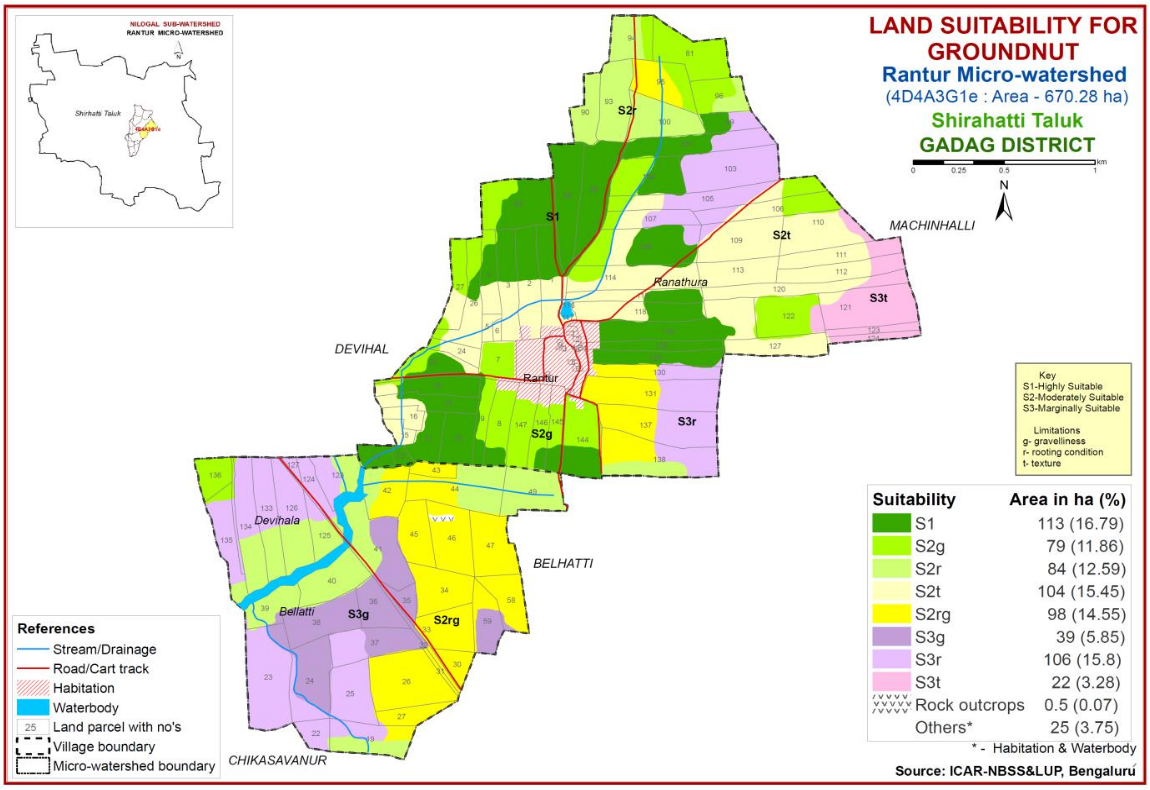


Fig. 7.6 Land Suitability map of Groundnut

An area of about 113 ha (17%) is highly suitable (Class S1) for growing groundnut. They are distributed in the northwestern, central and eastern part of the microwatershed. Moderately suitable lands (Class S2) cover major area of 365 ha (54%) and are distributed in all parts of the microwatershed. They have minor limitations of gravelliness, texture and rooting depth. Marginally suitable lands (Class S3) for growing groundnut occupy an area of about 167 ha (25%) and are distributed in the southwestern, central and eastern part of the microwatershed with moderate limitations of gravelliness, rooting depth and texture.

7.7 Land Suitability for Chilli (*Capsicum annuum L*)

Chilli is one of the major fruit and spice crop grown in an area of 0.42 lakh ha in Karnataka State. The crop requirements for growing chilli (Table 7.8) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing chilli was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.7.

Highly suitable (Class S1) lands occupy an area of about 136 ha (20%) and occur in the western and central part of the microwatershed. Moderately suitable (Class S2) lands cover an area of about 186 ha (28%) and are distributed in the northern, western, eastern, central and northeastern part of the microwatershed. They have minor limitations of gravelliness, wetness and rooting depth. Major area of about 293 ha (44%) is marginally suitable (Class S3) lands for growing chilli and are distributed in all parts of the microwatershed and they have minor limitations of gravelliness and rooting depth. A small area of about 28 ha (4%) is not suitable (Class N) and occur in the central and a very small patch in the south-eastern part of the microwatershed with severe limitation of gravelliness.

Table 7.8 Crop suitability criteria for Chilli

Crop requirement		Rating			
Soil –site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Mean temperature in growing season	^{0}c	20-30	30-35 13-15	35-40 10-12	>40 <10
Slope	%	<3	3-5	5-10	>10
LGP	Days	>150	120-150	90-120	<90
Soil drainage	Class	Well drained	Moderately drained	Imp./ poor drained /excessively	V.poorly drained
Soil reaction	pH	6.5-7.8,6.0-7.0	7.8-8.4	8.4-9.0,5.0-5.9	>9.0
Surface soil texture	Class	scl, cl, sil	sl, sc, sic,c(m/k)	c(ss), ls, s	
Soil depth	cm	>75	50-75	25-50	<25
Gravel content	%vol.	<15	15-35	35-60	>60
Salinity (ECe)	dsm^{-1}	<1.0	1.0-2.0	2.0-4.0	<4
Sodicity (ESP)	%	<5	5-10	10-15	

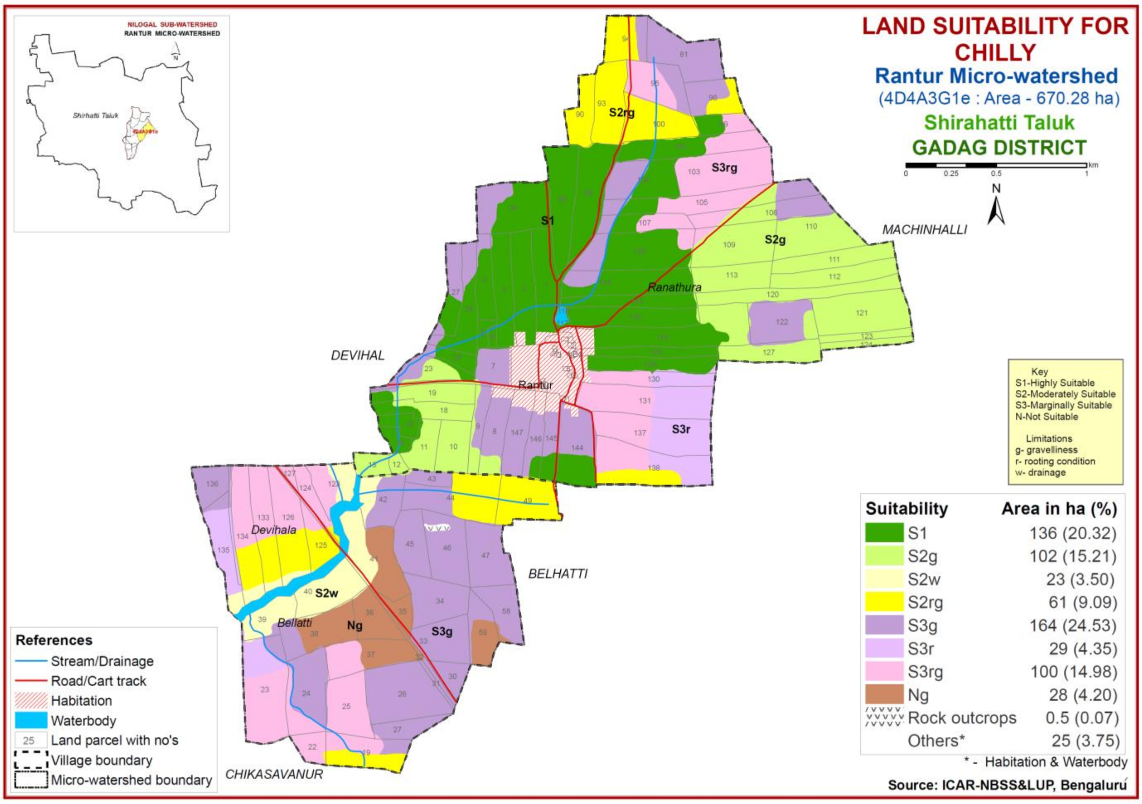


Fig. 7.7 Land Suitability map of chilli

7.8 Land Suitability for Sugarcane (*Saccharum officinarum*)

Sugarcane is the most important commercial crop grown in 6.7 lakh ha area in Kalaburgi, Bijapur, Bagalkot, Bidar, Mysore, Chamarajanagar and Mandya districts. The crop requirements for growing sugarcane (Table 7.9) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sugarcane was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.8.

Table 7.9 Land suitability criteria for Sugarcane

Crop requirement		Rating			
Soil–site characteristics	**Unit**	**Highly suitable(S1)**	**Moderately Suitable(S2)**	**Marginally suitable(S3)**	**Not suitable (N)**
Slope	%	<3	3-5	5-8	>8
Soil drainage	Class	Well drained	Mod./imperfectly drained	Poorly drained	V.poor/excessively drained
Soil reaction	pH	7.0-8.0	6.0-6.9, 8.1-9.0	4.0-5.9, 9.1-9.5	<4.0/ >9.5
Surface soil texture	Class	l, cl, sil, sicl	C(m/k), sl	C+(ss)	
Soil depth	Cm	>100	100-75	75-50	<50
stoniness	%	<15	15-35	35-50	>50
Salinity (EC)	dSm^{-1}	<2.0	2.0-4.0	4.0-9.0	>9
Sodicity (ESP)	%	<10	10-15	15-25	>25

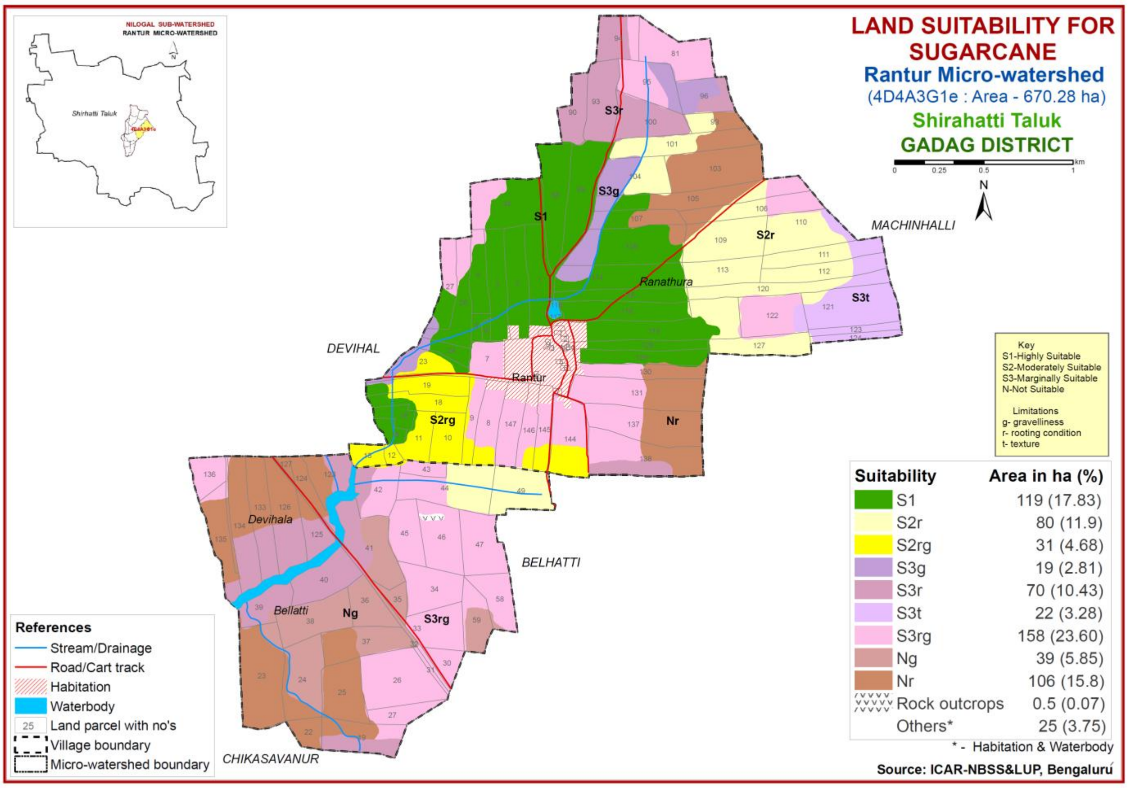


Fig. 7.8 Land Suitability map of Sugarcane

Highly suitable (Class S1) land occupy an area of about 119 ha (18%) for growing sugarcane and occur in northwestern and central part of the microwatershed. Moderately suitable (Class S2) land occupies an area of about 111 ha (17%) and occurs in western, central and northeastern part of the microwatershed. They have minor limitation of rooting depth and gravelliness. Marginally suitable lands cover major area of about 269 ha (40%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth, texture and gravelliness. An area of about 145 ha (22%) is not suitable (Class N) for growing sugarcane and occur in central and small patches in southwestern, eastern and northeastern parts of the microwatershed and they have severe limitations of rooting depth, texture and gravelliness.

7.9 Land Suitability for Pomegranate (*Punica granatum*)

Pomegranate is one of the commercially grown fruit crop in Karnataka in an area of 0.18 lakh ha mainly in Bijapur, Bagalkot, Koppal, Gadag and Chitradurga districts. The crop requirements for growing pomegranate (Table 7.10) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing pomegranate was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.9.

An area of about 119 ha (18%) is highly suitable (Class S1) for growing pomegranate and are distributed in the northwestern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy an area of about 119 ha (17%) is for growing pomegranate and are distributed in the western, central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands for growing pomegranate occupy major area of about 272 ha (41%) and are distributed in all parts of the microwatershed with minor limitations of rooting depth, gravelliness and texture.

Table 7.10 Crop suitability criteria for Pomegranate

Crop requirement			Rating			
Soil–site characteristics		Unit	Highly suitable(S1)	Moderately Suitable(S2)	Marginally suitable(S3)	Not suitable (N)
Climate	Temperature in growing season	^0C	30-34	35-38 25-29	39-40 15-24	
Soil moisture	Growing period	Days	>150	120-150	90-120	<90
Soil aeration	Soil drainage	Class	Well drained	imperfectly drained		
Nutrient availability	Texture	Class	sl, scl, l, cl	c, sic, sicl	cl, s, ls	s, fragmental
Rooting conditions	pH	1:2.5	5.5-7.5	7.6-8.5	8.6-9.0	
	Soil depth	cm	>100	75-100	50-75	<50
	Gravel content	% vol.	nil	15-35	35-60	>60
Soil toxicity	Salinity	dS/m	Nil	<9	>9	<50
	Sodicity	%	nil			
Erosion	Slope	%	<3	3-5	5-10	

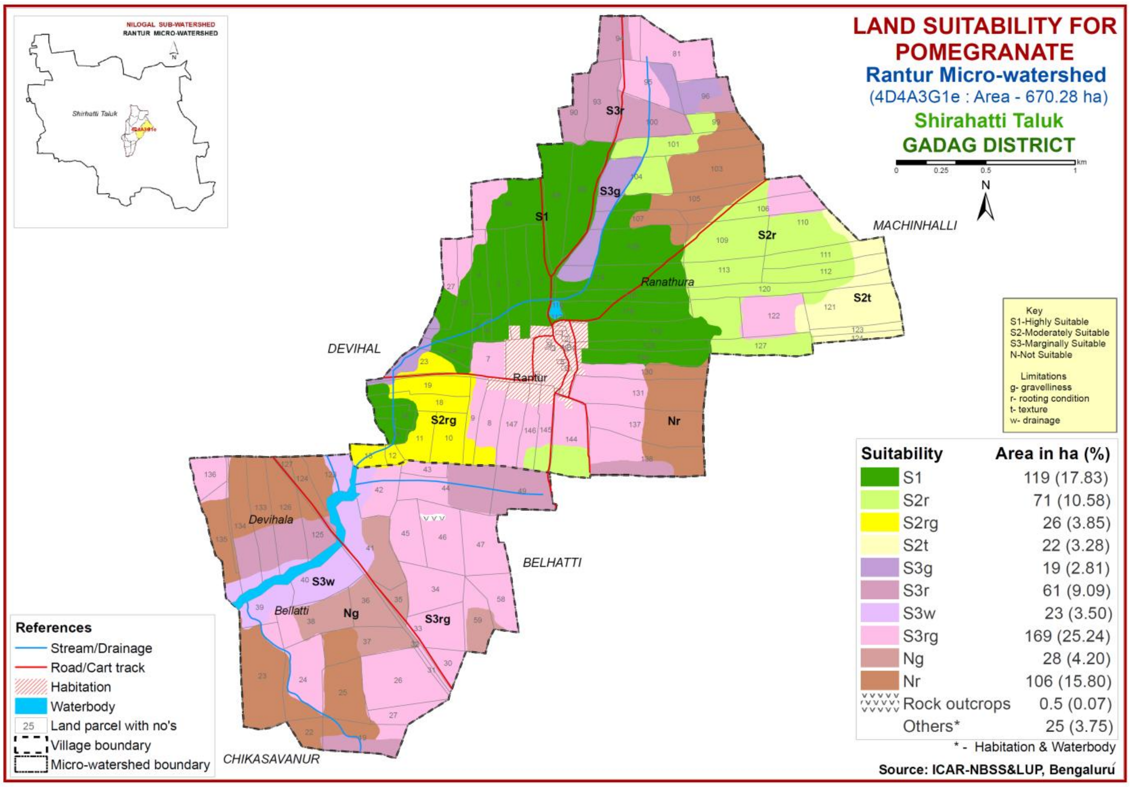


Fig. 7.9 Land Suitability map of Pomegranate

An area of about 134 ha (20%) is not suitable (Class N) for growing pomegranate and occur in the southwestern, eastern and northeastern part of the microwatershed and they have severe limitations of gravelliness and rooting depth.

7.10 Land suitability for Tomato (*Solanum lycopersicum*)

Tomato is the most important fruit crop grown in an area of 0.65 lakh ha in almost all the districts of the State. The crop requirements (Table 7.11) for growing tomato were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing tomato was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.10.

Highly suitable (Class S1) lands occupy an area of about 190 ha (28%) and are distributed in the northwestern, central and northeastern part of the microwatershed. An area of about 191 ha (28%) in the microwatershed is moderately suitable (Class S2) for growing tomato and are distributed in the northern, western and south-eastern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and texture. The marginally suitable (Class S3) lands cover maximum area of about 224 ha (33%) and are distributed in the southwestern, northern, central and eastern parts of the microwatershed. They have moderate limitations of gravelliness and rooting depth. An area of about 39 ha (6%) is not suitable (Class N) for growing tomato and occur in the central and a very small patch in the south-eastern part of the microwatershed.

Table 7.11 Crop suitability criteria for Tomato

Crop requirement			**Rating**			
Soil–site characteristics		**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Climate	Temperature in growing season	^{0}c	25-28	29-32 20-24	15-19 33-36	<15 >36
Soil moisture	Growing period	Days	>150	120-150	90-120	
Soil aeration	Soil drainage	Class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	l, sl, cl, scl	sic,sicl,sc,c(m/k	c (ss)	ls, s
	pH	1:2.5	6.0-7.0	5.0-5.9,7.1-8.5	<5, >8.5	
	$CaCO_3$ in root zone	%	Non calcareous	Slightly calcareous	Strongly calcareous	
Rooting conditions	Soil depth	cm	>75	50-75	25-50	<25
	Gravel content	% vol.	<15	15-35	>35	
Soil toxicity	Salinity	ds/m	Non saline	slight	strongly	
	Sodicity (ESP)	%	<10	10-15	>15	-
Erosion	Slope	%	1-3	3-5	5-10	>10

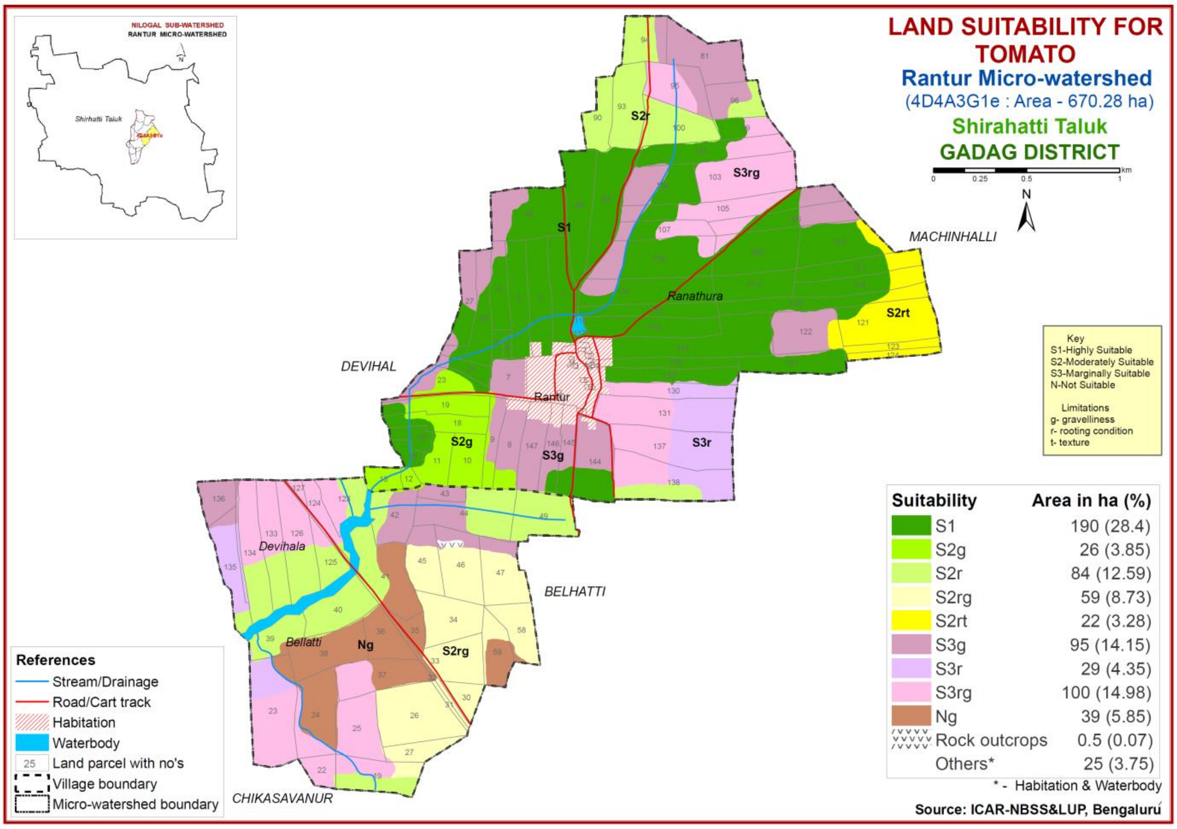


Fig. 7.10 Land Suitability map of Tomato

7.11 Land suitability for Guava (*Psidium guajava*)

Guava is the most important fruit crop grown in an area of 6558 ha in almost all the districts of the State. The crop requirements (Table 7.12) for growing guava were matched with the soil-site characteristics (7.1) and a land suitability map for growing guava was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.11.

An area of about 70 ha (10%) is highly suitable (Class S1) for growing guava and occur in the northwestern, central and northeastern part of the microwatershed. Moderately suitable (Class S2) lands occupy an area of about 140 ha (21%) and occur in the western, central and northeastern part of the microwatershed with minor limitations of rooting depth, texture and gravelliness. The marginally suitable (Class S3) lands cover major area of about 300 ha (45%) and are distributed in all parts of the microwatershed and they have moderate limitations of gravelliness, rooting depth, texture and wetness. An area of about 134 ha (20%) is not suitable (Class N) for growing guava and are distributed in the southwestern and northeastern part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.12 Crop suitability criteria for Guava

Crop requirement			Rating			
Soil–site characteristics		Unit	Highly suitable(S1)	Moderately suitable(S2)	Marginally suitable(S3)	Not suitable(N)
Climate	Temperature in growing season	^0C	28-32	33-36 24-27	37-42 20-23	
Soil moisture	Growing period	Days	>150	120-150	90-120	<90
Soil aeration	Soil drainage	Class	Well drained	Mod. to imperfectly	poor	Very poor
Nutrient availability	Texture	Class	scl, l, cl, sil	sl,sicl,sic.,sc,c	c (<60%)	c (>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0:5.0-5.9	8.1-8.5:4.5-4.9	>8.5:<4.5
	$CaCO_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	cm	>100	75-100	50-75	<50
	Gravel content	% vol.	<15	15-35	>35	
Soil toxicity	Salinity	dS/m	<2.0	2.0-4.0	4.0-6.0	
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10

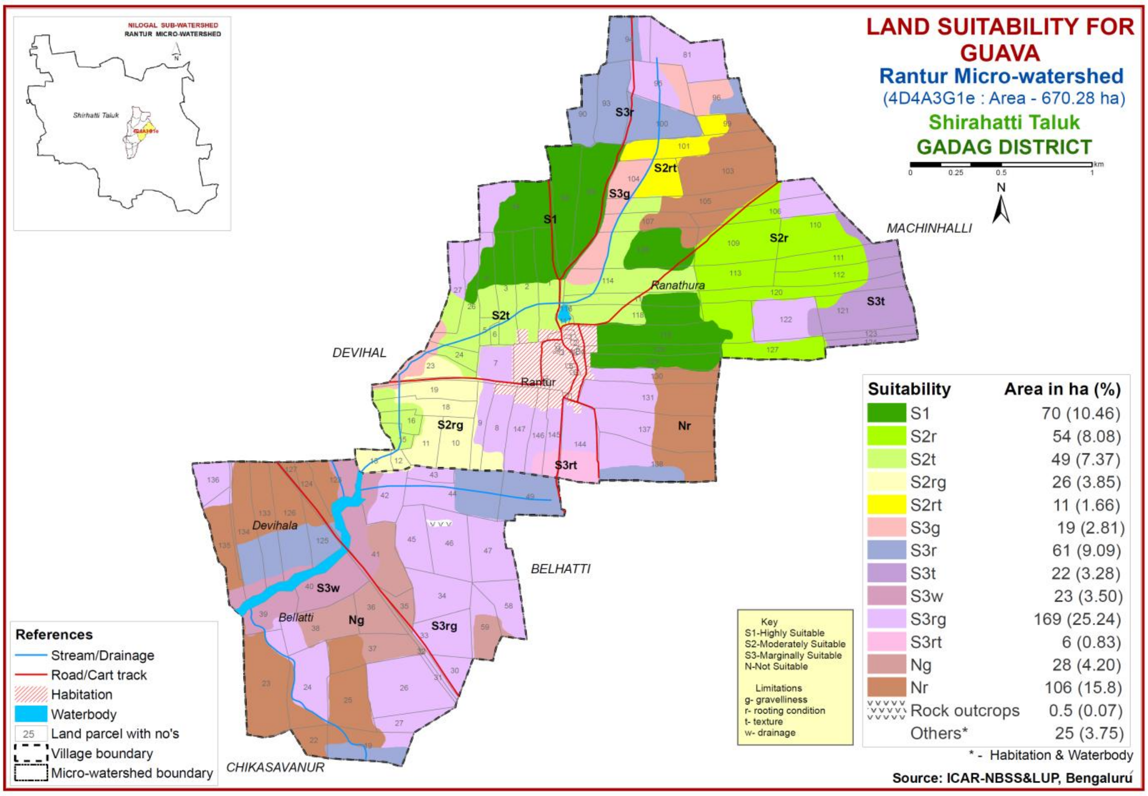


Fig. 7.11 Land Suitability map of Guava

7.12 Land suitability for Mango (*Mangifera indica*)

Mango is the most important fruit crop grown in about 1.73 lakh ha area in almost all the districts of the State. The crop requirements (Table 7.13) for growing mango were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mango was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.12.

Highly suitable (Class S1) lands occupy a very small area of about 7 ha (1%) and are distributed in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class S2) for growing mango and occur in western, central and eastern part of the microwatershed with minor limitation of rooting depth. Marginally suitable (Class S3) lands for growing pomegranate occupy an area of about 116 ha (17%) and are distributed in the western, central and northeastern part of the microwatershed. They have minor limitations of gravelliness and rooting depth. Major area of about 410 ha (61%) is not suitable (Class N) for growing mango and occur in all parts of the microwatershed.

Table 7.13 Crop suitability criteria for Mango

Crop requirement			Rating			
Soil-site characteristics		Unit	Highly suitable(S1)	Moderately suitable(S2)	Marginally suitable(S3)	Not suitable (N)
Climate	Temp. in growing season	^{0}C	28-32	24-27 33-35	36-40	20-24
	Min. temp. before flowering	^{0}C	10-15	15-22	>22	
Soil moisture	Growing period	Days	>180	150-180	120-150	<120
Soil aeration	Soil drainage	Class	Well drained	Mod. to imper. drained	Poor drained	Very poorly drained
	Water table	M	>3	2.50-3.0	2.5-1.5	<1.5
Nutrient availability	Texture	Class	sc, l, sil, cl	sl,sc,sic,l, c	c (<60%)	c (>60%),
	pH	1:2.5	5.5-7.5	7.6-8.5,5.0-5.4	8.6-9.04.0-4.9	>9.0<4.0
	OC	%	High	medium	low	
	$CaCO_3$ in root zone	%	Non calcareous	<5	5-10	>10
Rooting conditions	Soil depth	cm	>200	125-200	75-125	<75
	Gravel content	%vol	Non-gravelly	<15	15-35	>35
Soil toxicity	Salinity	dS/m	Non saline	<2.0	2.0-3.0	>3.0
	Sodicity	%	Non sodic	<10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

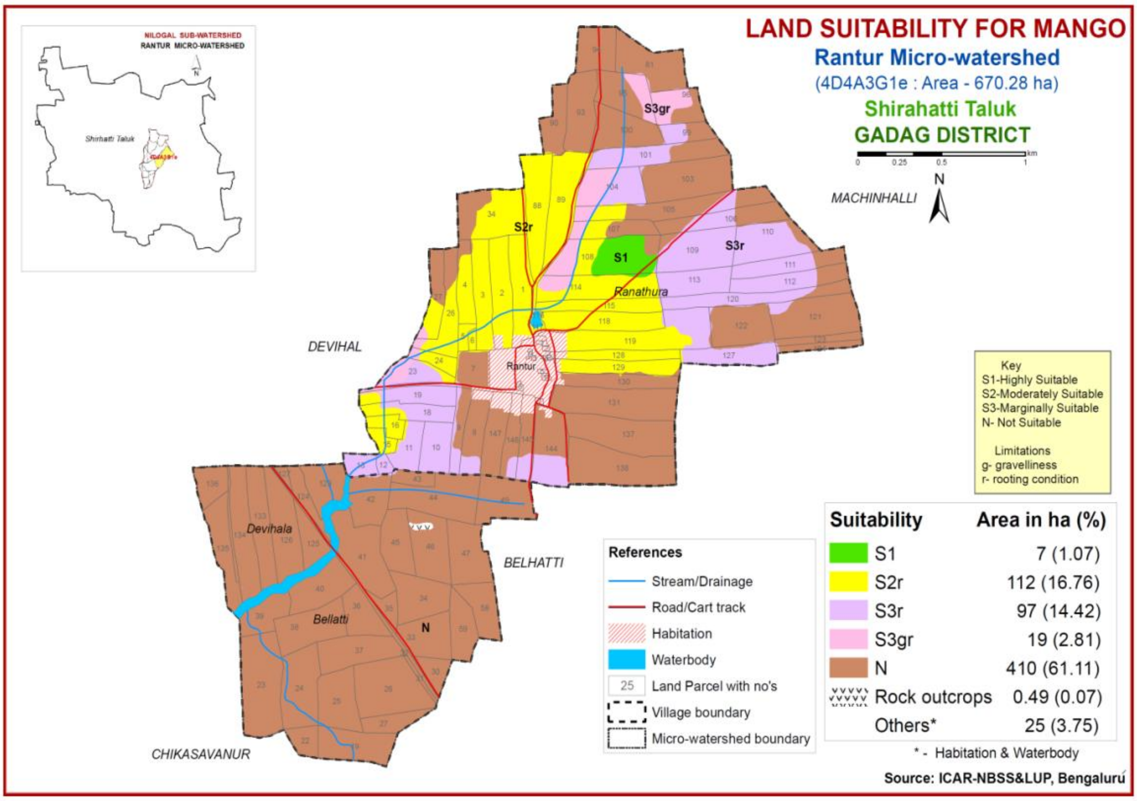


Fig. 7.12 Land Suitability map of Mango

7.13 Land suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in an area of 29373 ha in almost all the districts of the State. The crop requirements (Table 7.14) for growing sapota were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sapota was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.13.

Highly suitable (Class S1) lands occupy an area of about 57 ha (8%) for growing sapota and occur in the western and central part of the microwatershed. An area of about 160 ha (24%) is moderately suitable (Class 2) occur in the northwestern, central and northeastern part of the microwatershed. They have minor limitations of gravelliness and rooting depth. The marginally suitable (Class S3) lands cover major area of about 294 ha (44%) and are distributed in all parts of the microwatershed. They have moderate limitations of gravelliness, rooting depth, texture and wetness. An area of about 134 ha (20%) is not suitable (Class N) and are distributed in the southwestern, central and northeastern part of the microwatershed. They have very severe limitations of gravelliness and rooting depth.

Table 7.14 Crop suitability criteria for Sapota

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable(S1)	Moderately Suitable(S2)	Marginally suitable(S3)	Not suitable(N)
Climate	Temperature in growing season	^{0}C	28-32	33-36 24-27	37-42 20-23	>42 <18
Soil moisture	Growing period	Days	>150	120-150	90-120	<120
Soil aeration	Soil drainage	Class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	Scl,l,cl,sil	Sl, sicl, sc	C (<60%)	ls, s, C (>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0 5.0-5.9	8.1-9.0 4.5-4.9	>9.0 <4.5
	$CaCO_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	Cm	>150	75-150	50-75	<50
	Gravel content	% vol.	Non gravelly	<15	15-35	<35
Soil toxicity	Salinity	dS/m	Non saline	Up to 1.0	1.0-2.0	2.0-4.0
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10

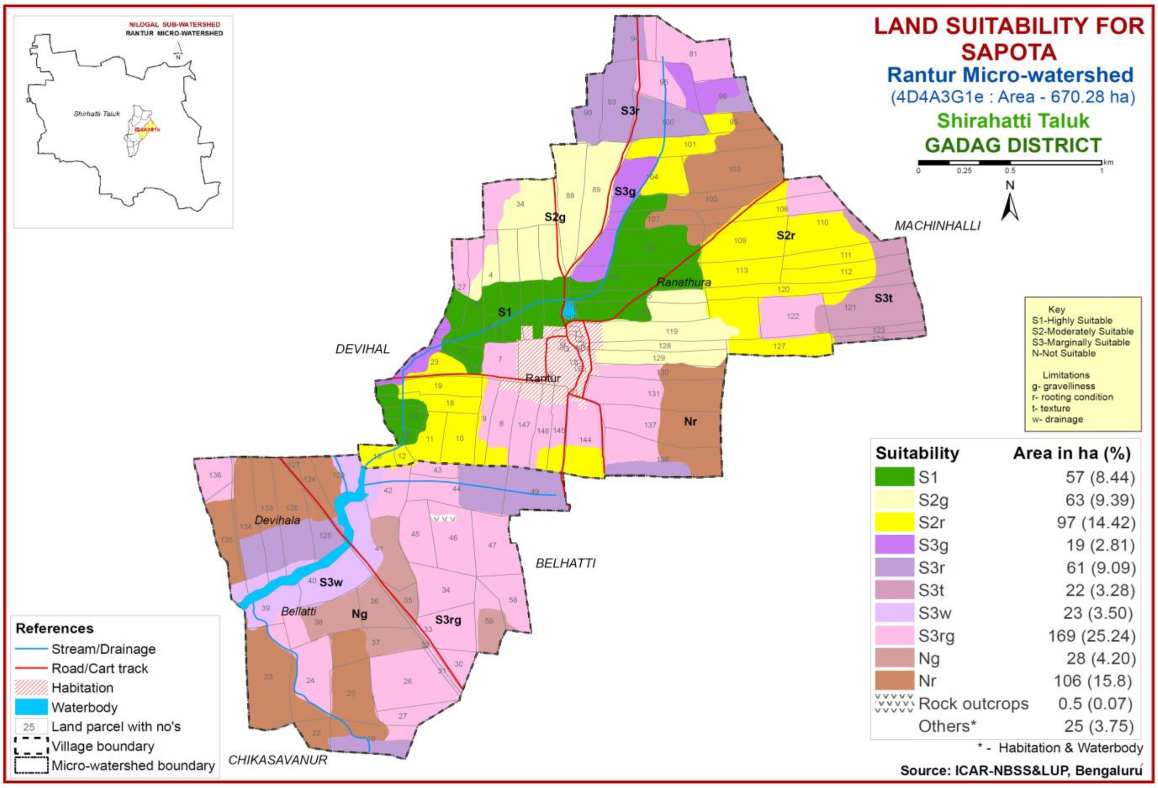


Fig. 7.13 Land Suitability map of Sapota

7.14 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in 5368 ha in all the districts of the state. The crop requirements for growing jackfruit were matched with the soil-site characteristics and a land suitability map for growing jackfruit was generated.

The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.14.

A very small area of about 7 ha (1%) is highly suitable (Class S1) land for growing jackfruit and are distributed in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class S2) and occur in the northwestern, central and eastern part of the microwatershed. They have minor limitation of rooting depth. The marginally suitable (Class S3) lands cover an area of about 116 ha (17%) and are distributed in the western, central and northeastern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Maximum area of about 410 ha (61%) is not suitable (Class N) for growing jackfruit and occur in all parts of the microwatershed.

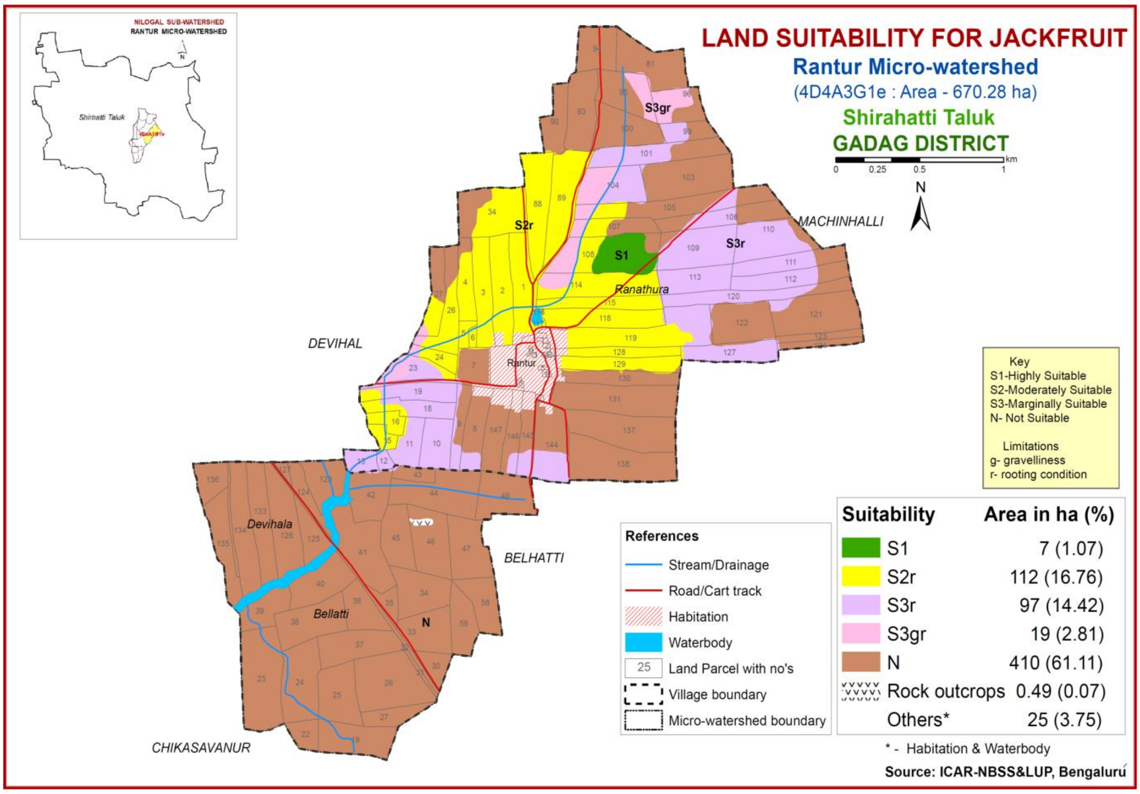


Fig. 7.14 Land Suitability map of Jackfruit

7.15 Land Suitability for Jamun (*Syzygium cumini*)

Jamun is an important fruit crop grown in almost all the districts of the State. The crop requirements for growing jamun were matched with the soil-site characteristics and a land suitability map for growing jamun was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.15.

Highly suitable (Class S1) land for growing jamun occupy a small area of about 7 ha (1%) and are distributed in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class S2) and occur in the western, central and eastern part of the microwatershed. They have minor limitation of rooting depth. The marginally suitable (Class S3) lands cover maximum area of about 420 ha (62%) and are distributed in all parts of the microwatershed with moderate limitations of gravelliness and rooting depth. An area of about 106 ha (16%) is not suitable (Class N) and are distributed in southwestern and northeastern part of the microwatershed.

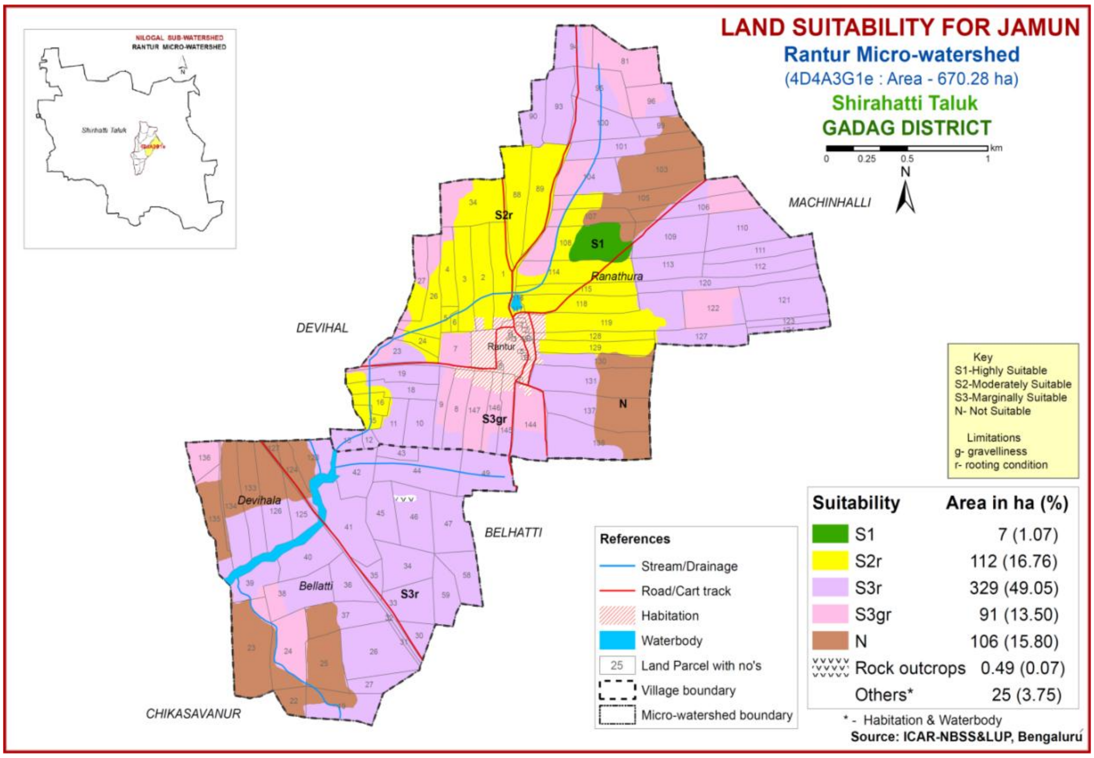


Fig. 7.15 Land Suitability map of Jamun

7.16 Land Suitability for Musambi (*Citrus limetta*)

Musambi is the most important fruit crop grown in an area of 5446 ha in almost all the districts of the state. The crop requirements for growing musambi were matched with the soil-site characteristics and a land suitability map for growing musambi was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.16.

A very small area of about 7 ha (1%) is highly suitable (Class S1) land for growing musambi and are distributed in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class 2) and occur in the western, central and eastern part of the microwatershed. They have minor limitation of rooting depth. An area of about 138 ha (20%) is marginally suitable (Class S3) for growing musambi and are distributed in the northwestern and central part of the microwatershed with moderate limitations of gravelliness and rooting depth. Maximum area of about 388 ha (58%) is not suitable (Class N) for growing musambi and are distributed in all parts of the microwatershed.

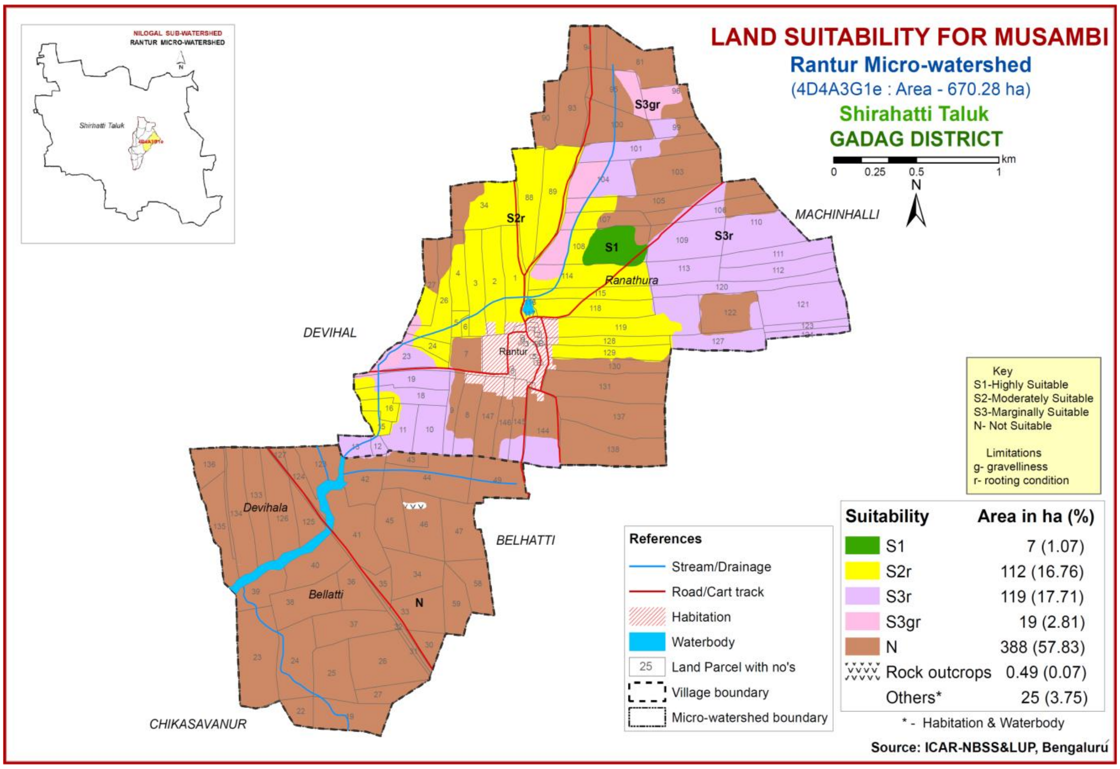


Fig. 7.16 Land Suitability map of Musambi

7.17 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 11752 ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.15) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated.

Table 7.15 Crop suitability criteria for Lime

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable(S1)	Moderately suitable (S2)	Marginally suitable(S3)	Not suitable(N)
Climate	Temperature in growing season	^{0}C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	Class	Well drained	Mod. to imper.drained	Poorly	Very poorly
Nutrient availability	Texture	Class	scl,l,sicl,cl,s	sc, sc, c	c (>70%)	s, ls
	pH	1:2.5	6.0-7.5	5.5-6.4,7.6-8.0	4.0-5.4,8.1-8.5	<4.0,>8.5
	$CaCO_3$ in root zone	%	Non calcareous	Upto 5	5-10	>10
Rooting conditions	Soil depth	cm	>150	100-150	50-100	<50
	Gravel content	% vol.	Non gravelly	15-35	35-55	>55
Soil toxicity	Salinity	dS/m	Non saline	Upto 1.0	1.0-2.5	>2.5
	Sodicity	%	Non sodic	5-10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

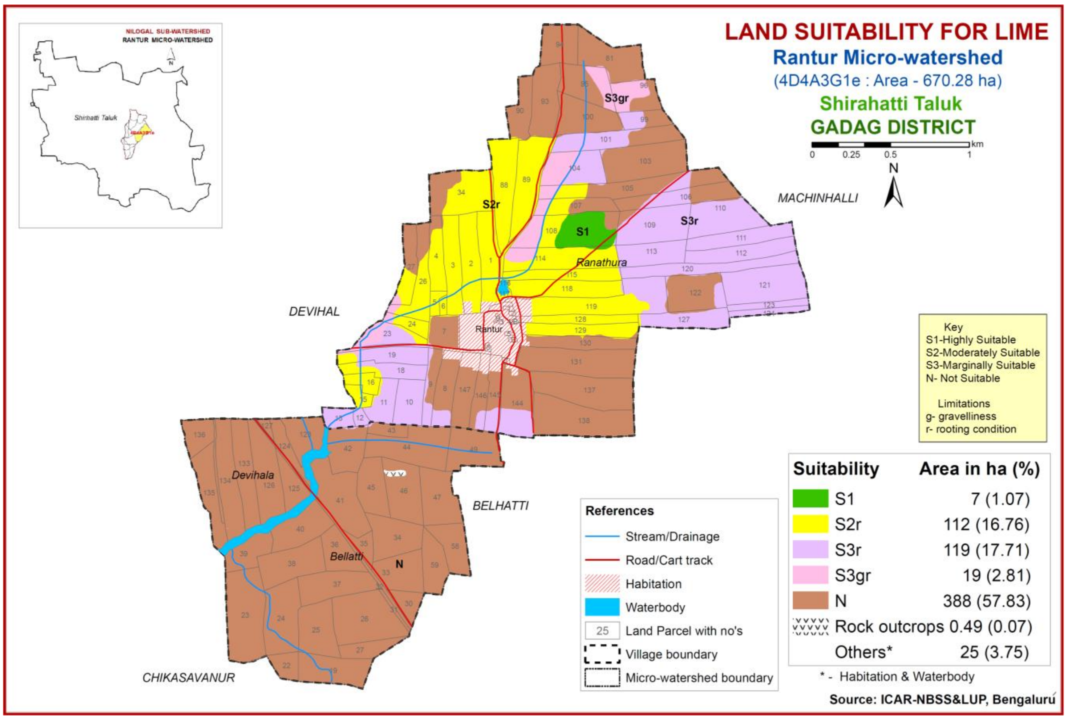


Fig. 7.17 Land Suitability map of Lime

The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.17.

Highly suitable (Class S1) land for growing lime occupy a small area of about 7 ha (1%) and are distributed in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class 2) occur in the northwestern and central part of the microwatershed with minor limitation of rooting depth. An area of about 138 ha (20%) is marginally suitable (Class S3) and are distributed in the western, central and northeastern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Maximum area of about 388 ha (58%) is not suitable (Class N) for growing lime and are distributed in all parts of the microwatershed.

7.18 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important fruit crop grown in an area of 7052 ha in almost all the districts of the State. The crop requirements for growing cashew were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cashew was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.18.

Highly suitable (Class S1) lands occupy a very small area of about 7 ha (1%) and are distributed in the central part of the microwatershed. An area of about 174 ha (26%) is moderately suitable and occur in the northwestern and central part of the microwatershed with minor limitation of rooting depth. The marginally suitable (Class S3) lands cover maximum area of about 259 ha (38%) and are distributed in the southwestern, northern, central and eastern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. An area of about 206 ha (31%) is not suitable (Class N) for growing cashew and are distributed in the southwestern and northeastern part of the microwatershed.

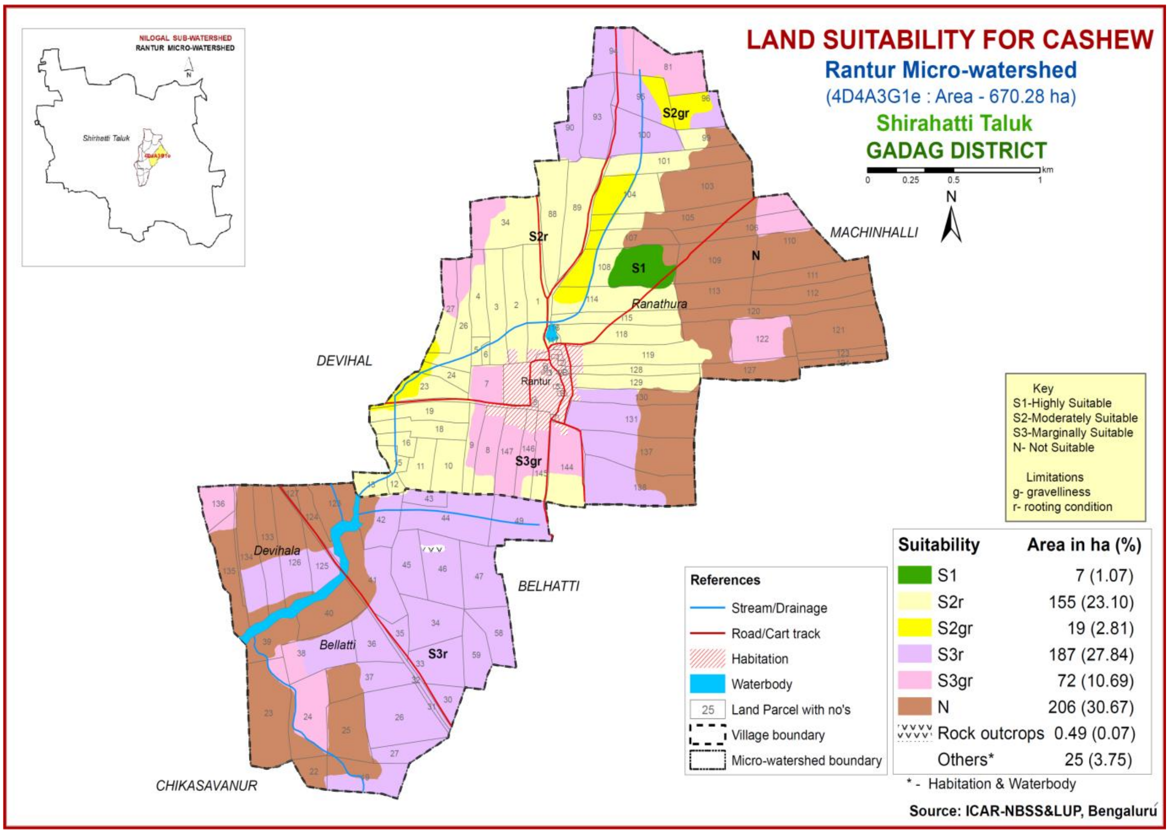


Fig. 7.18 Land Suitability map of Cashew

7.19 Land Suitability for Custard Apple (*Annona reticulata*)

Custard apple is one of the most important fruit crop grown in almost all the districts of the State. The crop requirements for growing custard apple were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing custard apple was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.19.

An area of about 119 ha (1%) is highly suitable (Class S1) land for growing custard apple. They are distributed in northwestern and central part of the microwatershed. Maximum area of about 420 ha (62%) is moderately suitable (Class S2) and occur in all parts of the microwatershed. They have minor limitations of gravelliness and rooting depth. An area of about 106 ha (16%) is marginally suitable (Class S3) for growing custard apple and are distributed in the southwestern and northeastern parts of the microwatershed.

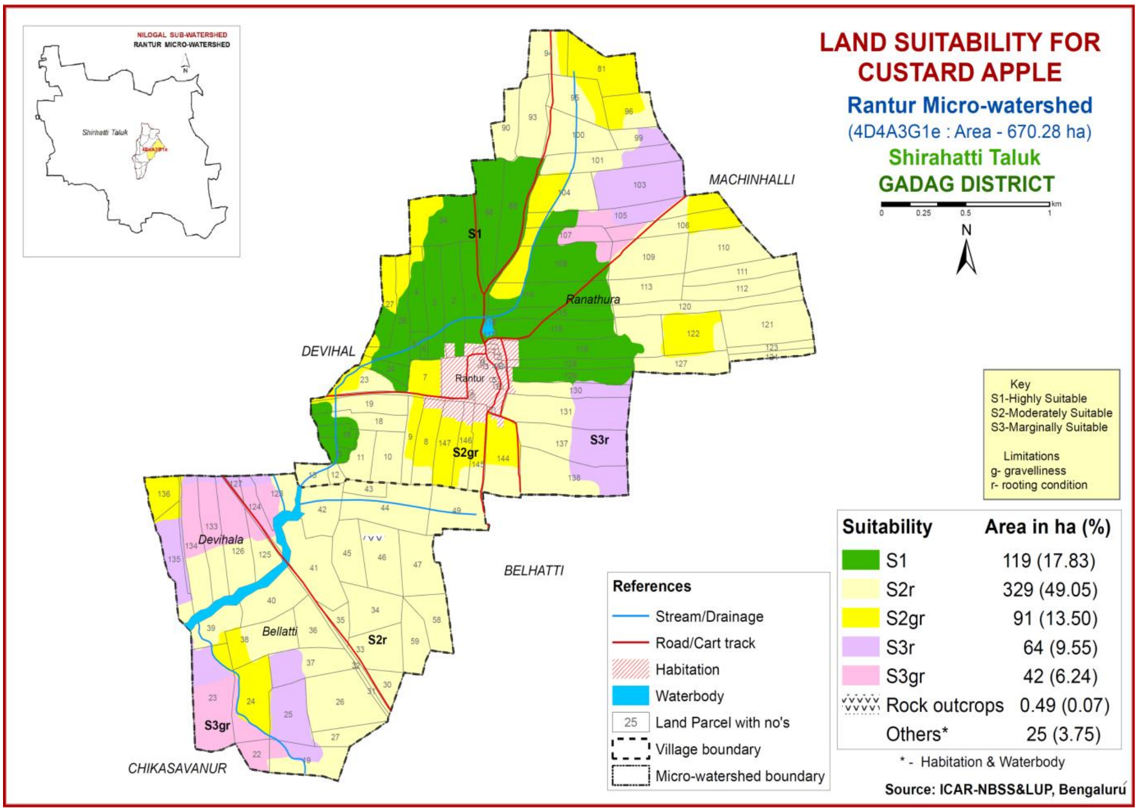


Fig. 7.19 Land Suitability map of Custard Apple

7.20 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the most important medicinal plants grown in 151 ha in all the districts of the State. The crop requirements for growing amla were matched with the soil-site characteristics and a land suitability map for growing amla was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.20.

Highly suitable (Class S1) lands occupy an area of about 119 ha (18%) for growing amla and occur in the northwestern and central part of the microwatershed. Maximum area of about 420 ha (62%) has soils that are moderately suitable (Class S2) with minor limitations of rooting depth and gravelliness and are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 106 ha (16%) and occur in the southwestern and northeastern part of the microwatershed.

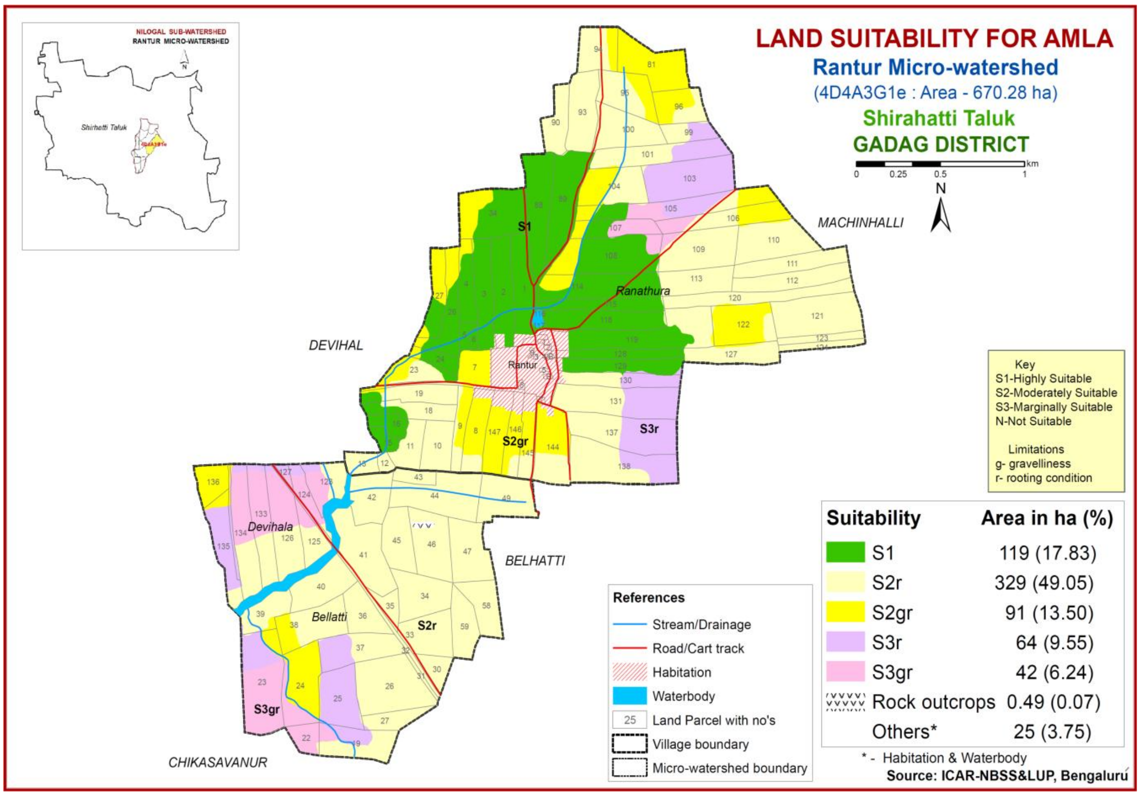


Fig. 7.20 Land Suitability map of Amla

7.21 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is the most important spice crop grown in 14897 ha in all the districts of the state. The crop requirements for growing tamarind were matched with the soil-site characteristics and a land suitability map for growing tamarind was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.21.

A very small area of 7 ha (1%) is highly suitable (Class S1) for growing tamarind occur in the central part of the microwatershed. An area of about 112 ha (17%) is moderately suitable (Class S2) lands occur in the northwestern and central part of the microwatershed. They have minor limitation of rooting depth. Maximum area of about 420 ha (62%) is marginally suitable (Class S3) lands and occurs in all parts of the microwatershed. They have moderate limitations of gravelliness and rooting depth. An area of about 106 ha (16%) is not suitable (Class N) for growing tamarind and are distributed in the northeastern and southwestern part of the microwatershed.

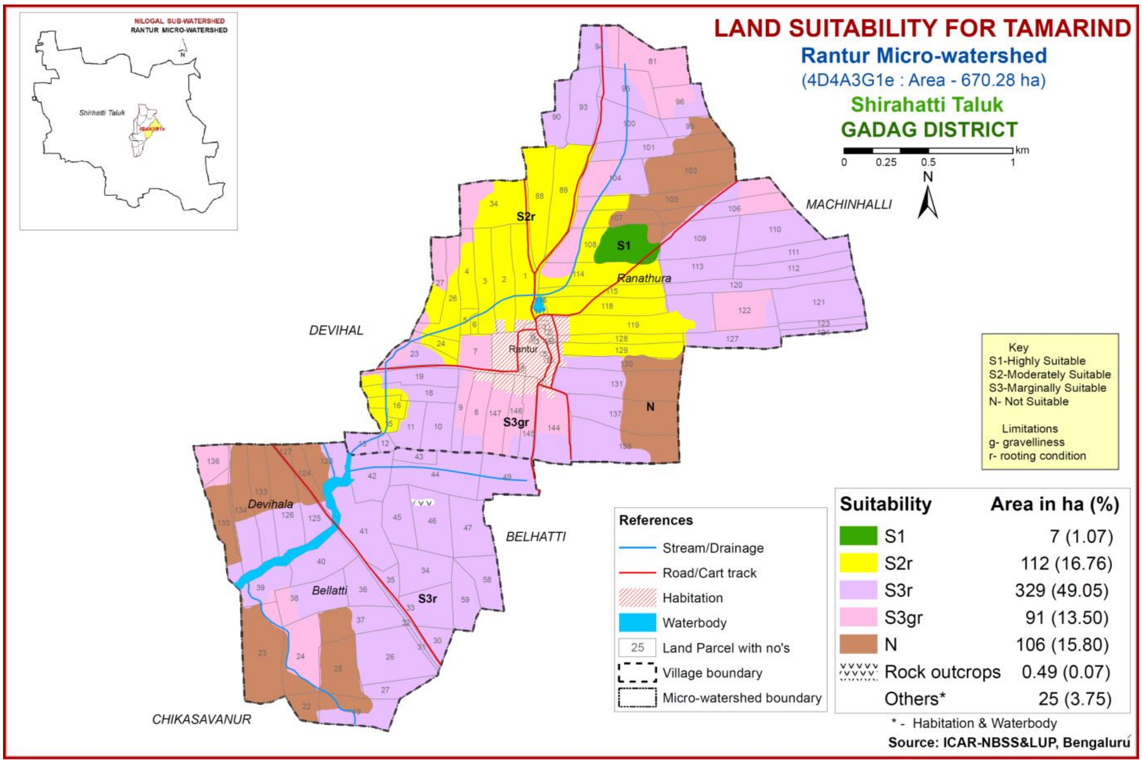


Fig. 7.21 Land Suitability map of Tamarind

7.22 Land Suitability for Marigold (*Tagetes erecta*)

Marigold is the most important flower crop grown in an area of 9108 ha in almost all the districts of the state. The crop requirements for growing marigold were matched with the soil-site characteristics and a land suitability map for growing marigold was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.22.

Highly suitable (Class S1) lands occupy an area of about 190 ha (28%) and is distributed in the western and southwestern, central and northeastern part of the microwatershed. An area of about 194 ha (29%) is moderately suitable (Class S2) for growing marigold and occur in the western, northern, central and a small patch in southern part of the microwatershed with minor limitations of gravelliness, rooting depth, texture and wetness. Marginally suitable (Class S3) lands cover an area of about 233 ha (35%) and occur in the northeastern, southwestern, northern and central part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. An area of about 28 ha (4%) is not suitable (Class N) for growing marigold and occur in the central and small patch in the south-eastern part of the microwatershed with severe limitation of gravelliness.

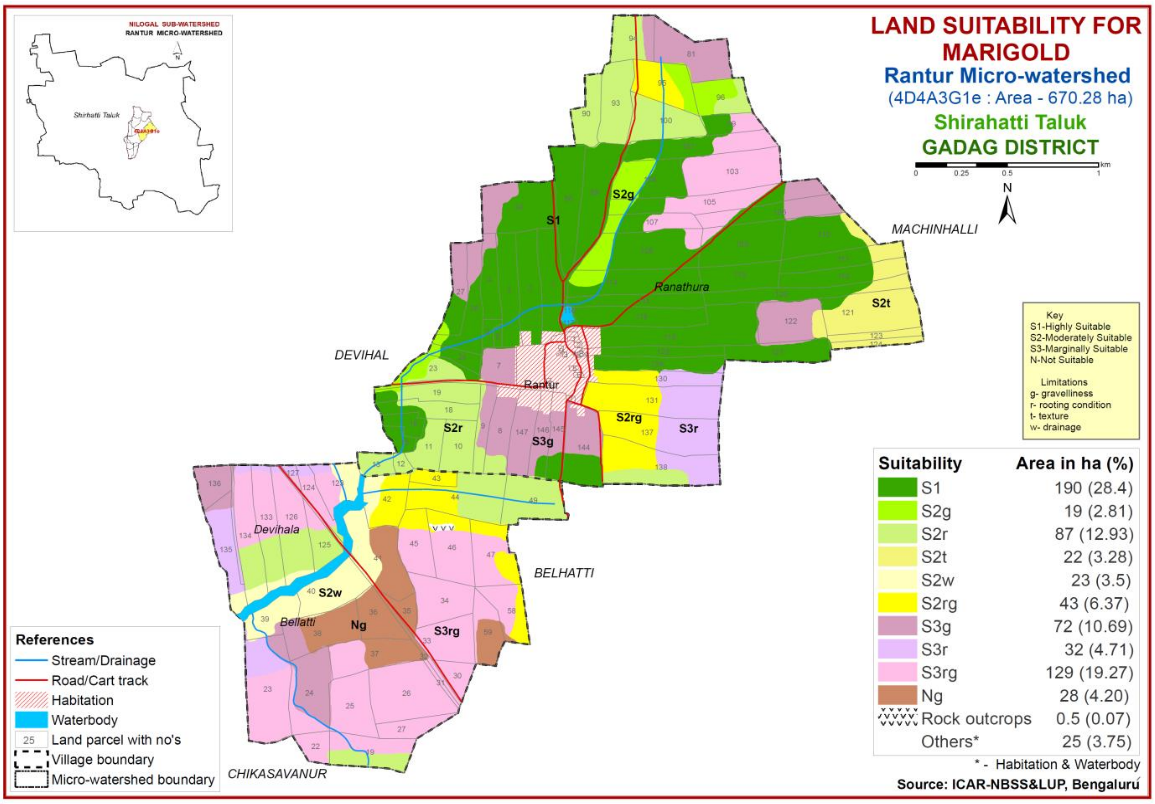


Fig. 7.22 Land Suitability map of Marigold

7.23 Land Suitability for Chrysanthemum (*Chrysanthemum indicum*)

Chrysanthemum is the most important flower crop grown in an area of 803 ha in almost all the districts of the State. The crop requirements for growing chrysanthemum were matched with the soil-site characteristics and a land suitability map for growing chrysanthemum was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.23.

Highly suitable (Class S1) lands occupy an area of about 190 ha (28%) and are distributed in the northwestern, central and northeastern part of the microwatershed. An area of about 194 ha (29%) is moderately suitable (Class S2) for growing chrysanthemum and occur in the western, southern, central and northern part of the microwatershed and they have minor limitations of gravelliness, rooting depth, texture and wetness. Marginally suitable (Class S3) lands cover an area of about 233 ha (35%) and occur in the eastern, southwestern, central and northeastern part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. A Small area of about 28 ha (4%) is not suitable (Class N) for growing chrysanthemum and occur in the central and a very small patch in the south-eastern parts of the microwatershed with severe limitation of gravelliness.

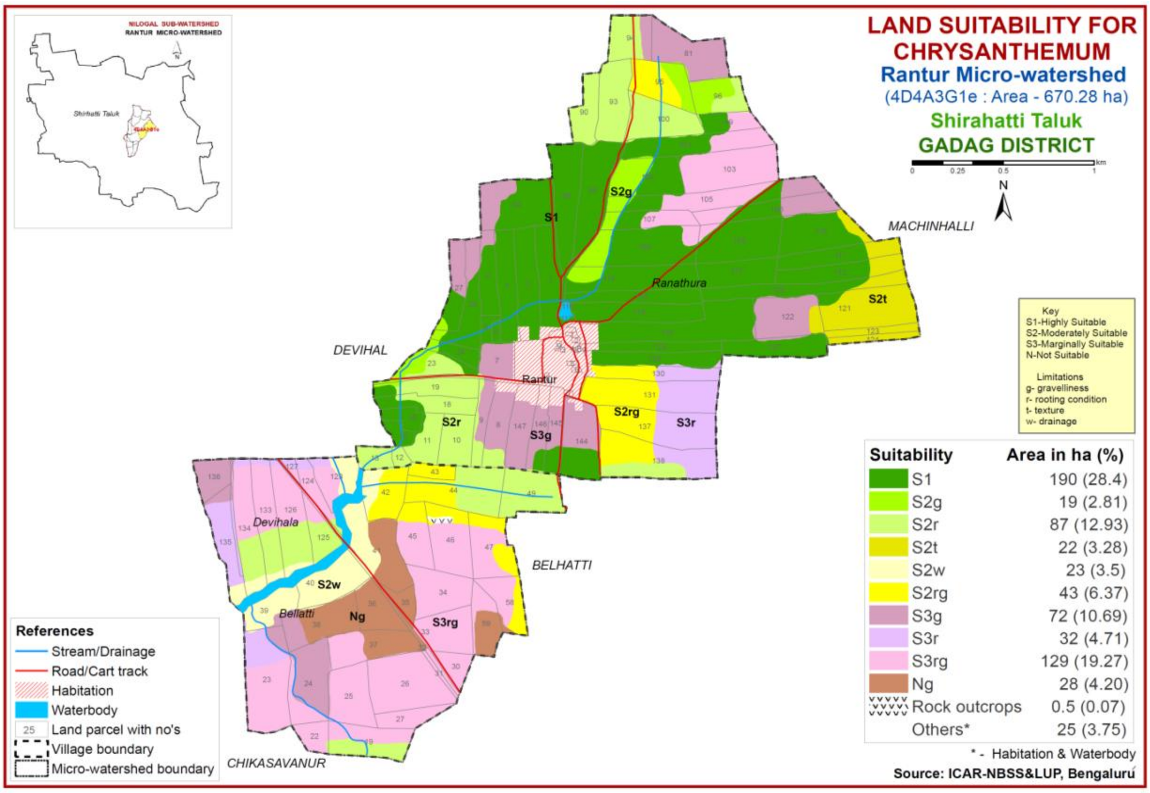


Fig. 7.23 Land Suitability map of Chrysanthemum

7.24 Land Management Units (LMUs)

The 46 soil map units identified in Rantur Microwatershed have been regrouped into 9 Land Management Units (LMU's) for the purpose of preparing a Proposed Crop Plan. Land management units are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a land management units map (Fig.7.22) has been prepared. These land management units are expected to behave similarly for a given level of management.

The map units that have been grouped into 9 land management units along with brief description of soil and site characteristics are given below.

LMUs	Soil map units	Soil and site characteristics
LMU-1	MRDfA1	Very deep, dark reddish brown to dark red sandy clay loam to sandy clay soils with slopes of 0-1% and slight erosion
LMU-2	KMHcB1g1 KMHiA1g1 VDHhA1g1 VDHiA1 VDHiB2g1	Deep, dark reddish brown sandy clay loam to clayey soils with slopes of 0-3%, gravelly (15-35%) and slight to moderate erosion
LMU-3	CKMhA1 CKMiB1g1 GHThB1g1	Moderately deep, dark reddish brown sandy clay loam to sandy clay soils with slopes of 0-3%, gravelly (15-35%) and slight erosion
LMU-4	HDHhA2g1 HDHhB2g2 HDHiA1g1	Moderately deep , reddish brown gravelly sandy clay loam to clay soils with slopes of 0-3%, gravelly to very gravelly (15-60%) and slight to moderate erosion
LMU-5	JLGmB1g1 KKRhB1g1 KKRmB2g1	Moderately deep, reddish brown gravelly sandy clay loam to clayey soils with slope of 1-3%, gravelly (15-35%) and slight to moderate erosion
LMU-6	HNHhB1 HNHiA1	Moderately deep, dark brown clay soils with slope of 1-3% and slight erosion
LMU-7	KGHcB1 KGHcB2g1 KGHcB2g3 KGHiB2g2 KTPcB2g2 KTPhB2g2 KTPiA1g1 KTPiB2g2 KTPmB2g1 LKRcB2g1 LKRhB1g1 LKRhB2g3 LKRhC2g2 LKRmB2g1 MKHcB2g2 MKHhB1g1 MKHmB2g1	Moderately shallow, reddish brown dark red gravelly sandy clay loam to clayey soils with slopes of 0-3%, gravelly to extremely gravelly (15-80%) and slight to moderate erosion
LMU-8	TDHbA2g1 TDHfB2g1 TDHhB2g1	Moderately shallow, dark brown to light brown loamy sand to sandy clay loam soils with slope of 0-3%, gravelly (15-35%) and moderate erosion
LMU-9	CSRbB1g2 CSRbB2g1 HRVbB2g1 HRVcB1g2 KGPcB2g2 KGPfB2g2 KGPiB2g1 KNHhB1g1	Shallow, brown to dark brown loamy sand to sandy clay loam soils with slope of 0-3%, gravelly to very gravelly (15-60%) and slight to moderate erosion

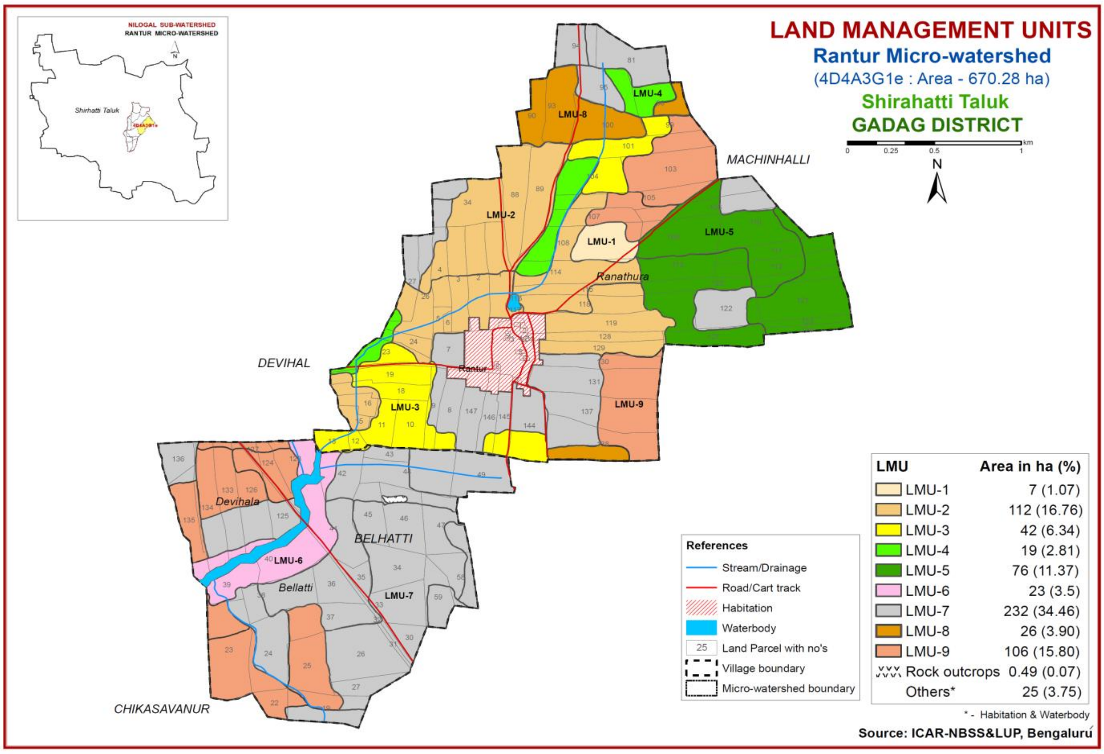


Fig. 7.24 Land Management Units Map- Rantur Microwatershed

7.25 Proposed Crop Plan for Rantur Microwatershed

After assessing the land suitability for the 23 crops, the proposed crop plan has been prepared for the 9 identified LMUs by considering only the moderately (Class S2) suitable lands for each of the 23 crops. The resultant proposed crop plan is presented below in Table 7.16.

Table 7.16 Proposed Crop Plan for Rantur Microwatershed

LMU No	Mapping Units	Survey Number	Field Crops/ Forestry	Suitable Horticulture Crops under Irrigation	Horticulture Crops with suitable Interventions	Suitable Interventions
LMU-1	39 (>150 cm) Very deep	**Ranathura:**108	Redgram (short duration). Bajra, Sorghum, Sesamum, Green gram, Black gram, Horsegram, Redgram+Maize, Redgram+Groundnut, Redgram+Fodder Jowar	**Perennial Component:** Mango, Tamarind, Aonla, Pomelo. **Intercrops:** Groundnut, Hebbal Avare, Cluster bean, Coriander **Vegetables:** Tomato, Green Chillies, French Bean, Bhendi, Vegetable Cowpea, Cucurbits, Onion **Flower Crops:** Marigold, Gaillardia	Mango, Sapota, Guava, Lime, Banana, Papaya, Jamun **Mixed Orchard:** Mango+Guava+Drumsticks Sapota+Guava+Drumsticks+Curry leaf **Vegetables**: Tomato, Capsicum, Green chillies, French Bean, Bhendi, Crucifers, Cucurbits **Flower Crops:** Tuberose, Aster, Rose, Chrysanthemum, Jasmine, Spider Lilly	Drip irrigation, Mulching, other suitable conservation practices (Crescent Bunding with Catch Pit etc)
LMU-2	23, 24, 43, 44, 45 (100-150 cm) Deep	**Ranathura:**1,2,3,4,5,6, 15,16,24,26,34,88,89,114,115,117,118,119,128,129	Ragi, Maize, Groundnut, Sorghum, Sunflower, Bajra, Sesamum, Castor	**Perennial Component:** Mango, Tamarind, Aonla, Pomelo **Intercrops:** Groundnut, Hebbalavare, Cluster bean, Coriander **Vegetables:** Green chillies, Tomato, French Bean, Bhendi, Vegetable Cowpea, Cucurbits **Flower crops:** Marigold, Gaillardia	Mango, Sapota, Guava, Lime, Banana, Papaya, Jamun **Mixed Orcharding:** Mango+Guava+Drumsticks Sapota+Guava+Drumsticks+Curryleaf **Vegetables**: Tomato, Capsicum, Green Chillies, French Bean, Bhendi, Crucifers, Cucurbits **Flower Crops:** Tuberose, Aster, Chrysanthemum, Rose, Jasmine, Spider Lilly	-do-
LMU-3	1, 2, 5 (75-100 cm) Moderately deep	**Ranathura:**10,11,12,13,18,19,23,99,101,104	Ragi, Maize, Groundnut, Sorghum, Sunflower, Bajra, Sesamum, Castor	**Perennial Component:** Mango, Tamarind, Aonla, Pomelo **Intercrops:** Groundnut, Hebbal, Avare, Cluster bean, Coriander **Vegetables:** Tomato, Green chillies, French Bean, Bhendi, Vegetable Cowpea, Cucurbits **Flower crops:** Marigold, Gaillardia	Mango, Sapota, Guava, Lime,Banana, Papaya, Jamun **Mixed Orcharding:** Mango+Guava+Drumsticks Sapota+Guava+Drumsticks+Curryleaf **Vegetables**: Tomato, Capsicum, Green chillies, French bean, Bhendi, Crucifers, Cucurbits **Flower crops:** Tuberose, Aster, Rose, Chrysanthemum, Jasmine, Spider Lilly	Drip irrigation, Mulching, other suitable conservation practices (Crescent Bunding with Catch Pit etc)

LMU-4	6, 7, 8 (75-100 cm) Moderately deep	**Ranathura:**96	-do-	-do-	-do-	-do-
LMU-5	13, 21, 22 (75-100 cm) Moderately deep	**Ranathura:**109,110,111,112,113,120,121,123,124,127	Sorghum, Bajra, Sunflower, Cotton, Safflower **Multiple/Crop rotation:** Redgram +Maize, Redgram+ Fodder Jowar, Pulses+Sorghum	**Vegetables:** Chillies, Tomato, Bhendi, Onion, Cabbage, Drumstick **Perennial Components:** Tamarind, Custard Apple, Amla, Lime, Musambi, Pomegranate	**Flower Crops:** Marigold, Gaillardia, Tuberose, Chrysanthemum **Perennial Components:** Tamarind, Custard Apple, Amla, Lime, Musambi, Pomegranate **Vegetables:** Chillies, Bhendi, Crucifers	Drip irrigation, Mulching, other suitable conservation practices
LMU-6	9, 10 (50-75 cm) Moderately deep	**Bellati:**39,40 **Devihala**:123	Ragi, Maize, Bajra	**Vegetables:** Cluster Bean, Ridge Gourd, Ash Gourd	Custard Apple, Bear, Fig, Aonla, Pomelo	-do-
LMU-7	14,15,16,17, 26, 27,28,29, 30, 31,32,33, 34, 35,36,37, 38 (50-75 cm) Moderately shallow	Ranathura:7,8,9,27,81, 94,95,106,122,131,138, 144,145,146,147 **Bellati:**19,24,26,27,30, 31,32,33,34,35,36,37,38,41,42,43,44,45,46,47, 49,58,59 **Devihala:**125,126,136	Ragi, Bajra, Horsegram, Groundnut	Bear, Custard Apple **Vegetables:** Cluster Bean, Ridge gourd, Ash gourd	Fig, Aonla, Pomelo	Drip irrigation, Mulching, other suitable conservation practices
LMU-8	40, 41, 42 (50-75 cm) Moderately shallow	**Ranathura:**90,93,100	Ragi, Sorghum, Maize, Bajra, Horsegram, Castor	Bear, Fig, Aonla, Bael, Wood apple	Custard Apple, Bear, Fig, Aonla, Pomelo	-do-
LMU-9	3, 4, 11, 12, 18, 19, 20, 25 (25-50- cm) Shallow	**Ranathura:**103,105,107,130,137 **Bellati:** 22,23,25 **Devihala:**124,127,133, 134,135	Groundnut, Horsegram, Greengram **Silviculture:** *Acacia auriculiformis*, Agave, Simaruba, Glyricidia, Subabul, *Cassia sp*.	**Vegetables:** Chillies, Tomato	Bear, Fig, Aonla, Pomelo	-do-

Chapter 8

SOIL HEALTH MANAGEMENT

8.1 Soil Health

Soil is fundamental to crop production. Without soil, no food could be produced nor would livestock be fed on a large scale. Because it is finite and fragile, soil is a precious resource that requires special care from its users.

Soil health or the capacity of the soil to function is critical to human survival. Soil health has been defined as: "the capacity of the soil to function as a living system without adverse effect on the ecosystem". Healthy soils maintain a diverse community of soil organisms that help to form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, improve soil structure with positive repercussions for soil, water and nutrient holding capacity and ultimately improve crop production and also contribute to mitigating climate change by maintaining or increasing its carbon content.

Functional interactions of soil biota with organic and inorganic components, air and water determine a soil's potential to store and release nutrients, and water to plants and to promote and sustain plant growth. Thus, maintaining soil health is vital to crop production and conserve soil resource base for sustaining agriculture.

The most important characteristic of a healthy soil are

- Good soil tilth
- Sufficient soil depth
- Good water storage and good drainage
- Adequate supply, but not excess of nutrients
- Large population of beneficial organisms
- Small proportion of plant pathogens and insect pests
- Low weed pressure
- Free of chemicals and toxins that may harm the crop
- Resistance to degradation
- Resilience when unfavorable conditions occur

Characteristics of Rantur Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of KTP (101 ha), KMH (63 ha), KGH (59 ha), LKR (55 ha), KKR (54 ha), KGP (52 ha), VDH (49 ha), HRV (42 ha), GHT (26 ha), TDH (26 ha), HNH (23 ha), JLG (22 ha), HDH (19 ha), CKM (17 ha), MKH (17 ha), MRD (7 ha), KNH (6 ha) and CSR (6 ha).
- As per land capability classification, entire area in the microwatershed falls under arable land category (Class II, III and IV). The major limitations identified in the arable lands were soil erosion and wetness.

- ❖ On the basis of soil reaction, maximum area of about 219 ha (33%) is moderately alkaline (pH 7.8-8.4). An area of about 133 ha (20%) is under strongly alkaline (pH 8.4-9.0) and about 162 ha (24%) is under slightly alkaline (pH 7.3-7.8). Slightly acid (pH 6.0-6.5) soils occupy an area of about 14 ha (2%) and neutral (pH 6.5-7.3) is under 116 ha (17%).

Soil Health Management

The following actions are required to improve the current land husbandry practices that provide a sound basis for the successful adoption of sustainable crop production system.

Alkaline soils

(Slightly alkaline to moderately alkaline soils)

1. Regular addition of organic manure, green manuring, green leaf manuring, crop residue incorporation and mulching needs to be taken up to improve the soil organic matter status.
2. Application of biofertilizers (AzospirulLMU, Azatobacter, Rhizobium).
3. Application of 25% extra N and P (125 % RDN&P).
4. Application of $ZnSO_4$ – 12.5 kg/ha (once in three years).
5. Application of Boron – 5 kg/ha (once in three years).

Neutral soils

1. Regular addition of organic manure, green manuring, green leaf manuring, crop residue incorporation and mulching needs to be taken up to improve the soil organic matter status.
2. Application of biofertilizers, (AzospirulLMU, Azotobacter, Rhizobium).
3. Application of 100 per cent RDF.
4. Need based micronutrient applications.

Besides the above recommendations, the best transfer of technology options are also to be adopted.

Acid soils

(Slightly acid to strongly acid soils)

1. Application of lime in the form of calcium carbonate or lime stone ($CaCO_3$)
2. Regular addition of organic manure, green manuring, green leaf manuring, crop residue incorporation and mulching needs to be taken up to improve the soil organic matter status.
3. Use of rock phosphate (30-50 % of CaO) which helps in improving soil pH.
4. Application of basic fertilizers (Sodium nitrate, basic slag etc reduces acidity in acid soils)

Besides the above recommendations, the best transfer of technology options are also to be adopted.

Soil Degradation

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 670 ha area in the microwatershed, an area of 347 ha is suffering from moderate erosion. These areas need immediate soil and water conservation and, other land development and land husbandry practices for restoring soil health.

Disseminate information and communicate benefits

Any large scale implementation of soil health management requires that supporting information is made available widely, particularly through channels familiar to farmers and extension workers. Given the very high priority attached to soil health especially by the Central Government on issuing Soil-Health Cards to all the farmers, media outlets like regional, state and national newspapers, Radio and Dooradarshan programs in local languages but also modern information and communication technologies such as cellular phones and the Internet, which can be much more effective in reaching younger farmers.

Inputs for Net Planning (Saturation Plan) and Interventions needed

Net planning in IWMP is focusing on preparation of

1. Soil and Water Conservation Treatment Plans for each plot or farm.
2. Productivity enhancement measures/ interventions for existing crops/livestock/other farm enterprises.
3. Diversification of farming mainly with perennial horticultural crops and livestock.
4. Improving livelihood opportunities and income generating activities.

In this connection, how various outputs of Sujala-III are of use in addressing these objectives of Net Planning (Saturation Plan) are briefly presented below.

- ❖ **Soil Depth:** The depth of a soil decides the amount of moisture and nutrients it can hold, what crops can be taken up or not, depending on the rooting depth and the length of growing period available for raising any crop. Deeper the soil, better for a wide variety of crops. If sufficient depth is not available for growing deep rooted crops, either choose medium or short duration crops or deeper planting pits need to be opened and additional good quality soil brought from outside has to be filled into the planting pits.
- ❖ **Surface soil texture:** Lighter soil texture in the top soil means, better rain water infiltration, less run-off and soil moisture conservation, less capillary rise and less evaporation losses. Lighter surface textured soils are amenable to good soil tilth and are highly suitable for crops like groundnut, root vegetables (carrot, radish, potato etc) but not ideal for crops that need stagnant water like lowland paddy. Heavy textured soils are poor in water infiltration and percolation. They are prone for sheet erosion; such soils can be improved by sand mulching. The technology that is developed by the AICRP-Dryland Agriculture, Vijayapura, Karnataka can be adopted.

- **Gravelliness:** More gravel content is favorable for run-off harvesting but poor in soil moisture storage and nutrient availability. It is a significant parameter that decides the kind of crop to be raised.
- **Land Capability Classification:** The land capability map shows the areas suitable and not suitable for agriculture and the major constraints in each of the plot/survey number. Hence, one can decide what kind of enterprise is possible in each of these units. In general, erosion and soil are the major constraints in Rantur Microwatershed.
- **Organic Carbon:** The OC content (an index of available Nitrogen) is medium (0.5-0.75%) in about 238 ha (35%) area, low (<0.5%) in maximum area of 334 ha (50%) and high (>0.5%) in an area of about 73 ha (11%). The areas that are low and medium in OC needs to be further improved by applying farmyard manure and rotating crops with cereals and legumes or mixed cropping.
- **Promoting green manuring:** Growing of green manuring crops costs Rs. 1250/ha (green manuring seeds) and about Rs. 2000/ha towards cultivation that totals to Rs. 3250/- per ha. On the other hand, application of organic manure @ 10 tons/ha costs Rs. 5000/ha. The practice needs to be continued for 2-3 years or more. Nitrogen fertilizer needs to be supplemented by 25% in addition to the recommended level in 334 ha area where OC is less than 0.5% and 238 ha area is medium (0.5-0.75%) in OC. For example, for rainfed maize, recommended level is 50 kg N per ha and an additional 12 kg /ha needs to be applied for all the crops grown in these plots.
- **Available Phosphorus**: In 504 ha (75%) area, the available phosphorus is low and 140 ha (21%) is medium in available phosphorus. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is medium in 512 ha (76%) area of the microwatershed. For all crops, additional 25 % potassium may be applied. It is high in 133 ha (20%) area of the microwatershed.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. Available sulphur is medium in maximum area of about 382 ha (57%) and low in area of about 210 ha (31%) in the microwatershed. These areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertilizer (13% sulphur) for 2-3 years for the deficiency to be corrected. It is high (>20ppm) in 53 ha (8%) area of the microwatershed.
- **Available Boron:** Available boron is medium in an area of 294 ha (44%), low in 349 ha (52%). These areas need to be applied with sodium borate @ 10 kg/ha as soil application or 0.2% borax as foliar application to correct the boron deficiency. It is high (>0.1 ppm) in about 2 ha (<1%).
- **Available iron:** It is deficient in an area of 257 ha (38%) in the microwatershed. To manage iron deficiency, iron sulphate @ 25kg /ha needs to be applied for 2-3 years. It is sufficient in the rest of 388 ha (58 %) area in the microwatershed.

- **Available Zinc:** It is deficient (<0.6 ppm) in maximum area of 599 ha (89%) area and sufficient (>0.6 ppm) in 45 ha (7%) in the microwatershed. Application of zinc sulphate @ 25kg/ha is to be followed.
- **Soil alkalinity:** The microwatershed has 514 ha (77%) area with soils that are moderately to strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acasia, Neem, Ber etc, are recommended.

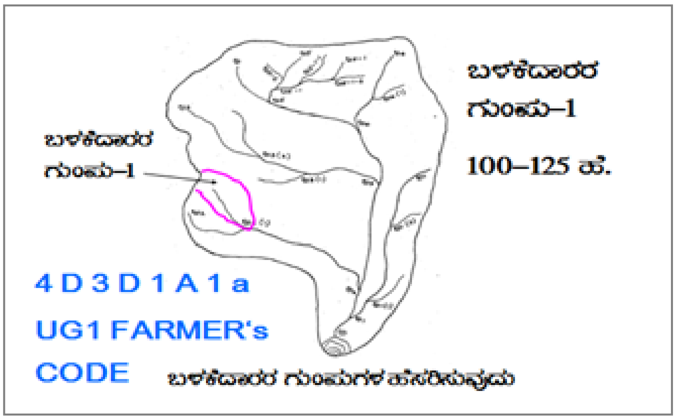
  Land Suitability for various crops: Areas that are highly, moderately and marginally suitable for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth and salinity/alkalinity are the major constraints in various plots. With suitable management interventions, the productivity can be enhanced. In order to increase water holding capacity of light textured soils, growing of green manure crops and application of organic manure is recommended.

Chapter 9

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Rantur Microwatershed, the land resource inventory database generated under Sujala-III project has been transformed as information through series of interpretative (thematic) maps using soil phase map as a base. The various thematic maps (1:7920 scale) generated were

- Soil depth
- Surface soil texture
- Available water capacity
- Soil slope
- Soil gravelliness
- Land capability
- Present land use and land cover
- Crop suitability
- Rainfall
- Hydrology
- Water Resources
- Socio-economic data
- Contour plan with existing features- Network of waterways, pothissa boundaries, cut up/ minor terraces etc.
- Cadastral map (1:7920 scale)
- Satellite imagery (1:7920 scale)



Apart from these, Hand Level/ Hydro Marker/ Dumpy Level/ Total Station and Kathedars' List has to be collected.

Steps for Survey and Preparation of Treatment Plan

The boundaries of Land User Groups' and Survey No. boundaries are traced in the field.

- Naming of user groups and farmers
- Identification of arable and non arable lands
- Identification of drainage lines and gullies
- Identification of non treatable areas
- Identification of priority areas in the arable lands
- Treatment plan for arable lands
- Location of water harvesting and recharge structures

9.1 Treatment Plan

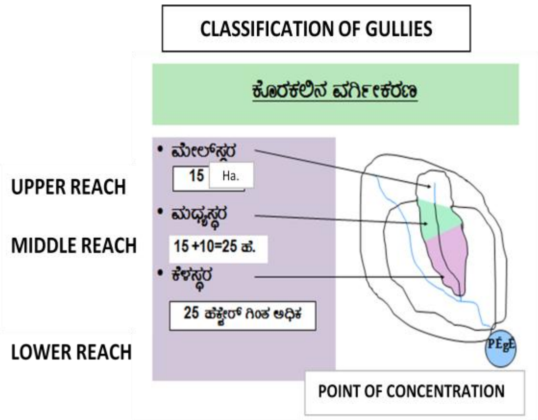
The treatment plan recommended for arable lands is briefly described below.

9.1.1 Arable Land Treatment

A. BUNDING

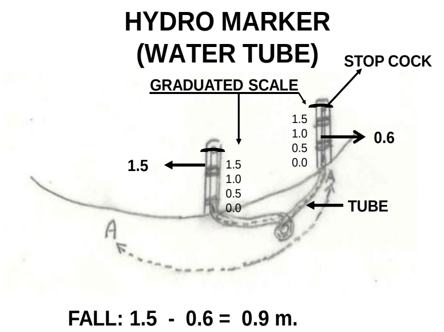
Steps for Survey and Preparation of Treatment Plan	
Cadastral map (1:7920 scale) is enlarged to a scale of 1:2500 scale Existing network of waterways, pothissa boundaries, grass belts, natural drainage lines/ watercourse, cut ups/ terraces are marked on the cadastral map to the scale. Drainage lines are demarcated into	
Small gullies	(up to 5 ha catchment)
Medium gullies	(5-15 ha catchment)
Ravines	(15-25 ha catchment) and
Halla/Nala	(more than 25ha catchment)

USER GROUP-1



Measurement of Land Slope

Land slope is estimated or determined by the study and interpretation of contours or by measurement in the field using simple instruments like Hand level or Hydromarker.



Vertical and Horizontal intervals between bunds as recommended by the Watershed Development Department.

Slope percentage	Vertical interval (m)	Corresponding Horizontal Distance (m)
2 - 3%	0.6	24
3 - 4%	0.9	21
4 - 5%	0.9	21
5 - 6%	1.2	21
6 - 7%	1.2	21

Note: i) The above intervals are maximum.

(ii) Considering the slope class and erosion status (A1… A= 0-1% slope, 1= slight erosion) the intervals have to be decided.

Bund length recording: Considering the contour plan and the existing grass belts/partitions, the bunds are aligned and lengths are measured.

Section of the Bund

Bund section is decided considering the soil texture class and gravelliness Class (bg_0 - loamy sand, <15% gravel). The recommended sections for different soils are given below.

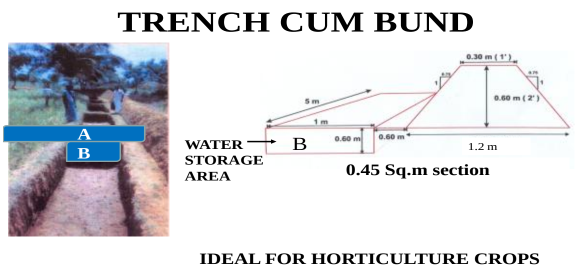
Recommended Bund Section

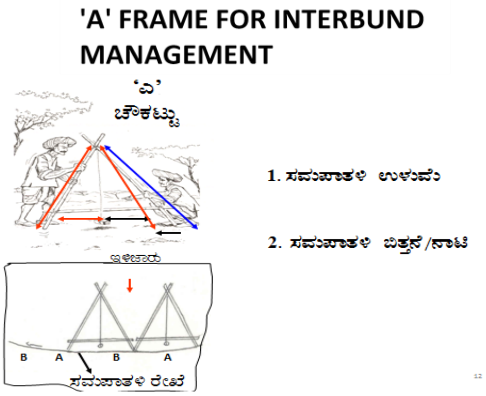
Top width (m)	Base width (m)	Height (m)	Side slope (Z:1;H:V)	Cross section (sq m)	Soil Texture	Remarks
0.3	0.9	0.3	01:01	0.18	Sandy loam	Vegetative bund
0.3	1.2	0.3	1.5:1	0.225	Sandy clay	
0.3	1.2	0.5	0.9:1	0.375	Red gravelly soils	
0.3	1.2	0.6	0.75:1	0.45		
0.3	1.5	0.6	01:01	0.54	Red sandy loam	
0.3	2.1	0.6	1.5:1	0.72	Very shallow black soils	
0.45	2	0.75	01:01	0.92		
0.45	2.4	0.75	1.3:1	1.07	Shallow black soils	
0.6	3.1	0.7	1.78:1	1.29	Medium black soils	
0.5	3	0.85	1.47:1	1.49		

Formation of Trench cum Bund

Dimensions of the Borrow Pits/ Trenches to be excavated (machinery are decided considering the Bund Section).

Details of Borrow Pit dimensions are given below





Size of Borrow Pits/ Trench recommended for Trench cum Bund (by machinery)

Bund section	Bund length	Earth quantity	Pit				Berm (pit to pit)	Soil depth Class
m^2	m	m^3	L(m)	W(m)	D(m)	Quantity(m^3)	m	
0.375	6	2.25	5.85	0.85	0.45	2.24	0.15	Shallow
0.45	6	2.7	5.4	1.2	0.43	2.79	0.6	Shallow
0.45	6	2.7	5	0.85	0.65	2.76	1	Moderately Shallow
0.54	5.6	3.02	5.5	0.85	0.7	3.27	0.1	Moderately shallow
0.54	5.5	2.97	5	1.2	0.5	3	0.5	Shallow
0.72	6.2	4.46	6	1.2	0.7	5.04	0.2	Moderately shallow
0.72	5.2	3.74	5.1	0.85	0.9	3.9	0.1	Moderately deep

B. Waterways

a) Existing waterways are marked on the cadastral map (1:7920 scales) and their dimensions are recorded.

b) Considering the contour plan of the MWS, additional waterways/ modernization of the existing ones can be thought of.

c) The design details are given in the Manual.

C. Farm Ponds

Waterways and the catchment area will give an indication on the size of the Farm Pond. Location of the pond can be decided based on the contour plan/ field condition and farmers' need/desire.

D. Diversion channel

Existing EPT/ CPT are marked on the cadastral map. Looking to the need, these can be modernized or fresh diversion channel can be proposed and runoff from this can be stored in Gokatte/ Recharge ponds.

9.1.2 Non-Arable Land Treatment

Depending on the gravelliness and crops preferred by the farmers, the concerned authorities can decide appropriate treatment plan. The recommended treatments may be Contour Trench, Staggered Trench, Crescent Bund, Boulder Bund or Pebble Bund are formed in the field.

9.1.3 Treatment of Natural Water Course/ Drainage Lines

a) The cadastral map has to be updated as regards the network of drainage lines (gullies/ nalas/ hallas) and existing structures are marked to the scale and storage capacity of the existing water bodies are documented.

b) The drainage line will be demarcated into Upper Reach, Middle Reach and Lower Reach.

c) Considering the Catchment, Nala bed and bank conditions, suitable structures are decided.
d) Number of storage structures (Check dam/ Nala bund/ Percolation tank) will be decided considering the commitments and available runoff in water budgeting and quality of water in the wells and site suitability.
e) Detailed Leveling Survey using Dumpy Level / Total Station has to be carried out to arrive at the site-specific designs as shown in the Manual.
f) The location of ground water recharge structures are decided by examining the lineaments and fracture zones from geological maps.
g) Rainfall intensity data of the nearest Rain gauge station is considered for Hydrologic Designs.
h) Silt load to the Storage/Recharge structures is reduced by providing vegetative, boulder and earthern checks in the natural water course. Location and design details are given in the Manual.

9.2 Recommended Soil and Water Conservation Measures

The appropriate conservation structures best suited for each of the land parcel/ survey number (Appendix-I) are selected based on the slope per cent, severity of erosion, amount of rainfall, land use and soil type. The different kinds of conservation structures recommended are

1. Graded / Strengthening of bunds
2. Trench cum Bunds (TCB)
3. Trench cum Bunds / Strengthening
4. Crescent Bunds

A map (Fig. 9.1) showing soil and water conservation plan with different kinds of structures recommended has been prepared which shows the spatial distribution and extent of area. Maximum area of about 526 ha (78%) requires trench cum bunding. About 118 ha (18%) area needs graded bunds or strengthening of existing bunds. The conservation plan prepared may be presented to all the stakeholders including farmers and after including their suggestions, the conservation plan for the microwatershed may be finalised in a participatory approach.

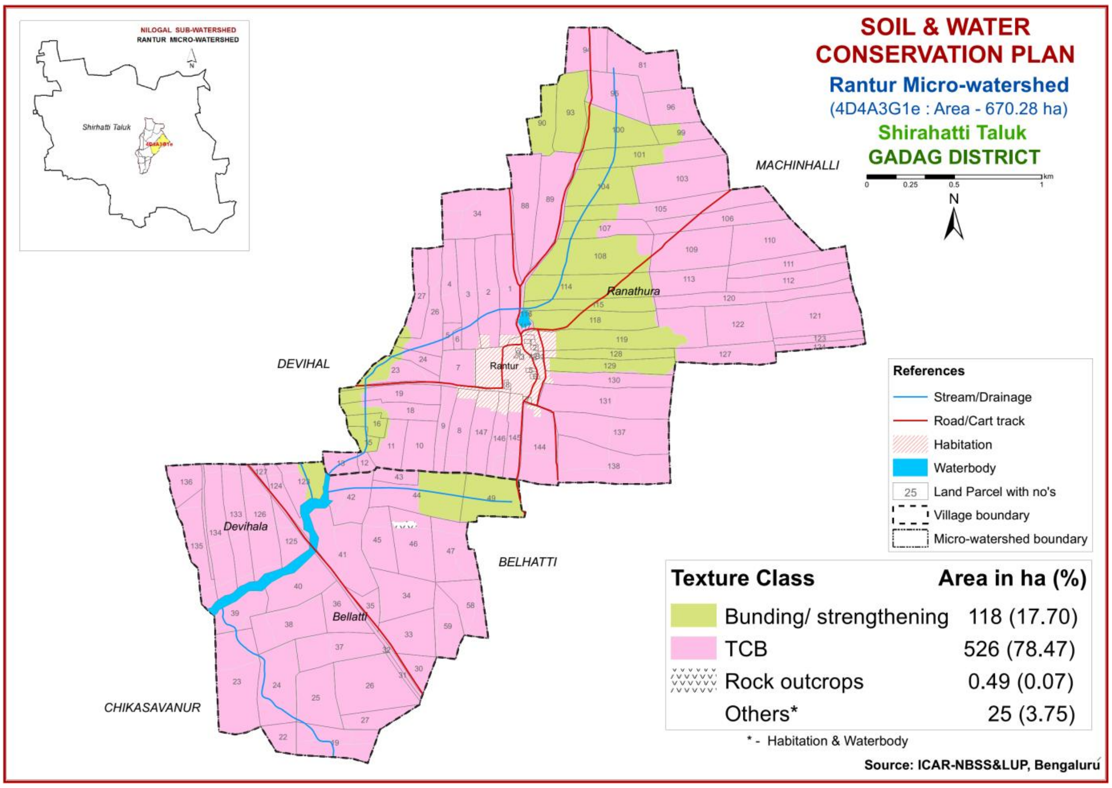


Fig. 9.1 Soil and Water Conservation Plan map of Rantur Microwatershed

9.3 Greening of Microwatershed

As part of the greening programme in the watersheds, it is envisaged to plant a variety of horticultural and other tree plants that are edible, economical and produce lot of biomass which helps to restore the ecological balance in the watersheds. The lands that are suitable for greening programme are non-arable lands (land capability classes V, VI and VII) and also the lands that are not suitable or marginally suitable for growing annual and perennial crops. The method of planting these trees is given below.

It is recommended to open pits during the 1st week of March along the contour and heap the dugout soil on the lower side of the slope in order to harness the flowing water and facilitate weathering of soil in the pit. Exposure of soil in the pit also prevents spread of pests and diseases due to scorching sun rays. The pits should be filled with mixture of soil and organic manure during the second week of April and keep ready with sufficiently tall seedlings produced either in poly bags or in root trainer nurseries so that planting can be done during the 2nd or 3rd week of April depending on the rainfall.

The tree species suitable for the area considering rainfall, temperature and adaptability is listed below; waterlogged areas are recommended to be planted with species like Neral (*Sizyzium cumini*) and Bamboo. Dry areas are to be planted with species like Honge, Bevu, Seetaphal *etc*.

Dry Deciduous Species			Temp (°C)	Rainfall(mm)
1.	Bevu	*Azadiracta indica*	21–32	400 –1,200
2.	Tapasi	*Holoptelia integrifolia*	20-30	500 - 1000
3.	Seetaphal	*Anona Squamosa*	20-40	400 - 1000
4.	Honge	*Pongamia pinnata*	20 -50	500–2,500
5.	Kamara	*Hardwikia binata*	25 -35	400 - 1000
6.	Bage	*Albezzia lebbek*	20 - 45	500 - 1000
7.	Ficus	*Ficus bengalensis*	20 - 50	500–2,500
8.	Sisso	*Dalbargia Sissoo*	20 - 50	500 -2000
9.	Ailanthus	*Ailanthus excelsa*	20 - 50	500 - 1000
10.	Hale	*Wrightia tinctoria*	25 - 45	500 - 1000
11.	Uded	*Steriospermum chelanoides*	25 - 45	500 -2000
12.	Dhupa	*Boswella Serrata*	20 - 40	500 - 2000
13.	Nelli	*Emblica Officinalis*	20 - 50	500 -1500
14.	Honne	*Pterocarpus marsupium*	20 - 40	500 - 2000
Moist Deciduous Species				
15.	Teak	*Tectona grandis*	20 - 50	500-5000
16.	Nandi	*Legarstroemia lanceolata*	20 - 40	500 - 4000
17.	Honne	*Pterocarpus marsupium*	20 - 40	500 - 3000
18.	Mathi	*Terminalia alata*	20 -50	500 - 2000
19.	Shivane	*Gmelina arboria*	20 -50	500 -2000
20.	Kindal	*T.Paniculata*	20 - 40	500 - 1500
21.	Beete	*Dalbargia latifolia*	20 - 40	500 - 1500
22.	Tare	*T. belerica*	20 - 40	500 - 2000
23.	Bamboo	*Bambusa arundinasia*	20 - 40	500 - 2500
24.	Bamboo	*Dendrocalamus strictus*	20 – 40	500 – 2500
25.	Muthuga	*Butea monosperma*	20 - 40	400 - 1500
26.	Hippe	*Madhuca latifolia*	20 - 40	500 - 2000
27.	Sandal	*SantaLMU album*	20 - 50	400 - 1000
28.	Nelli	*Emblica officinalis*	20 - 40	500 - 2000
29.	Nerale	*Sizyzium cumini*	20 - 40	500 - 2000
30.	Dhaman	*Grevia tilifolia*	20 - 40	500 - 2000
31.	Kaval	*Careya arborea*	20 - 40	500 - 2000
32.	Harada	*Terminalia chebula*	20 - 40	500 - 2000

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Appendix I

Rantur Microwatershed

Soil Phase Information

Village	Sy No.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Cap ability	Conserva tion Plan
Bellatti	19	7.79	KGHcB2g1	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	Not Available	IIes	TCB
Bellatti	22	2.69	HRVbB2g1	LMU-9	Shallow (25-50 cm)	Loamy sand	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IVes	TCB
Bellatti	23	13.53	HRVbB2g1	LMU-9	Shallow (25-50 cm)	Loamy sand	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	1 Bore Well	IVes	TCB
Bellatti	24	9.65	LKRhB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Extremely gravelly (60-80%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	Not Available	IIIes	TCB
Bellatti	25	7.61	KGPcB2g2	LMU-9	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton (Mz+Ct)	1 Open Well	IVes	TCB
Bellatti	26	12.19	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Bellatti	27	3.38	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Horse gram (Rg+Hg)	Not Available	IIes	TCB
Bellatti	30	2.75	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Horse gram (Sf+Hg)	Not Available	IIes	TCB
Bellatti	31	0.6	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIes	TCB
Bellatti	32	0.04	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIes	TCB
Bellatti	33	6.67	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Bellatti	34	7.4	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+HorseGram +Maize(Sf+Hg+Mz)	Not Available	IIes	TCB
Bellatti	35	2.11	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IIes	TCB
Bellatti	36	5.1	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+HorseGram +Maize(Rg+Hg+Mz)	Not Available	IIes	TCB
Bellatti	37	7.81	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	1 Bore Well	IIes	TCB
Bellatti	38	8.43	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize +Groundnut(Hg+Mz+Gn)	1 OpenWell, 2 Bore Well	IIes	TCB
Bellatti	39	4.75	HNHhB1	LMU-6	Moderately shallow (50-75 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Fallow land (Fl)	Not Available	IIIw	TCB
Bellatti	40	7.02	HNHhB1	LMU-6	Moderately shallow (50-75 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	Not Available	IIIw	TCB
Bellatti	41	10.23	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+ Groundnut(Mz+Ct+Gn)	1 Bore Well	IIes	TCB
Bellatti	42	6.43	KGHiB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Eucalyptous trees+ Maize (Et+Mz)	2 Bore Well	IIes	TCB
Bellatti	43	2	KGHiB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIes	TCB
Bellatti	44	10.72	KTPiA1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Cotton+Redgram+ Coconut+Onion (Ct+Rg+CN+On)	2 Bore Well, 2 Open Well	IIs	Bunding/ Field Bunds

Village	Sy No.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	45	6.07	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Bellatti	46	8.34	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Horsegram +Maize (Rg+Hg+Mz)	Not Available	IIes	TCB
Bellatti	47	7.75	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Bellatti	49	7.8	KTPiA1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Cotton+Redgram+Maize (Ct+Rg+Mz)	1 Bore Well	IIs	Bunding/ Field Bunds
Bellatti	58	5.48	KTPcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Bellatti	59	5.23	KGHcB2g3	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Maize (Hg+Mz)	Not Available	IIes	TCB
Devihala	123	5.22	HNHiA1	LMU-6	Moderately shallow (50-75 cm)	Sandy clay	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Eucalyptous trees+Maize(Et+Mz)	Not Available	IIw	Bunding/ Field Bunds
Devihala	124	2.76	HRVcB1g2	LMU-9	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Fallow land (Fl)	Not Available	IVs	TCB
Devihala	125	3.71	KGHcB1	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	Not Available	IIs	TCB
Devihala	126	9.08	KGHcB1	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Cotton+ Redgram+Groundnut (Mz+Ct+Rg+Gn)	2 Bore Well	IIs	TCB
Devihala	127	0.63	CSRbB1g2	LMU-9	Shallow (25-50 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	NA	Not Available	IIIs	TCB
Devihala	133	7.51	HRVbB2g1	LMU-9	Shallow (25-50 cm)	Loamy sand	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	2 Bore Well, 1 Open Well	IVes	TCB
Devihala	134	8.74	HRVbB2g1	LMU-9	Shallow (25-50 cm)	Loamy sand	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Redgram+ Coconut (Ct+Rg+CN)	2 Bore Well,1 Open Well	IVes	TCB
Devihala	135	6.62	KNHhB1g1	LMU-9	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	1 OpenWell, 1 Bore Well	IIIs	TCB
Devihala	136	3.7	MKHcB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	Not Available	IIIes	TCB
Nelogal	STREAM	5.95	Waterbody	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Ranathura	1	7.38	KMHcB1g1	LMU-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Cotton (Mz+Ct)	Not Available	IIs	TCB
Ranathura	2	7.66	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Onion (Mz+On)	1 Bore Well, 1 Open Well	IIes	TCB
Ranathura	3	6.64	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Redgram (Ct+Rg)	3 OpenWell, 3 Bore Well	IIes	TCB
Ranathura	4	4.38	KMHcB1g1	LMU-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize+ Cotton (Rg+Mz+Ct)	1 OpenWell, 1 Bore Well	IIs	TCB
Ranathura	4/A1	0.01	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Ranathura	4/B	0.01	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	NA	Others	Others
Ranathura	4/B1	0.12	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Ranathura	5	1.23	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	1 Bore Well	IIes	TCB
Ranathura	6	0.69	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIes	TCB

Village	Sy No.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Ranathura	7	4.15	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	1 Open Well	IIIs	TCB
Ranathura	8	6.01	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	Not Available	IIIs	TCB
Ranathura	9	3.7	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	1 Bore Well, 1 Open Well	IIIs	TCB
Ranathura	10	5.09	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Onion (Mz+On)	1 Bore Well	IIs	TCB
Ranathura	11	4.12	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Onion (Mz+On)	1 Bore Well	IIs	TCB
Ranathura	12	0.93	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Onion (On)	Not Available	IIs	TCB
Ranathura	13	2.44	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Cotton+Onion (Ct+On)	Not Available	IIs	TCB
Ranathura	15	1.64	VDHiA1	LMU-2	Deep (100-150 cm)	Sandy clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Cotton (Ct)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	16	2.14	VDHiA1	LMU-2	Deep (100-150 cm)	Sandy clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Cotton+Onion (Ct+On)	1 Bore Well	IIs	Bunding/ Field Bunds
Ranathura	18	4.78	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Cotton+Onion (Mz+Ct+On)	2 Bore Well, 1 Open Well	IIs	TCB
Ranathura	19	5.34	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	1 Bore Well	IIs	TCB
Ranathura	23	4.59	GHThB1g1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	Not Available	IIs	TCB
Ranathura	24	2.23	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Onion (Ct+On)	2 Bore Well	IIes	TCB
Ranathura	26	6.61	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	3 OpenWell, 1 Bore Well	IIes	TCB
Ranathura	27	4.88	MKHhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Maize (Mz)	Not Available	IIIs	TCB
Ranathura	34	10.94	KMHcB1g1	LMU-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Sugarcane+Maize+ Cotton(Sc+Mz+Ct)	1 Bore Well	IIs	TCB
Ranathura	81	8.85	LKRhC2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Eucalyptous trees+Forest (Et+F)	Not Available	IIIes	TCB
Ranathura	88	9.03	KMHcB1g1	LMU-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize+ Cotton (Rg+Mz+Ct)	2 Open Well	IIs	TCB
Ranathura	89	8.82	KMHcB1g1	LMU-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize+ Cotton+Onion (Rg+Mz+Ct+On)	2 OpenWell, 1 Bore Well	IIs	TCB
Ranathura	90	4.68	TDHbA2g1	LMU-8	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Nearly level (0-1%)	Moderate	Groundnut+Red gram+Maize(Gn+Rg+Mz)	Not Available	IIes	Bunding/ Field Bunds
Ranathura	93	7.66	TDHbA2g1	LMU-8	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Nearly level (0-1%)	Moderate	Groundnut+Sunflower +Redgram+Maize (Gn+Sf+Rg+Mz)	2 Open Well	IIes	Bunding/ Field Bunds
Ranathura	94	5.82	KTPmB2g1	LMU-7	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Eucalyptous trees+Forest (Et+F)	Not Available	IIes	TCB
Ranathura	95	7.28	KTPiB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Eucalyptous trees+Forest (Et+F)	Not Available	IIes	TCB

Village	Sy No.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Ranathura	96	5.53	HDHhB2g2	LMU-4	Moderately deep (75-100 cm)	Sandy clay loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Horse gram (Rg+Hg)	Not Available	IIIes	TCB
Ranathura	99	3.26	CKMhA1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Sugarcane (Sc)	1 Bore Well, 1 Open Well	IIs	Bunding/ Field Bunds
Ranathura	100	7.65	TDHbA2g1	LMU-8	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Nearly level (0-1%)	Moderate	Groundnut+Redgram+Maize+Cotton (Gn+Rg+Mz+Ct)	Not Available	IIes	Bunding/ Field Bunds
Ranathura	101	8.65	CKMhA1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Redgram+Maize+Cotton+Sorghum+Onion (Rg+Mz+Ct+Sg+On)	2 Bore Well	IIs	Bunding/ Field Bunds
Ranathura	103	11.25	KGPfB2G2	LMU-9	Shallow (25-50 cm)	Clay loam	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+Sorghum+Onion (Mz+Ct+Sg+On)	2 Open Well	IVes	TCB
Ranathura	104	7.94	CKMhA1	LMU-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Maize (Mz)	1 Open Well	IIs	Bunding/ Field Bunds
Ranathura	105	11.37	KGPfB2G2	LMU-9	Shallow (25-50 cm)	Clay loam	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+Sorghum+Onion (Mz+Ct+Sg+On)	1 Open Well	IVes	TCB
Ranathura	106	7.25	MKHmB2g1	LMU-7	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+Sorghum (Mz+Ct+Sg)	Not Available	IIIes	TCB
Ranathura	107	4.84	HRVbB2g1	LMU-9	Shallow (25-50 cm)	Loamy sand	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize+Cotton+Onion (Rg+Mz+Ct+On)	3 Bore Well, 1 Open Well	IVes	TCB
Ranathura	108	12.82	MRDfA1	LMU-1	Very deep (>150 cm)	Clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Redgram+Horsegram+Maize+Cotton (Rg+Hg+Mz+Ct)	1 Bore Well, 2 Open Well	IIs	Bunding/ Field Bunds
Ranathura	109	10.09	KKRhB1g1	LMU-5	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Cotton+Sorghum (Ct+Sg)	Not Available	IIs	TCB
Ranathura	110	9.11	KKRhB1g1	LMU-5	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Sorghum+Groundnut (Mz+Sg+Gn)	Not Available	IIs	TCB
Ranathura	111	6.16	KKRhB1g1	LMU-5	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIs	TCB
Ranathura	112	6.62	KKRhB1g1	LMU-5	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Sorghum (Mz+Sg)	Not Available	IIs	TCB
Ranathura	113	6.12	KKRmB2g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum+Horse gram (Sg+Hg)	Not Available	IIes	TCB
Ranathura	114	10.07	VDHhA1g1	LMU-2	Deep (100-150 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Cotton+Sorghum (Ct+Sg)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	115	5.2	VDHhA1g1	LMU-2	Deep (100-150 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Maize+Sorghum (Mz+Sg)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	116	0.18	Waterbody	Others	Others	Others	Others	Others	Others	Oters	NA	Not Available	Others	Others
Ranathura	117	0.82	VDHiB2g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIes	TCB
Ranathura	118	7.8	VDHhA1g1	LMU-2	Deep (100-150 cm)	Sandy clay loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Cotton+Onion (Ct+On)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	119	14.27	KMHiA1g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Maize+Cotton+Redgram (Mz+Ct+Rg)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	120	7.71	KKRmB2g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Sorghum (Mz+Sg)	Not Available	IIes	TCB

Village	Sy No.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Cap ability	Conserva tion Plan
Ranathura	121	11.29	JLGmB1g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Sorghum+ Horsegram(Mz+Sg+Hg)	Not Available	IIIs	TCB
Ranathura	122	8.18	LKRmB2g1	LMU-7	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Horsegram +Sorghum+Maize (Rg+Hg+Sg+Mz)	Not Available	IIIes	TCB
Ranathura	123	2.14	JLGmB1g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Ranathura	124	1.97	JLGmB1g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Ranathura	127	6.08	KKRmB2g1	LMU-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Onion+Sor ghum (Ct+On+Sg)	Not Available	IIes	TCB
Ranathura	128	4.15	KMHiA1g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Sorghum+Horse gram (Sg+Hg)	Not Available	IIs	Bunding/ Field Bunds
Ranathura	129	6.01	KMHiA1g1	LMU-2	Deep (100-150 cm)	Sandy clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Maize (Mz)	1 Bore Well	IIs	Bunding/ Field Bunds
Ranathura	130	5.72	KGPiB2g1	LMU-9	Shallow (25-50 cm)	Sandy clay	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Groundnut (Mz+Gn)	Not Available	IVes	TCB
Ranathura	131	12.26	KTPiB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	1 Bore Well	IIes	TCB
Ranathura	137	11.65	KGPiB2g1	LMU-9	Shallow (25-50 cm)	Sandy clay	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	Not Available	IVes	TCB
Ranathura	138	12.92	KTPiB2g2	LMU-7	Moderately shallow (50-75 cm)	Sandy clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut+Redgram+ Horsegram+Cotton (Gn+Rg+Hg+Ct)	Not Available	IIes	TCB
Ranathura	144	8.81	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Cotton+Red gram (Mz+Ct+Rg)	1 Open Well	IIIs	TCB
Ranathura	145	4.2	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Horsegram+Maize+ Cotton (Hg+Mz+Ct)	Not Available	IIIs	TCB
Ranathura	146	4.06	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize+Cotto n (Rg+Mz+Ct)	Not Available	IIIs	TCB
Ranathura	147	5.83	LKRhB1g1	LMU-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Maize (Rg+Mz)	1 Bore Well	IIIs	TCB

Appendix II

Rantur Microwatershed

Soil Fertility Information

Village	Sy No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	19	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	22	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	23	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	24	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	25	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	26	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	27	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	30	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	31	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	32	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	33	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	34	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	35	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	36	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	37	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	38	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	39	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	40	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	41	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Sufficient (>0.6 ppm)
Bellatti	42	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Sufficient (>0.6 ppm)
Bellatti	43	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	44	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Sy No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	45	Slightly acid (pH 6.0-6.5)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Sufficient (>0.6 ppm)
Bellatti	46	Slightly acid (pH 6.0-6.5)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	47	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	49	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	58	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	59	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	123	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	124	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	125	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	126	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	127	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	133	Slightly acid (pH 6.0-6.5)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	134	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	135	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Devihala	136	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Nelogal	STREAM	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	1	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	2	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	3	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	4	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	4/A1	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	4/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	4/B1	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	5	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	6	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	7	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Sy No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Ranathura	8	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	9	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	10	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	11	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	12	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	13	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	15	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	16	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	18	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	19	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	23	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	24	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	26	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	27	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	34	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	81	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	88	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	89	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	90	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	93	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	94	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	95	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	96	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	99	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Sy No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Ranathura	100	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	101	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	103	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	104	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	105	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	106	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	107	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	108	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Sufficient (>0.6 ppm)
Ranathura	109	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	110	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	111	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	112	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	113	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	114	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	115	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	116	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	117	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	118	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	119	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	120	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	121	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	High (>0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	122	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	123	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	High (>0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	124	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	High (>0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Ranathura	127	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Sy No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Ranathura	**128**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Medium (23-57 kg/ha)**	**Medium (145-337 kg/ha)**	**Medium (10-20 ppm)**	**Medium (0.5-1.0 ppm)**	**Deficient (<4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**129**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Medium (23-57 kg/ha)**	**Medium (145-337 kg/ha)**	**Low (<10 ppm)**	**Low (<0.5 ppm)**	**Deficient (<4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**130**	**Neutral (pH 6.5-7.3)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Medium (23-57 kg/ha)**	**Medium (145-337 kg/ha)**	**Low (<10 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**131**	**Neutral (pH 6.5-7.3)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Medium (23-57 kg/ha)**	**Medium (145-337 kg/ha)**	**Low (<10 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**137**	**Neutral (pH 6.5-7.3)**	**Non Saline (<2 dsm)**	**Low (<0.5 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**Low (<10 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**138**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Low (<0.5 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**High (>20 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**144**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Low (<0.5 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**Medium (10-20 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**145**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Low (<0.5 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**Low (<10 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**146**	**Slightly alkaline (pH 7.3-7.8)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**Medium (10-20 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**
Ranathura	**147**	**Moderately alkaline (pH 7.8-8.4)**	**Non Saline (<2 dsm)**	**Medium (0.5-0.75 %)**	**Low (<23 kg/ha)**	**Medium (145-337 kg/ha)**	**Medium (10-20 ppm)**	**Low (<0.5 ppm)**	**Sufficient (>4.5 ppm)**	**Sufficient (>1.0 ppm)**	**Sufficient (>0.2 ppm)**	**Deficient (<0.6 ppm)**

Appendix III

Rantur Microwatershed

Soil Suitability Information

Village	Sy No.	Mango	Mai ze	Sap ota	Sor gham	Guava	Cotton	Tama rind	Lime	Sun flower	Amla	Jack fruit	Custard-apple	Cashew	Jamun	Musa mbi	Sugar cane	Ground nut	Onion	Chilly	Tom ato	Mari gold	Chrysan themum	Pomeg ranate	Citrus	Bhendi
Bellatti	19	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	22	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Bellatti	23	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Bellatti	24	N	Ng	S3rg	Ng	S3rg	Ng	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	Ng
Bellatti	25	N	S3rg	Nr	S3rg	Nr	S3g	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Bellatti	26	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	27	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	30	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	31	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	32	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	33	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	34	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	35	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	36	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	37	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	38	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	39	N	S2rw	S3w	S2r	S3w	S2r	S3r	N	S2w	S2r	N	S2r	N	S3r	N	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w
Bellatti	40	N	S2rw	S3w	S2r	S3w	S2r	S3r	N	S2w	S2r	N	S2r	N	S3r	N	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w
Bellatti	41	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Bellatti	42	N	S3rg	S3rg	S3rg	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3g	S3g	S3g	S2rg	S2rg	S3rg	S3r	S2rg
Bellatti	43	N	S3rg	S3rg	S3rg	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3g	S3g	S3g	S2rg	S2rg	S3rg	S3r	S2rg
Bellatti	44	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S2r	S2r	S2r	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	45	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	46	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	47	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	49	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S2r	S2r	S2r	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	58	N	S3rg	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	59	N	Ng	Ng	Ng	Ng	Ng	S3r	N	Ng	S2r	N	S2r	S3r	S3r	N	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	Ng
Devihala	123	N	S2rw	S3w	S2r	S3w	S2r	S3r	N	S2w	S2r	N	S2r	N	S3r	N	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w

Village	Sy No.	Mango	Maize	Sapota	Sorgham	Guava	Cotton	Tamarind	Lime	Sun flower	Amla	Jack fruit	Custard-apple	Cashew	Jamun	Musambi	Sugar cane	Ground nut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Devihala	124	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Devihala	125	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Devihala	126	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Devihala	127	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3r	S3r	Nr	Nr	S3rg
Devihala	133	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Devihala	134	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Devihala	135	N	S3r	Nr	S3r	Nr	S3r	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Devihala	136	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Nelogal	STREAM	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	1	S2r	S2g	S2g	S2g	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S2r	S1
Ranathura	2	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	3	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	4	S2r	S2g	S2g	S2g	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S2r	S1
Ranathura	4/A1	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	4/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	4/B1	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	5	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	6	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	7	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	8	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	9	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	10	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	11	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	12	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	13	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	15	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	16	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	18	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	19	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Ranathura	23	S3r	S2g	S2r	S2g	S2rg	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1

Village	Sy No.	Mango	Maize	Sapota	Sorghum	Guava	Cotton	Tamarind	Lime	Sunflower	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Ranathura	24	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	26	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	27	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	34	S2r	S2g	S2g	S2g	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S2r	S1
Ranathura	81	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	88	S2r	S2g	S2g	S2g	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S2r	S1
Ranathura	89	S2r	S2g	S2g	S2g	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S2r	S1
Ranathura	90	N	S2rg	S3r	S2rg	S3r	S2rg	S3r	N	S2rg	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Ranathura	93	N	S2rg	S3r	S2rg	S3r	S2rg	S3r	N	S2rg	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Ranathura	94	N	S2rg	S3r	S2rg	S3r	S2r	S3r	N	S3r	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Ranathura	95	N	S3g	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3rg	S2rg
Ranathura	96	S3gr	S3g	S3g	S3g	S3g	S3g	S3gr	S3gr	S3g	S2gr	S3gr	S2gr	S2gr	S3gr	S3gr	S3g	S2g	S3g	S3g	S3g	S2g	S2g	S3g	S3g	S2g
Ranathura	99	S3r	S1	S2r	S1	S2rt	S2r	S3r	S3r	S2r	S2r	S3r	S2r	S2r	S3r	S3r	S2r	S1	S1	S1	S1	S1	S1	S2r	S2r	S1
Ranathura	100	N	S2rg	S3r	S2rg	S3r	S2rg	S3r	N	S2rg	S2r	N	S2r	S3r	S3r	N	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Ranathura	101	S3r	S1	S2r	S1	S2rt	S2r	S3r	S3r	S2r	S2r	S3r	S2r	S2r	S3r	S3r	S2r	S1	S1	S1	S1	S1	S1	S2r	S2r	S1
Ranathura	103	N	S3rg	Nr	S3rg	Nr	S3g	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Ranathura	104	S3r	S1	S2r	S1	S2rt	S2r	S3r	S3r	S2r	S2r	S3r	S2r	S2r	S3r	S3r	S2r	S1	S1	S1	S1	S1	S1	S2r	S2r	S1
Ranathura	105	N	S3rg	Nr	S3rg	Nr	S3g	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Ranathura	106	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	107	N	S3rg	Nr	S3rg	Nr	S3rg	N	N	Nr	S3gr	N	S3gr	N	N	N	Nr	S3r	S3rg	S3rg	S3rg	S3rg	S3rg	Nr	Nr	S3rg
Ranathura	108	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Ranathura	109	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	110	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	111	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	112	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	113	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	114	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	115	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	116	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Ranathura	117	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Ranathura	118	S2r	S1	S1	S1	S2t	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1

Village	Sy No.	Mango	Mai ze	Sap ota	Sor gham	Guava	Cotton	Tama rind	Lime	Sun flower	Amla	Jack fruit	Custard-apple	Cashew	Jamun	Musa mbi	Sugar cane	Ground nut	Onion	Chilly	Tom ato	Mari gold	Chrysan themum	Pomeg ranate	Citrus	Bhendi
Ranathura	119	S2r	S1	S2g	S1	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Ranathura	120	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	121	N	S3t	S3t	S1	S3t	S2r	S3r	S3r	S2r	S2r	N	S2r	N	S3r	S3r	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Ranathura	122	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	123	N	S3t	S3t	S1	S3t	S2r	S3r	S3r	S2r	S2r	N	S2r	N	S3r	S3r	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Ranathura	124	N	S3t	S3t	S1	S3t	S2r	S3r	S3r	S2r	S2r	N	S2r	N	S3r	S3r	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Ranathura	127	S3r	S2g	S2r	S2g	S2r	S2r	S3r	S3r	S2rg	S2r	S3r	S2r	N	S3r	S3r	S2r	S2t	S1	S2g	S1	S1	S1	S2r	S2r	S2t
Ranathura	128	S2r	S1	S2g	S1	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Ranathura	129	S2r	S1	S2g	S1	S1	S1	S2r	S2r	S1	S1	S2r	S1	S2r	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Ranathura	130	N	S3r	Nr	S3r	Nr	S3r	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Ranathura	131	N	S3g	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3rg	S2rg
Ranathura	137	N	S3r	Nr	S3r	Nr	S3r	N	N	Nr	S3r	N	S3r	N	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Ranathura	138	N	S3g	S3rg	S3g	S3rg	S3g	S3r	N	S3rg	S2r	N	S2r	S3r	S3r	N	S3rg	S2rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3rg	S2rg
Ranathura	144	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	145	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	146	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g
Ranathura	147	N	S3g	S3rg	S3g	S3rg	S3g	S3gr	N	S3rg	S2gr	N	S2gr	S3gr	S3gr	N	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3g

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

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Chapter 1

EXECUTIVE SUMMARY

Baseline socioeconomic characterisation is prerequisite to prepare action plan for program implementation and to assess the project performance before making any changes in the watershed development program. The baseline provides appropriate policy direction for enhancing productivity and sustainability in agriculture.

Methodology: *Rantur micro-watershed (Nilogal sub-watershed, Shirahatti taluk, Gadag district) is located in between $15^0 5'$ – $15^0 7'$ North latitudes and $75^0 36'$ – $75^0 39'$ East longitudes, covering an area of about 670 ha, bounded by Belhatti, Devihal, Chikasavanur and Machinahalli villages with an length of growing period (LGP) 150-180 days. We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and ecosystem services were quantified.*

Results: *The socio-economic outputs for the Rantur micro-watershed (Nilogal sub-watershed, Shirahatti taluk, Gadag district) are presented here.*

Social Indicators;

- *Male and female ratio is 55.6 to 44.4 per cent to the total sample population.*
- *Younger age 18 to 50 years group of population is around 31.1 per cent to the total population.*
- *Literacy population is around 80 per cent.*
- *Social groups belong to other backward caste (OBC) is around 70 per cent.*
- *Fire wood is the source of energy for a cooking among all sample households.*
- *About 60 per cent of households have a yashaswini health card.*
- *Majority of farm households (60 %) are having MGNREGA card for rural employment.*
- *Dependence on ration cards for food grains through public distribution system among the all sample households.*
- *Swach bharath program providing closed toilet facilities around 90 per cent of sample households.*
- *Women participation in decision making for agriculture production of households was found.*

Economic Indicators;

- *The average land holding is 1.26 ha indicates that majority of farm households are belong to small and medium farmers. The dry land of 76.3 % and irrigated land 23.7 % of total cultivated land area among the sample farmers.*

- *Agriculture is the main occupation among 33.3 per cent and agriculture is the main and agriculture labour is the subsidiary occupation around 62.2 percent of sample households.*
- *The average value of domestic assets is around Rs. 15759 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets is around Rs. 169500 per household, about 20 per cent of sample farmers having sprayer.*
- *The average value of livestock is around Rs. 8163 per household; about 37.5 per cent of household are having bullocks.*
- *The average per capita food consumption is around 808.9 grams (1759.5 kilo calories) against national institute of nutrition (NIN) recommendation at 60 gram. Around 40 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs.1113 per household. Among the all sample farm households are below poverty line.*
- *The per capita average monthly expenditure is around Rs.1358.*

Environmental Indicators-Ecosystem Services;

- *The value of ecosystem service helps to support investment to decision on soil and water conservation and in promoting sustainable land use.*
- *The onsite cost of different soil nutrients lost due to soil erosion is around Rs. 609 per ha/year. The total cost of annual soil nutrients is around Rs. 392197 per year for the total area of 670.28 ha.*
- *The average value of ecosystem service for food grain production is around Rs 13035/ ha/year. Per hectare food grain production services is maximum in sorghum (Rs.7497) followed by onion (Rs.5348), sunflower (Rs. 3663), maize (Rs. 1285) and red gram is negative returns.*
- *The average value of ecosystem service for fodder production is around Rs. 1654/ ha/year. Per hectare fodder production services is maximum in maize (Rs. 3862) followed by sorghum (Rs. 656).*
- *The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum in redgram (Rs. 61682) followed by sorghum (Rs. 35290), maize (Rs. 26373), sunflower (Rs. 24777) and onion (Rs.15676).*

Economic Land Evaluation;

- *The major cropping pattern is maize (67.5 %) followed by onion (12.9 %), Sorghum (10.1 %) and sunflower (9.5 %).*
- *In Rantur Microwatershed, major soil is Tammmadahalli (TDH) series is having moderately shallow soil depth cover around 3.91 % of area. On this soil*

farmers are presently growing maize (78.5 %) and sunflower (21.5 %). Chikkamegeri (CKM) are also having moderately deep soil depth cover 2.49 % of area, and the crop is maize (100 %). Gollarahatti (GHT) soil series having moderately deep soil depth cover around 3.82 % of areas, crop is red gram. Hooradahalli (HDH) soil series having moderately deep soil depth cover around 2.81 % of area, crop is bajra maize. Kanchikere (KKR) soil series are having moderately deep soil depth cover around 8.09 % of area; the major crop is growing sorghum. Kumchahalli (KMH) soil series are having deep soil depth covers around 9.39 % of area, the major crop grown is maize. Vaddarahalli (VDH) soil series having deep soil depth cover 7.37 % of areas; crop is maize. Muradi (MRD) soil series having very deep soil depth cover 1.07 % of areas; crop is maize.

- ❖ *The total cost of cultivation and benefit cost ratio (BCR) in study area for maize ranges between Rs. 46647/ha in VDH soil (with BCR of 1.05) and Rs. 13567/ha in THD soil (with BCR of 1.45).*
- ❖ *In sunflower the cost of cultivation in TDH soil is Rs 19892/ha (with of 1.18).*
- ❖ *In red gram the cost of cultivation in GHT soil is Rs. 63090/ha (with BCR of 0.99).*
- ❖ *In sorghum the cost of cultivation in KKR soil is Rs.15659/ha (with BCR of 1.52) and onion the cost of cultivation in MRD soil is Rs 23469/ha (with BCR of 1.23).*
- ❖ *The land management practices reported by the farmers are crop rotation, tillage practices, fertilizer application and use of farm yard manure (FYM). Due to higher wages farmer are following labour saving strategies is not prating soil and water conservation measures. Less ownership of livestock limiting application of FYM.*
- ❖ *It was observed soil quality influences on the type and intensity of land use. More fertilizer applications in deeper soil to maximize returns.*

Suggestions;

- ❖ *Involving farmers is watershed planning helps in strengthing institutional participation.*
- ❖ *The per capita food consumption and monthly income is very low. Diversifying income generation activities from crop and livestock production in order to reduce risk related to drought and market prices.*
- ❖ *Majority of farmers reported that they are not getting timely support/extension services from the concerned development departments.*
- ❖ *By strengthing agricultural extension for providing timely advice improved technology there is scope to increase in net income of farm households.*

- *By adopting recommended package of practices by following the soil test fertiliser recommendation, there is scope to increase yield in Maize (61.3 to 83.6 %), onion (76.4 %), red gram (7.1 %), sunflower (54.8 %), sorghum (58.7 %).*

Chapter 2

INTRODUCTION

Watershed Development program aim to restore degraded watersheds in rainfed regions to increase their capacity to capture and store rain water, reduce soil erosion, and improved soil nutrients and carbon contents so they can produce greater agricultural yields and other benefits. As majority of rural poor live in these regions and dependent on natural resources for their livelihood and sustenance, improvements in agricultural yields improve human welfare and simultaneously improve national food security.

Sujala–III watershed development project conceptualised and implemented by the Watershed Development Department of Government of Karnataka with tripartite cost-sharing arrangements. The World Bank through International Development Association provided major portion of plan outlay as a loan to Government of India and in turn loan to Government of Karnataka.

The objectives of Sujala-III is to demonstrate more effective watershed management through greater integration of programs related to rain fed agriculture, innovative and science based approaches and strengthened institutions and capacities. The project is implemented in 11 districts of Bidar, Vijayapura, Gulbarga, Yadgir, Koppal, Gadag, Raichur, Davanagere, Tumkur, Chikkamangalur and Chamarajanagar which have been identified by the Watershed Development Department based on rainfall and socio-economic conditions. The project will be implemented over six years and linked with the centrally financed integrated watershed management programme.

Economic evaluations can better guide in watershed planning and implementation, as well as raise awareness of benefits of ecosystem restoration for food security and poverty alleviation program. The present study aims to characterize socio-economic status of farm households, assess the land and water use status, evaluate the economic viability of land use, prioritize farming constraints and suggest the measures for soil and water conservation for sustainable agriculture.

Objectives of the study

1. To characterize socio-economic status of farm households

2. To evaluate the economic viability of land use and land related constraints

3. To estimate the ecosystem service provided by the watershed and

4. To suggest alternatives for sustainable agriculture production.

Chapter 2

METHODOLOGY

Study area

Rantur micro-watershed is located in Northern Transition Zone of Karnataka (Figure 1). Extends over all area of 1.13 M ha of which 0.86 M ha is under cultivation. Nearly 0.052 M ha in the zone enjoys irrigation facilities. Elevation ranges between 450-900 m MSL with most parts situated between 800 and 900 m. Shallow to black soils and red loams are distributed in equal proportion. The average annual rainfall ranges from 620 to 1300 mm of which more than 60 per cent is received during the southwest monsoon (*kharif*). Sorghum, rice, groundnut, maize, chilli, pulses, sugarcane, tobacco and cotton are the major crops of the zone. It's represents Agro Ecological Sub Region (AESR) 6.4 having LGP 150-180 days.

Rantur micro-watershed (Nilogal sub-watershed, Shirahatti taluk, Gadag district) is located in between $15^0$5' – $15^0$7' North latitudes and $75^0$36' – $75^0$39' East longitudes, covering an area of about 670 ha, bounded by Belhatti, Devihal, Chikasavanur and Machinahalli villages.

Sampling Procedure:

In this study we have followed soil variability as criterion for sampling the farm households. In each micro-watershed the survey numbers and associated soil series are listed. Minimum three farm households for each soil series were taken and summed up to arrive at total sample for analysis.

Sources of data and analysis:

For evaluating the specific objectives of the study, primary data was collected from the sample respondents by personal interview method with the help of pre-tested questionnaire. The data on socio-economic characteristics of respondents such as family size and composition, land holdings, asset position, occupational pattern and education level was collected. The present cropping pattern and the level of input use and yields collected during survry. The data collected from the representative farm households were analysed using Automated Land Potential Evalution System (Figure 2).

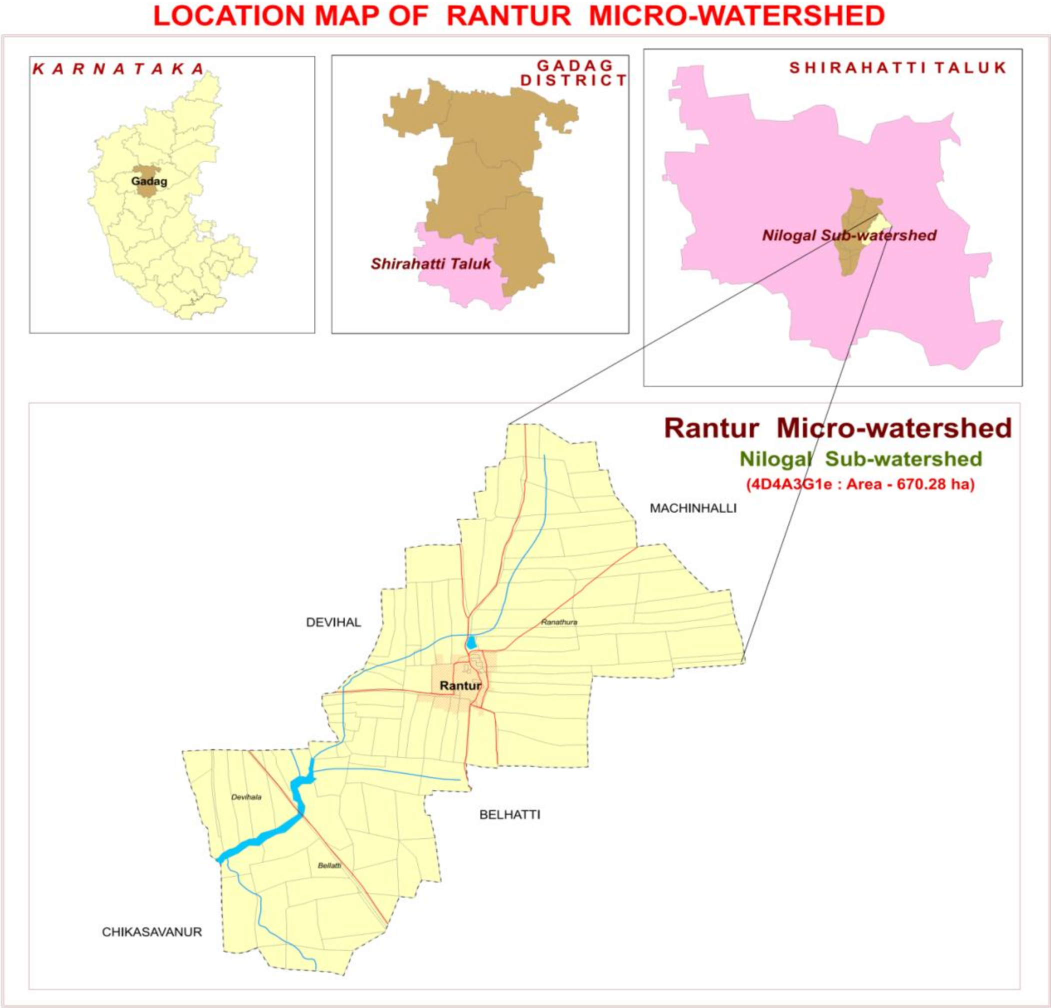

Figure 1: Location of study area

Steps followed in socio-economic assessment

1. After the completion of soil profile study link the cadastral number to the soil profile in the micro watershed.
2. Download the names of the farmers who are owning the land for each cadastral number in the Karnataka BHOOMI Website.
3. Compiling the names of the farmers representing for all the soil profiles studied in the micro watershed for socio-economic Survey.
4. Conducting the socioeconomic survey of selected farm households in the micro watershed.
5. Farm households database created using the Automated Land Potential Evaluation System (ALPES) for analysis of socio economic status for each micro watershed.
6. Synthesis of tables and preparation of report for each micro watershed.

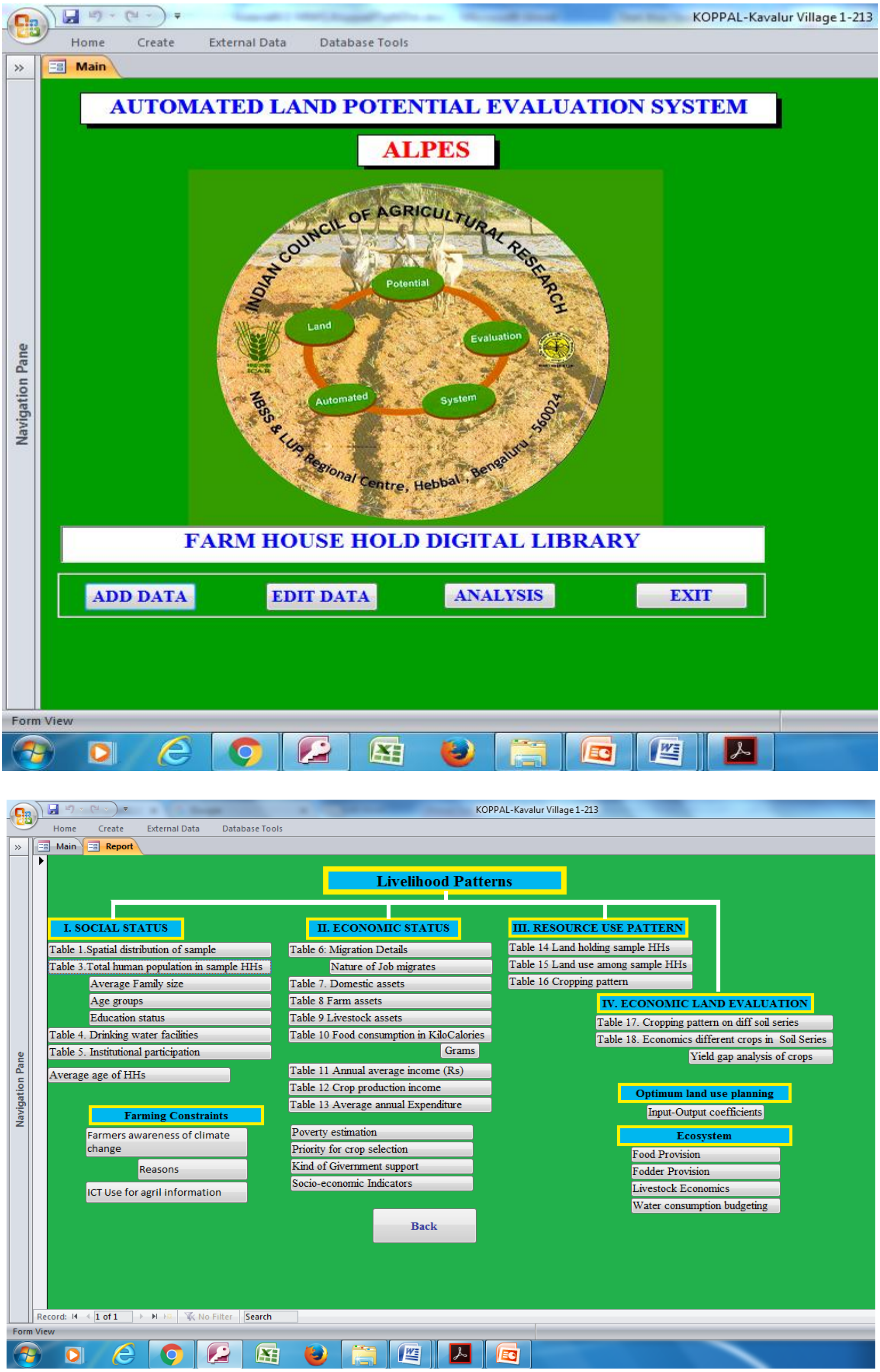

Figure 2: ALPES FRAMEWORK

The sample farmers were post classified in to marginal and small (0.0 to <=2 ha), medium and semi medium (>2 to <=10 ha) and large (>10 ha). The steps involved in estimation of soil potential involve estimation of total cost of cultivation, the yield/gross returns and net income per hectare. The cost of inputs such seed, manure and fertilizer, plant protection chemicals, payment towards human and bullock labour and interest on working capita are included under operational costs. In the case of perennial crops, the cost of establishment was estimated by using actual physical requirements and prevailing market prices. Estimation cost included maintenance cost up to bearing period. The value of main product and by product from the crop enterprise at the market rates were the gross returns of the crop. Net returns were worked out by deducting establishment and maintained cost from gross returns.

Operational Cost = cost of seeds, fertilizers, pesticides. Cost of human and bullock labour, cost of machinery, cost of irrigation water + interest on working capital.

Gross returns = Yield (Quintals/hectare)*Price (Rs/Quintal)

Net returns = Gross returns-Operational cost.

Benefit Cost Ratio = Net returns/Total cost.

Economic suitability classes: once each land use –land area combination has been assigned an economic value by the land evaluation, the question arises as to its 'suitability', that is, the degree to which it satisfies the land user. The FAO framework defines two suitability orders: 'S'(suitable if benefit cost ratio (BCR)>1) and 'N'(not suitable if (BCR<1), which are dived into five economic suitability classes:'S1'(highly suitable if BCR>3), 'S2'(suitable if BCR>2 and <3),'S3'(Marginally suitable if BCR >1 and <2), 'N1'(Not suitable for economic reasons but physically suitable) and 'N2'(not suitable for physical reasons). The limit between 'S3' and 'N1'must be at least at the point of financial feasibility (i.e. net returns, NPV, or IRR>0 and BCR>1). The other limits depend on social factors such as farm size, family size, alternative employment or investment possibilities and wealth expectations; these need to be specified for the Soil series.

Economic Valuation of Soil ecosystem services:

The replacement cost approach was followed for estimating the onsite cost of soil erosion, Market price method was followed for estimating the value of food and fodder production. Value transfer menthods was followed for estimating the value of water demand by different crops in the micro watershed.

Steps followed in Replacement cost methods for estimation of onsite cost of soil erosion.

1. Collect the Soil Map Units (SMU) / Land Use Type (LUT) with soil fertility analysis.
2. Integrate the erosion rates per SMU/LUT.
3. Estimate the nutrients lost per tone of soil erosion for each SMU/LUT.
4. Estimate the value of soil nutrients lost per ton of soil erosion for each SMU/LUT by taking the market price of soil nutrients.

Chapter 4

RESULTS AND DISCUSSIONS

The demographic information shows that the household population dynamics encompasses the socioeconomic status of the farmer. For a rural family, the household size should be optimal to earn a comfortable livelihood through farm and non-farm wage earning. The total number of population in watershed area was 45, out of which 55.6 per cent were males and 44.4 per cent females. Average family size of the households is 4.5. Age is an important factor, which affects the potential employment and mobility status of respondents. The data on age wise distribution of farmers in the sample households indicated that majority of the farmers are coming under the age group of 18 to 30 years (31.1 %) followed by 30 to50 years (31.1 %), 0 to 18 years (22.2 %) and more than 50 years (15.6 %). Hence, in the study area in general, the respondents were of young and middle age, indicating thereby that the households had almost settled with whatever livelihood options they were practicing and sample respondents were young by age who could venture into various options of livelihood sources. Data on literacy indicated that 20 per cent of respondents were illiterate and 80 per cent literate (Table 1).

Table 1: Human population among sample households in Rantur Micro watershed

Particulars	**Units**	**Value**
Total human population in sample HHs	Number	45
Male	% to total Population	55.6
Female	% to total Population	44.4
Average family size	Number	4.5
Age group		
0 to 18 years	% to total Population	22.2
18 to 30 years	% to total Population	31.1
30 to 50 years	% to total Population	31.1
>50 years	% to total Population	15.6
Average age	Age in years	31.6
Education Status		
Illiterates	% to total Population	20.0
Literates	% to total Population	80.0
Primary School (<5 class)	% to total Population	6.7
Middle School (6- 8 class)	% to total Population	31.1
High School (9- 10 class)	% to total Population	20.0
Others	% to total Population	22.2

The ethnic groups among the sample farm households found to be 70 per cent belonging to other backward caste (OBC) and 30 per cent belonging to general caste (Table 2 and Figure 3). All the sample households are using wood as source of fuel for cooking. All the sample farmers are having electricity connection. About 66.0 per cent are sample households having health cards. Majority (60 %) are having MNREGA job cards for employment generation. About 60 per cent of farm households are having ration cards for taking food grains from public distribution system. About 90 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Rantur Micro-watershed

Particulars	Units	Value
Social groups		
OBC	% of Households	70.0
General	% of Households	30.0
Types of fuel use for cooking		
Fire wood	% of Households	100.0
Energy supply for home		
Electricity	% of Households	90.0
Solar Lamp	% of Households	10.0
Number of households having Health card		
Yes	% of Households	60.0
No	% of Households	40.0
MGNREGA Card		
Yes	% of Households	60.0
No	% of Households	40.0
Ration Card		
Yes	% of Households	100.0
Households with toilet		
Yes	% of Households	90.0
No	% of Households	10.0
Drinking water facilities		
Tube Well	% of Households	80.00
River	% of Households	20.00

The data collected on the source of drinking water in the study area is presented in Table 2. Majority of the sample respondents are having tube well source (80 %) for water supply for domestic purpose and twenty percent of households are having river source for domestic purpose.

The occupational pattern (Table 3) among sample households shows that agriculture is the main occupation around 33.3 per cent of farmers followed by subsidiary occupations like Agricultural labour (62.2 %)and main occupation government services is (2.2%) and private services is (2.2 %) per cent each.

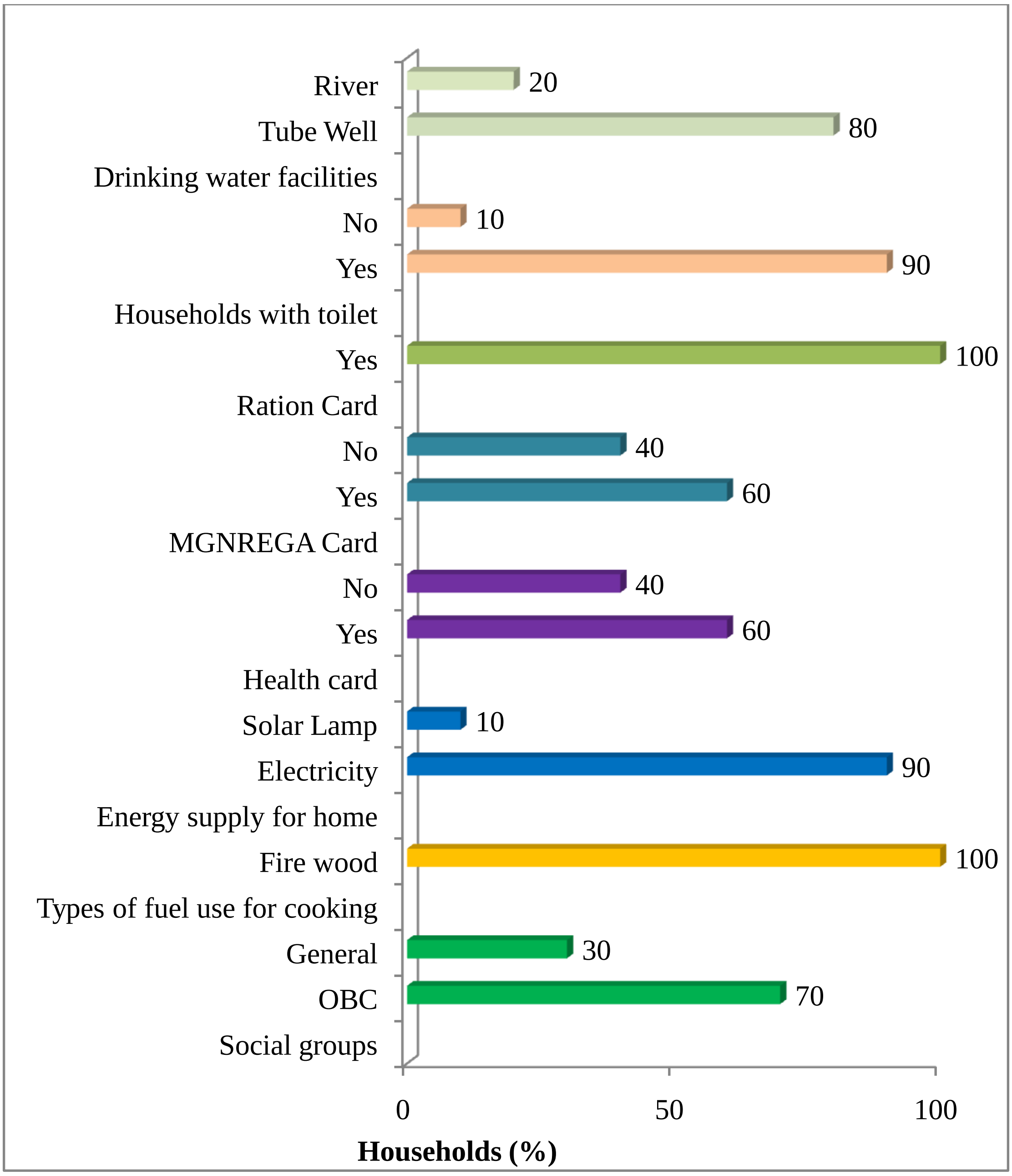

Figure 3: Basic needs of sample households in Rantur Microwatershed

Table 3: Occupational pattern in sample population in Rantur Micro-watershed

Occupation		**% to total**
Main	**Subsidiary**	
Agriculture	Agriculture	33.3
	Agriculture Labour	62.2
Government service	Agriculture labour	2.2
private service		2.2
Grand total		100
Family labour availability		**Man days/month**
Male		40.0
Female		24.0
Total		64.0

The important assets especially with reference to domestic assets were analyzed and are given in Table 4 and Figure 4. The important domestic assets possessed by all categories of farmers are mobile phones (100 %) followed by television (80.0%), mixer/grinder (40.0%) and motorcycle (10 %). The average value of domestic assets is around Rs 15759 per households.

Table 4: Domestic assets among the sample households in Rantur Micro-watershed

Particulars	% of households	Average value in Rs
Mixer/grinder	40.0	2750
Mobile Phone	100.0	3100
Motorcycle	10.0	50000
Television	80.0	7188
Average Value	15759	

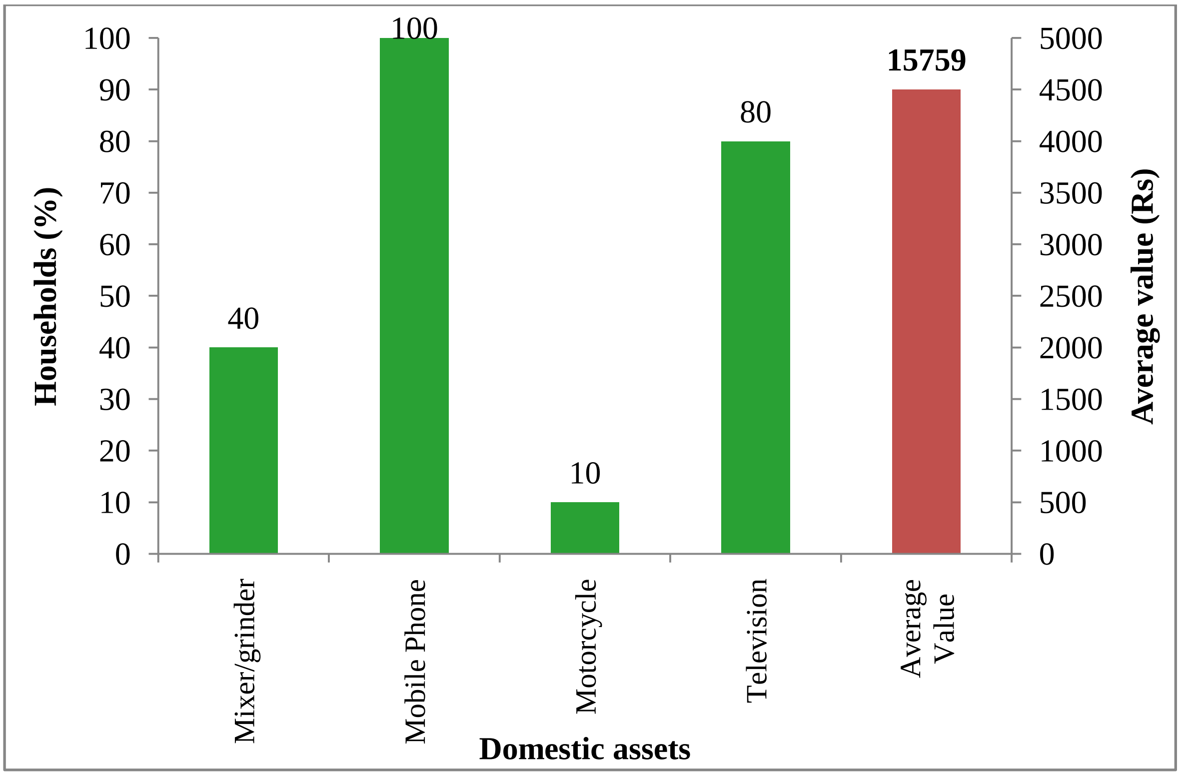

Figure 4: Domestic assets among the sample households in Rantur Micro watershed

The most popularly owned farm equipments were sickles, plough, cattle shed; pump sets, chaff cutter, bullock cart, sprayer and thresher. Plough and sickle were commonly present in all the sampled farmers; these were primary implements in agriculture. The per cent of households owned sprayer (20 %) earth remover (10%), seed cum fertilizer drill (10%) and tractor (10%) was found highest among the sample farmers. The average value of farm assets is around Rs 169500 per households (Table 5 and Figure 5).

Table 5: Farm assets among samples households in Rantur Microwatershed

Particulars	% of households	Average value in Rs
Bullock cart	10.0	25000
Earth remover	10.0	10000
Seed Cum fertilizer drill	10.0	5000
Sprayer	20.0	7500
Tractor	10.0	800000
Average Value	169500	

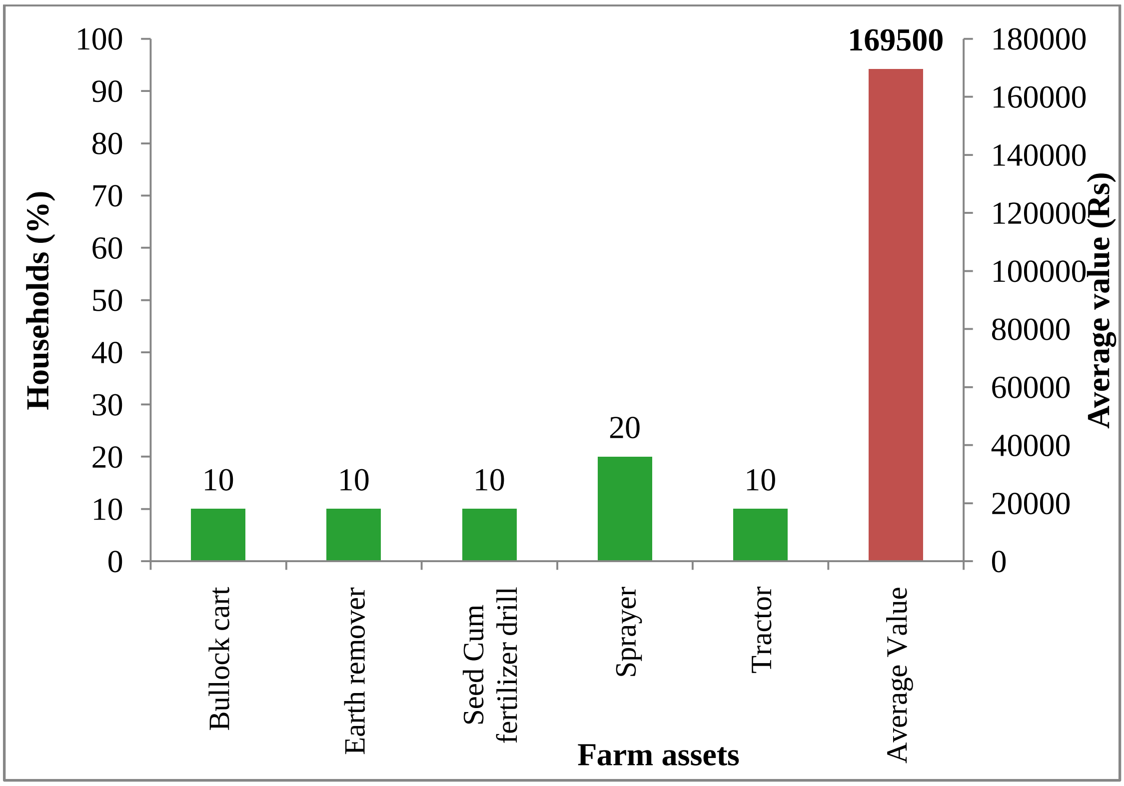

Figure 5: Farm assets among the sample households in Rantur Micro watershed

Livestock is an integral component of the conventional farming systems (Table 6 and Figure 6). The highest livestock population is bullocks were around 37.5 per cent followed by local mulching cow (25.0 %), local dry cow (25.0 %) and sheep's (12.5 %). The average livestock value was Rs 17291 per households.

Table 6: Livestock assets among sample households in Rantur micro-watershed

Particulars	% of livestock population	Average value in Rs
Local Dry Cow	25.0	10000
Local Milching Cow	25.0	12500
Bullocks	37.5	36667
Sheep's	12.5	10000
Average value	17291	

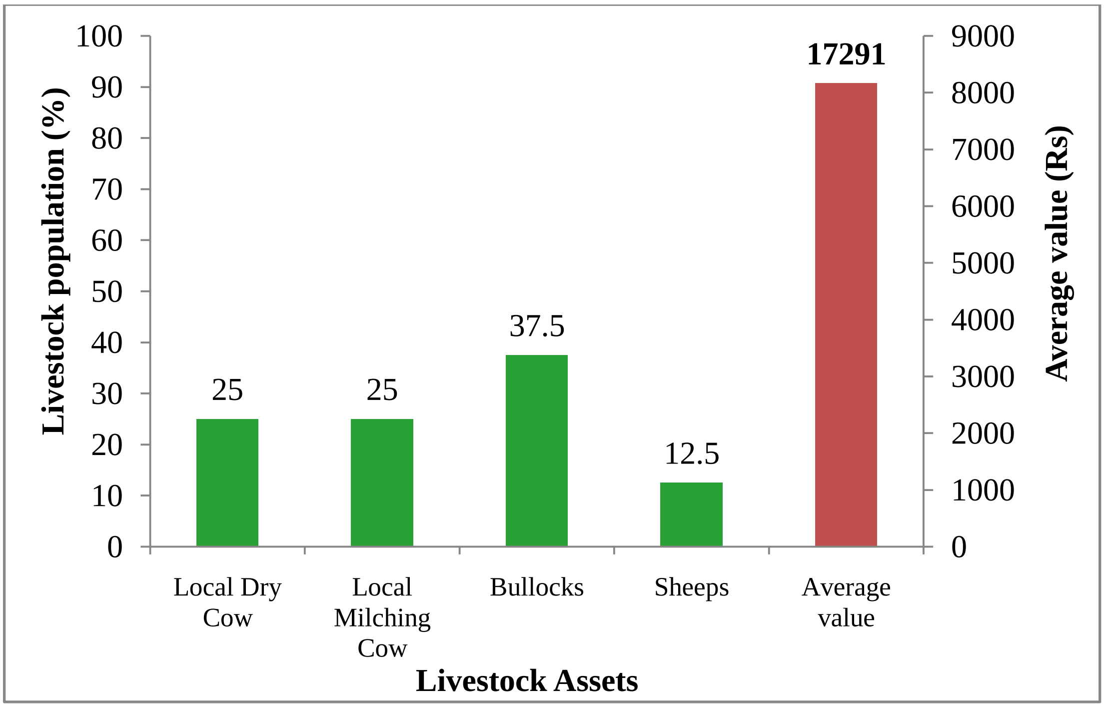

Figure 6: Livestock assets among sample households in Rantur micro-watershed

The farm households, maize and sorghum are the main crops for domestic food and fodder for animals. About 1967 kg /ha of average fodder is available per season for the livestock feeding (Table 7).

Table 7: fodder availability of sample households in Rantur Micro-watershed

Particulars	
Fodder produces	**Fodder yield (kg/ha.)**
Maize	2370
Sorghum	1563
Average fodder availability	1967
Livestock having households (%)	62
Livestock population (Numbers)	61

Table 8: Women empowerment of sample households in Rantur Micro-watershed

% to Grand Total

Particulars	**Yes**	**No**
Women participation in local organization activities	00.0	100.0
Women elected as panchayat member	00.0	100.0
Women earning for her family requirement	100.0	00.0
Women taking decision in her family and agriculture related activities	100.0	00.0

A woman participation in decision making is in this micro-watershed is presented in Table 8. About all sample households of women taking decision in her family and agriculture related activities and women earning for her family requirement.

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 9 and Figure 7. More quantity of cereals is consumed by sample farmers which accounted for 1042.1 kcal per person. The other important food items consumed was pulses 214.7 kcal followed by cooking oil 166.6 kcal, milk 94.3 kcal, vegetables 29.8 kcal, egg 189.4 kcal and meat 22.6 kcal. In the sampled households, farmers were consuming less (1759.5 kcal) than NIN- recommended food requirement (2250 kcal).

Table 9: Per capita daily consumption of food among the sample households in Rantur Micro-watershed

Particulars	NIN recommendation (gram/ per day/ person)	Present level of consumption (gram/ per day/ person)	Kilo Calories /day/person
Cereals	396	306.5	1042.1
Pulses	43	62.6	214.7
Milk	200	145.0	94.3
Vegetables	143	124.2	29.8
Cooking Oil	31	29.2	166.6
Egg	0.5	126.3	189.4
Meat	14.2	15.1	22.6
Total	**827.7**	**808.9**	**1759.5**
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		40.0	60.0
% Above NIN		60.0	40.0

Note: * day/person

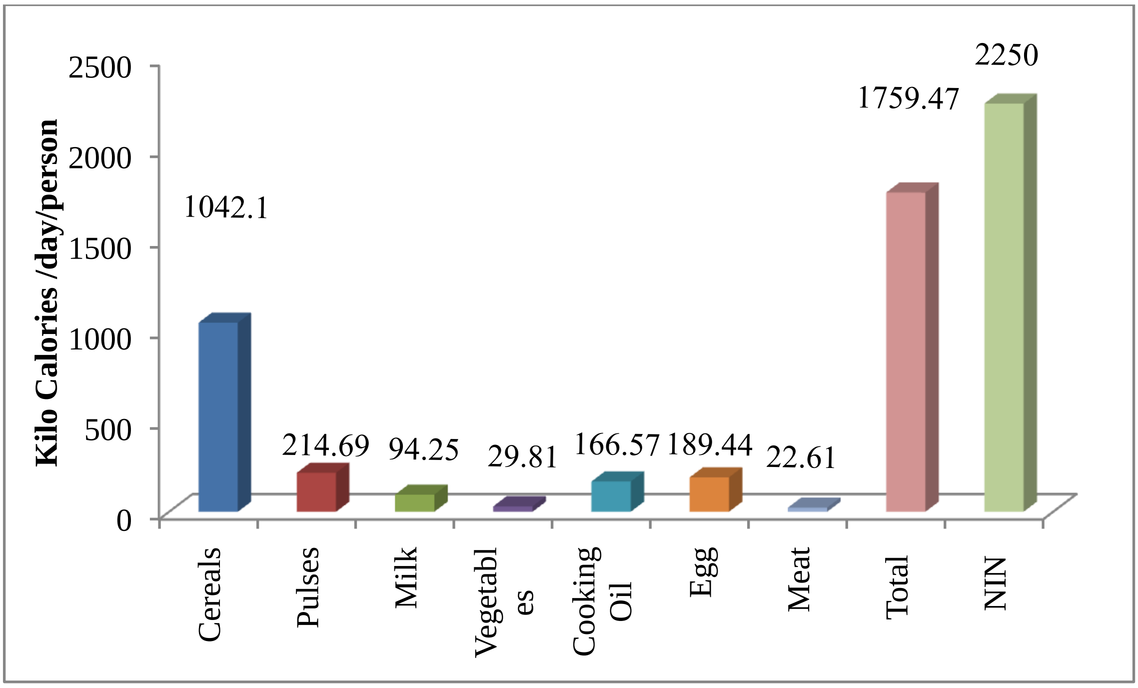

Figure 7: Per capita daily consumption of food among the sample households in Rantur Micro-watershed

Annual income of the sample HHs: The average annual household income is around Rs 1113. Major source of income to the farmers in the study area is from followed by crop production (Rs 6848), livestock income (Rs. -5735). The monthly per capita income is Rs. 21 for considering above poverty line. Due to the fact that erratic rainfall and shortage of water, farmers are diverting from crop production activities to enable the household for a comfortable livelihood. The incomes from the other aforesaid sources are very meagre (Table 10).

Table 10: Annual average income of HHs from various sources in Rantur Micro-watershed

Particulars	Income *
Nonfarm income (Rs)	0 (0)
Livestock income (Rs)	-5735 (20)
Crop Production (Rs)	6848 (100)
Total Annual Income (Rs)	***1113***
Average monthly per capita income (Rs)	21
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	100.0
% of households above poverty line	0.0

* Figure in the parenthesis indicates % of Households

The average annual expenditure of farm households indicated that farmers in the study area spend highest on food (Rs. 40231) followed by education, clothing, social function and health. Now a day's education is most important among all of us. In today's competitive world, education is a necessity for man after food, clothing, and shelter. It is the only fundamental way by which a desired change in the society can happen. The average per capita monthly expenditure is around Rs 1358 and all the farm of households is below poverty line (Table 11 and Figure 8).

Table 11: Average annual expenditure of sample HHs in Rantur Micro-watershed

Particulars	Value in Rupees	Per cent
Food	40231	54.9
Education	6500	8.9
Clothing	6000	8.2
Social functions	16750	22.8
Health	3850	5.3
Total Expenditure (Rs/year)	73331	100.0
Monthly per capita expenditure (Rs)	1358	

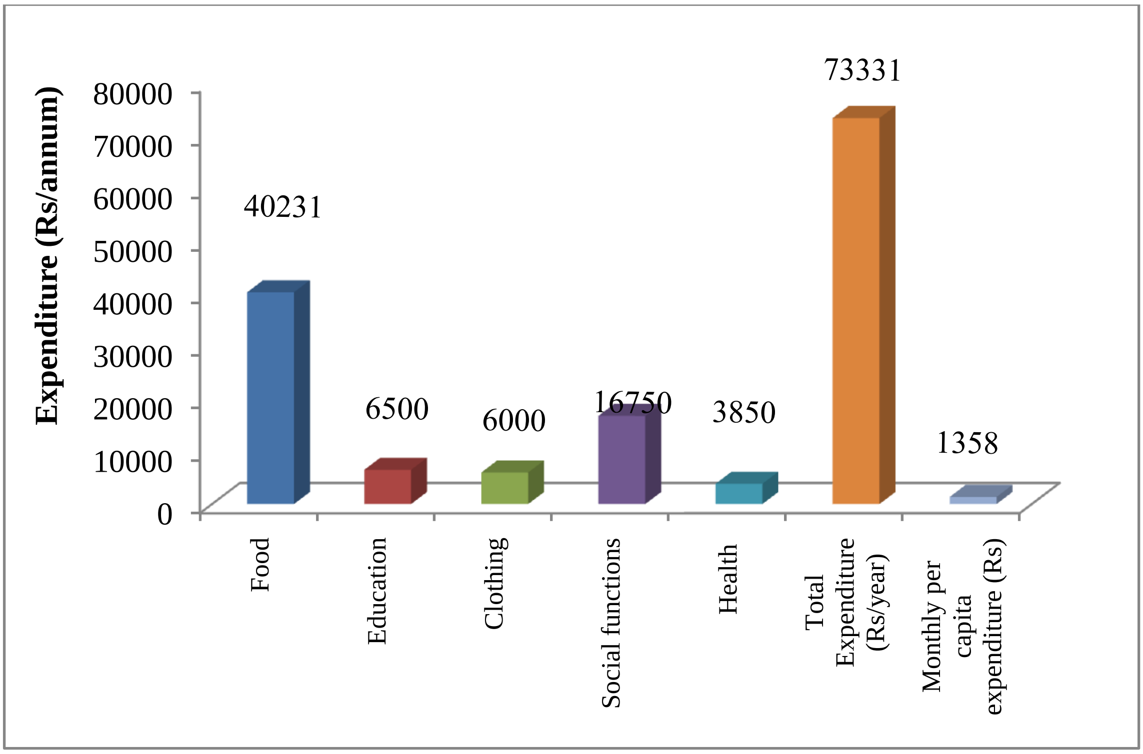

Figure 8: Average annual expenditure of sample HHs in Rantur Micro-watershed

Land holding: Total sample households are total area cultivated by them is 12.6 ha. The average land holding of sample HHs is 1.26 ha. Large number of sample HHs (80.0%) belong to small size group with an average holding size of 1.01 ha and medium farmers (20.0%) with a average land holding size of 1.3 ha (Table 12).

Table 12: Distribution of land holding among the sample households in Rantur micro-watershed

Particulars	Units	Values
Small farmers		
Total land	ha	8.11
Sample size	Per cent	80.0
Average land holding	ha	1.01
Medium farmers		
Total land	ha	4.45
Sample size	Per cent	20.0
Average land holding	ha	2.23
Total sample households		
Total land	ha	12.57
Sample size	Per cent	100.0
Average land holding	ha	1.26

Land use: The total land holding in the Rantur micro watershed is 12.6 ha (Table 13). Of which 9.6 (76.3 %) ha is dry land and 3.0 (23.7 %) ha is irrigated land. The average land holding per household is worked out to be 1.26 ha.

Table 13: Land use among samples households in Rantur Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	23.7	3.0
Dry Land	76.3	9.6
Fallow Land	0.0	0.0
Total land holding	100.0	12.6
Average land holding	1.26	

In the micro-watershed, the prevalent present land uses under perennial plants are coconut (61.5%) followed by neem trees (33.8 %) and teak (4.6 %). (Table14).

Table 14: Number of trees/plants covered in sample farm households in Rantur Microwatershed

Particulars	Number of Plants/trees	Per cent
Banyan tree(Alada)	2	1.9
Coconut	3	2.8
Mango	60	56.6
Neem trees	40	37.7
Tamarind	1	0.9
Grand Total	106	100.0

The land use decisions are usually based on experience of farmers, tradition, expected profit, personal preferences, resources and social requirements.

The present dominant crops grown in dry lands in the study area were by ragi (67.5%) followed by onion (12.9 %) and sunflower (9.5%) which are taken during the kharif season and sorghum (10.1%) during the rabi season, respectively. The crop intensity was 111 percent (Table 15 and Figure 9).

Table 15: Present cropping pattern and cropping intensity in Rantur Microwatershed

% to Grand Total

Crops	**Kharif**	**Rabi**	**Grand Total**
Maize	67.5	0.00	67.5
Onion	12.9	0.0	12.9
Sorghum	0.0	10.1	10.1
Sunflower	9.5	0.0	9.5
Grand Total	***89.9***	***10.1***	***100.0***
Cropping intensity (%)	111		

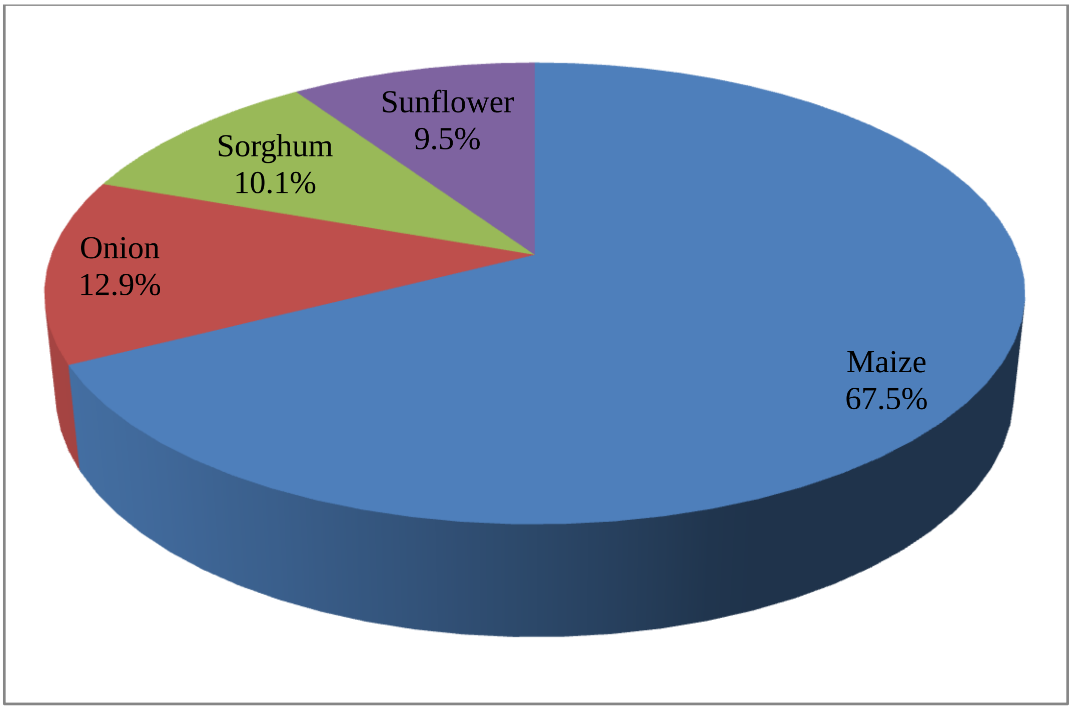

Figure 9: Present cropping pattern in Rantur Micro-watershed

Economic land evaluation

The main purpose of economic land evaluation in the watershed is to identify the existing production constraints and propose the potential/alternate options for agro-technology transfer and for bridging the adoption and yield gap.

In Rantur micro watershed, 18 soil series are identified and mapped (Table 16). The distribution of major soil series are Chikkamegeri covering an area around 16.70 ha (2.49 %) followed by Chikkasavanur 6 ha (0.88%), Gollarahatti 25.78 ha (3.82 %), Hooradahalli 18.87 ha (2.81 %), Honnenahalli 23.48 ha (3.50%), Harve 41.85 ha (6.25 %), Jelligeri 22.01 ha (3.28 %), Kutegoudanahundi 59.52 ha (8.88%), Kaggalipura 52.44ha (7.83 %), Kachikere 54.18 ha (8.09 %), Kumchahalli 62.93ha (9.39), Kanchanahalli 5.68ha (0.85 %), Ketanapura 100.92 ha(15.07 %), Lakkur 54.7ha (8.16 %), Mukhadahalli 16.96ha (2.54 %), Muradi 7.15ha (1.07 %), Tammadahalli 26.17ha (3.91 %) and Vaddarahalli 49.40ha (7.37 %).

Table 16: Distribution of soil series Rantur Micro-watershed

Soil No	Soil Series	Mapping unit description	Area in ha (%)
1	CKM	Chikkamegheri soils are moderately deep (75-100 cm), well drained, have dark brown to dark reddish brown sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation	16.70 (2.49)
2	CSR	Chikkasavanur soils are shallow (25-50 cm), well drained, have dark brown to light yellowish brown sandy clay to clay soils occurring on very gently sloping uplands under cultivation	5.91 (0.88)
3	GHT	Gollarahatti soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation	25.78 (3.82)

4	HDH	Hooradhahalli soils are moderately deep (75-100 cm), well drained, have red to dark red and reddish brown gravelly sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation	18.87 (2.81)
5	HNH	Honnenahalli soils are moderately deep (50-75 cm), well drained, have brown to dark brown clay soils occurring on nearly level to very gently sloping lowlands under cultivation	23.48 (3.50)
6	HRV	Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils occurring on very gently to moderately sloping uplands under cultivation	41.85 (6.25)
7	JLG	Jelligeri soils are moderately deep (75-100 cm), moderately well drained, very dark brown to dark brown and black cracking clay soils occurring on very gently sloping uplands under cultivation	22.01 (3.28)
8	KGH	Kutegoudanahundi soils are moderately shallow (50 - 75 cm), well drained, have brown to dark brown loamy sand to sandy loam soils occurring on very gently to gently sloping uplands under cultivation	59.52 (8.88)
9	KGP	Kaggalipura soils are shallow (25 - 50 cm), well drained, have brown to dark reddish brown sandy clay loam to sandy clay soils occurring on very gently sloping uplands under cultivation	52.44 (7.83)
10	KKR	Kanchikere soils are moderately deep (75-100 cm), well drained, have dark brown to very dark brown clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation	54.18 (8.09)
11	KMH	Kumchahalli soils are deep (100-150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation	62.93 (9.39)
12	KNH	Kanchanahalli soils are shallow (25 -50 cm), well drained, have dark reddish brown sandy clay soils occurring on very gently sloping uplands under cultivation	5.68 (0.85)
13	KTP	Kethanapura soils are moderately shallow (50-75 cm), well drained, have dark reddish brown gravelly sandy loam soils occurring on very gently to gently sloping uplands under cultivation	100.92 (15.07)
14	LKR	Lakkur soils are moderately shallow (50-75 cm), well drained, have reddish brown to dark red gravelly sandy clay loam to sandy clay red soils occurring on nearly level to gently and moderately sloping uplands under cultivation	54.7 (8.16)
15	MKH	Mukhadahalli soils are moderately shallow (50-75 cm), well drained, have dark brown to reddish brown gravelly sandy clay loam soils occurring on very gently to gently sloping uplands under cultivation	16.96 (2.54)
16	MRD	Muradi soils are very deep (>150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to gently sloping uplands under cultivation	7.15 (1.07)
17	TDH	Thammadahalli soils are moderately shallow (50 – 75 cm), well drained, have brown to very dark brown and dark reddish brown sandy loam to clay loam soils occurring on nearly level to gently sloping uplands under cultivation	26.17 (3.91)
18	VDH	Vaddarahalli soils are deep (100 - 150 cm), well drained, have dark reddish brown to dark brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation	49.40 (7.37)
Rock outcrops			0.49 (0.07)
Habitation			25.14 (3.75)

Present cropping pattern on different soil series are given in Table 17. Crops grown on Tammadahalli soils are green maize and sunflower. Maize is grown on Chikkamaegeri soils. Redgram on Gollarahatti soils are grow. Maize on Hooradahalli soils are grows, Sorghum is grown on Kanchikere soils, and Maize is growing on Kumchahalli soils. Maize is growing in Vaddarahalli soils and onion is growing in Muradi soils.

Table 17: Cropping pattern on major soil series in Rantur micro-watershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Irrigated	Grand Total
			Kharif	Rabi	Kharif	
TDH	Moderately shallow (50-75cm)	Maize	78.5	0.0	0.0	78.5
		Sunflower	21.5	0.0	0.0	21.5
CKM	Moderately deep (75-100cm)	Maize	100	0.0	0.0	100
GHT	Moderately deep (75-100cm)	Redgram	100	0.0	0.0	100
HDH	Moderately deep (75-100cm)	Maize	100	0.0	0.0	100
KKR	Moderately deep (75-100cm)	Sorghum	0.0	100	0.0	100
KMH	Deep (100-150 cm)	Maize	100	0.0	0.0	100
VDH	Deep (100-150 cm)	Maize	0.0	0.0	100	100
MRD	Very deep (>150 cm)	Onion	100	0.0	0.0	100

Land is used for agricultural use for growing cereals, pulse, oilseeds and agricultural -crops. The soil/ land potential are measures in terms of physical yield and net income. The alternative land use options for each micro-watershed are given below (Table 18).

Table 18: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Rantur Micro-watershed.

Soil Series	Small Farmers	Medium Farmers
TDH	Sunflower (1.18)	Maize 1.4
CKM	Maize (1.25)	
GHT	Red gram (0.99)	
HDH	Maize (1.19)	
KKR	Sorghum (1.52)	
KMH	Maize (1.12)	
MRD	Onion (1.23)	
VDH	Maize (1.05)	

The productivity of different crops grown in Rantur micro-watershed under potential yield of the crops is given in Table 19.

The data on cost of cultivation and benefit cost ratio (BCR) of different crops is given in Table 19. The total cost of cultivation in study area for maize ranges between Rs. 46647/ha (with BCR of 1.05) in VDH soil to Rs. 13567/ha (with BCR of 1.45) in TDH soil, sunflower cost of cultivation in TDH soil is Rs 19892/ha (with BCR of 1.18), red gram cost of cultivation in GHT soil is Rs. 63090/ha (with BCR of 0.99), sorghum cost of cultivation in KKR soil is Rs. 15659/ha (with BCR of 1.52) and onion cost of cultivation in MRD soil is Rs.23469/ha (with BCR of 1.23).

Table 19: Economic land evaluation and bridging yield gap for different crops in Rantur micro-watershed

Particulars	TDH (50-75 cm)		CKM (75-100 cm)	GHT (75-100 cm)	HDH (75-100 cm)	KKR (75-100 cm)	KMH (100-150 cm)	MRD (>150 cm)	VDH (100-150 cm)
	Maize	**Sunflower**	**Maize**	**Red gram**	**Maize**	**Sorghum**	**Maize**	**Onion**	**Maize**
Total cost (Rs/ha)	13567	19892	20894	63090	38656	15659	32692	23469	46647
Gross Return (Rs/ha)	19768	23555	26135	62317	45937	23812	36523	28817	49153
Net returns (Rs/ha)	6201	3663	5242	-774	7282	8153	3831	5348	2506
BCR	1.45	1.18	1.25	0.99	1.19	1.52	1.12	1.23	1.05
Farmers Practices (FP)									
FYM (t/ha)	1.1	4.1	0.0	2.3	5.8	4.7	3.6	1.7	2.5
Nitrogen (kg/ha)	45.9	30.6	77.5	73.4	141.9	50.0	144.5	56.3	102.5
Phosphorus (kg/ha)	36.4	53.8	55.7	52.8	110.4	35.9	129.1	83.8	115.0
Potash (kg/ha)	0.0	15.7	0.0	0.0	29.8	0.0	20.1	7.1	0.0
Grain (Qtl/ha)	13.8	7.5	18.2	11.5	29.2	11.7	23.7	58.3	32.5
Price of Yield (Rs/Qtl)	1300	3200	1350	5500	1400	2000	1400	500	1300
Soil test based fertilizer Recommendation (STBR)									
FYM (t/ha)	8.6	6.6	8.6	7.4	8.6	7.4	8.6	29.6	8.6
Nitrogen (kg/ha)	154.4	69.0	154.4	24.7	154.4	81.5	154.4	92.6	92.6
Phosphorus (kg/ha)	77.2	74.1	77.2	61.8	77.2	71.0	77.2	74.1	61.8
Potash (kg/ha)	24.1	27.8	24.1	24.7	32.1	39.5	32.1	92.6	24.1
Grain (Qtl/ha)	84.0	16.5	84.0	12.4	84.0	28.4	84.0	247.0	84.0
% of Adoption/yield gap (STBR-FP) / (STBR)									
FYM (%)	87.0	37.2	100.0	69.0	32.4	36.7	58.9	94.4	71.1
Nitrogen (%)	70.3	55.6	49.8	-197.1	8.1	38.7	6.4	39.3	-10.7
Phosphorus (%)	52.8	27.4	27.9	14.6	-43.0	49.4	-67.3	-13.0	-86.2
Potash (%)	100.0	43.4	100.0	100.0	7.2	100.0	37.3	92.4	0.0
Grain (%)	83.6	54.8	78.4	7.1	65.2	58.7	71.8	76.4	61.3
Value of yield and Fertilizer (Rs)									
Additional Cost (Rs/ha)	11098	4042	10995	5422	1538	5434	3162	29696	4165
Additional Benefits (Rs/ha)	91299	28852	88857	4852	76684	33373	84397	94333	66924
Net change Income (Rs/ha)	80201	24811	77862	-570	75146	27938	81235	64637	62759

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Table 19. There is a huge gap between FYM application by farmers and recommended FYM in all the crops across the soils. There is a larger yield gap in crops grown across different soil series. Adequate knowledge about recommended package of practices is the pre-requisite for their use in cultivation of crops. It is a fact that, recommended practices are major contributing factors to yield. Inadequate knowledge about recommended practices leads to their improper adoption. Strengthening of extension services by concerned agency is required to increase adoption of recommended cultivation practices and ultimately reducing the gap. By adopting soil-test fertiliser recommendation, there is scope to increase yield and income to a maximum of Rs 81235 in maize and a minimum of Rs 24811 in sunflower cultivation.

Economic valuation of Ecosystem Services (ES) was aimed at combining use and non-use values to determine Total Economic Value (TEV) of ES. Ecosystem Services (ES) were valued based on their annual flow or utilization in common monetary units, Rs/year. The valuation of ES was based on market price in 2017 or market cost approaches whichever is applicable, and in other cases on value or benefit transfer from previous valuation studies.

The onsite cost of different soil nutrients lost due to soil erosion is given in Table 20 and Figure 10. The average value of soil nutrient loss is around Rs 608 per ha/year. The total cost of annual soil nutrients is around Rs 392197 per year for the total area of 670.28 ha.

Table 20: Estimation of onsite cost of soil erosion in Rantur micro-watershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total
Organic matter	84.54	54531	532.63	343546
Phosphorus	0.09	56	3.80	2451
Potash	1.30	841	26.09	16829
Iron	0.06	38	2.86	1842
Manganese	0.11	72	30.85	19897
Cupper	0.01	6	5.49	3542
Zinc	0.00	2	0.13	87
Sulpher	0.15	97	6.02	3883
Boron	0.00	3	0.18	119
Total	126.76	55648	608.06	392197

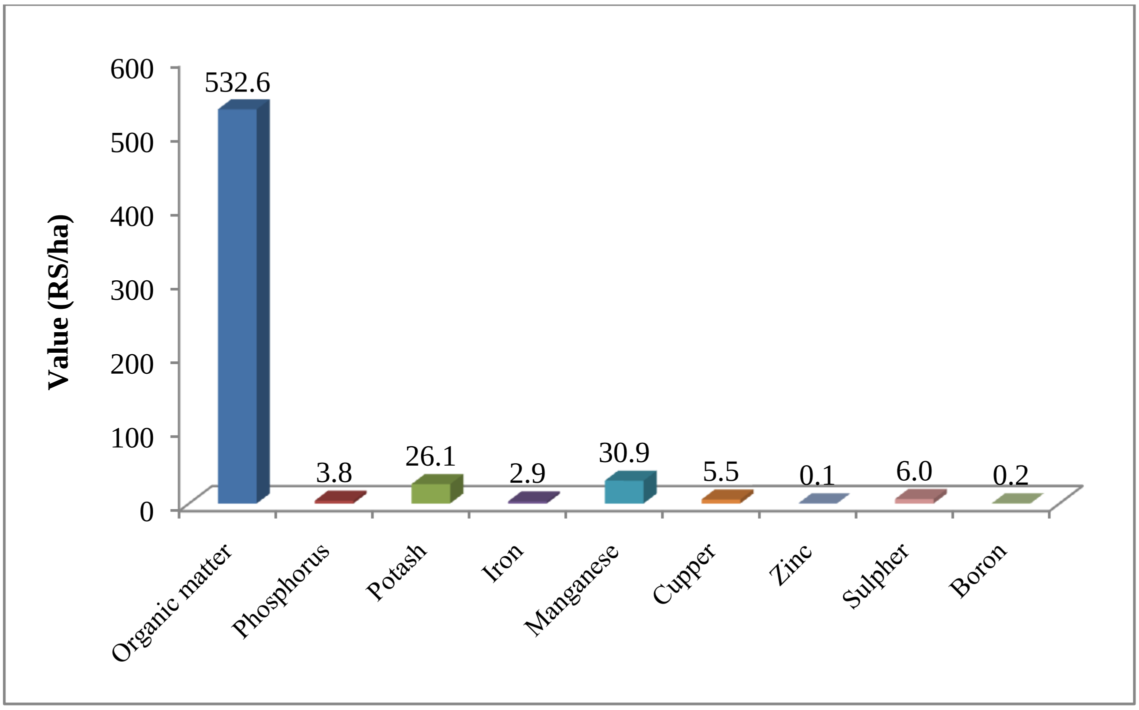

Figure 10: Estimation of onsite cost of soil erosion in Rantur micro-watershed

The average value of ecosystem service for food grain production is around Rs 3403/ ha/year (Table 21 and Figure 11). Per hectare food grain production services is maximum in sorghum (Rs. 7497) followed by onion (Rs. 5348), sunflower (Rs. 3663) and maize (Rs. 1285).

Table 21: Ecosystem services of food grain production in Rantur Micro-watershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)
Cereals	Maize	8.7	22	1342	28955	27670	1285
	Sorghum	1.3	12	2000	23156	15659	7497
Pulses	Red gram	0.4	11	5500	62317	63090	-774
Oil seeds	Sunflower	1.2	7	3200	23555	19892	3663
Vegetables	Onion	1.2	58	500	28817	23469	5348
Average value		12.8	22	2508.4	33360	29956	3403.8

The average value of ecosystem service for fodder production is around Rs 2259/ ha/year (Table 22). Per ha fodder production services were maximum in maize (Rs. 3862) and sorghum (Rs. 656).

Table 22: Ecosystem services of fodder production in Rantur Micro-watershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Net Returns (Rs/ha)
Cereals	Maize	8.7	4.2	917	3862
	Sorghum	1.3	0.8	850	656
Average value		10	2.5	883.5	2259

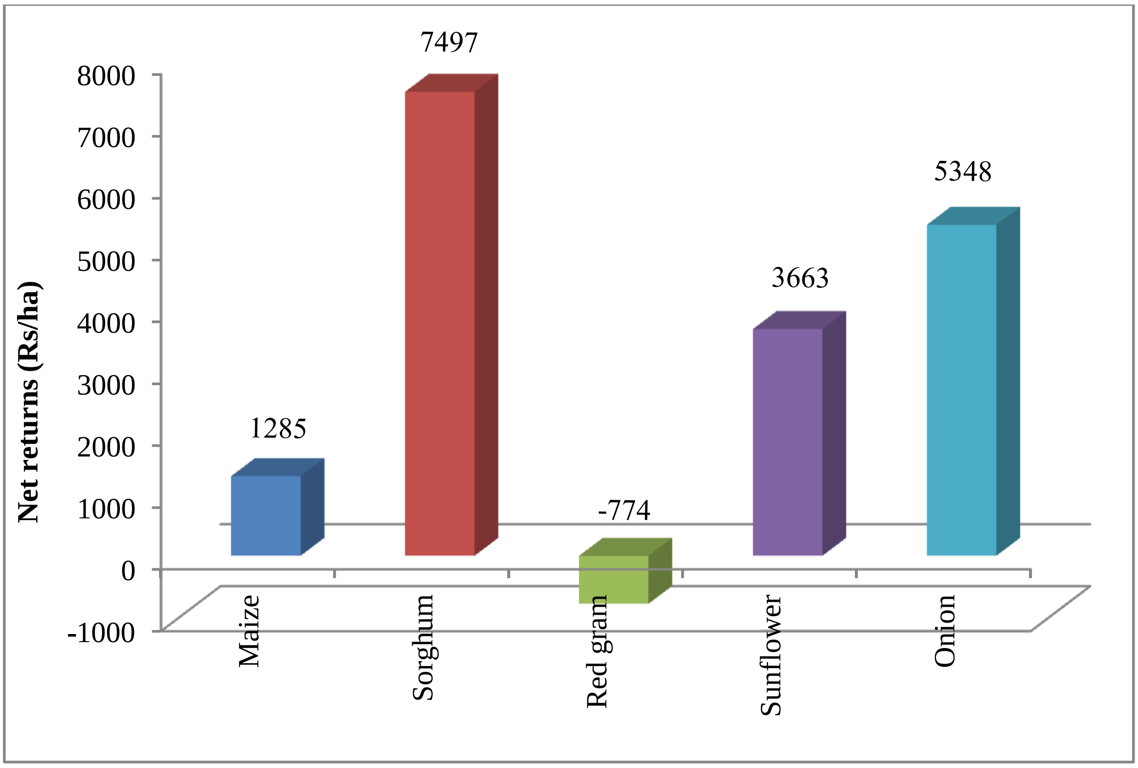

Figure 11: Ecosystem services of food production in Rantur Micro-watershed

The water demand for production of different crops was worked out in arriving at the ecosystem services of water support to crop growth. The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. Per hectare value of water used and value of water was maximum (Table 23 and Figure 12) in red gram (Rs 61682), sorghum (Rs 35290), maize (Rs 26373), sunflower (24777) and onion (15676).

Table 23: Ecosystem services of water supply in Rantur Microwatershed

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Maize	21.6	2637	26373	122
Onion	57.6	1568	15676	27
Red gram	11.3	6168	61682	544
Sorghum	11.6	3529	35290	305
Sunflower	7.4	2478	24777	337
average value	109.5	3276	32759.6	267

The main farming constraints in Rantur micro-watershed to be found are less rainfall, non availability fertilizers, high crop pests & diseases, animal pests & diseases, damage of crops by wild animals and non availability of plant protection chemicals. Majority of farmers depend up on money lender of the sources of loan for purpose of crop production. Farmers to sell the agriculture produce through village market and the farmers getting the agriculture related information on newspaper and television. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 24).

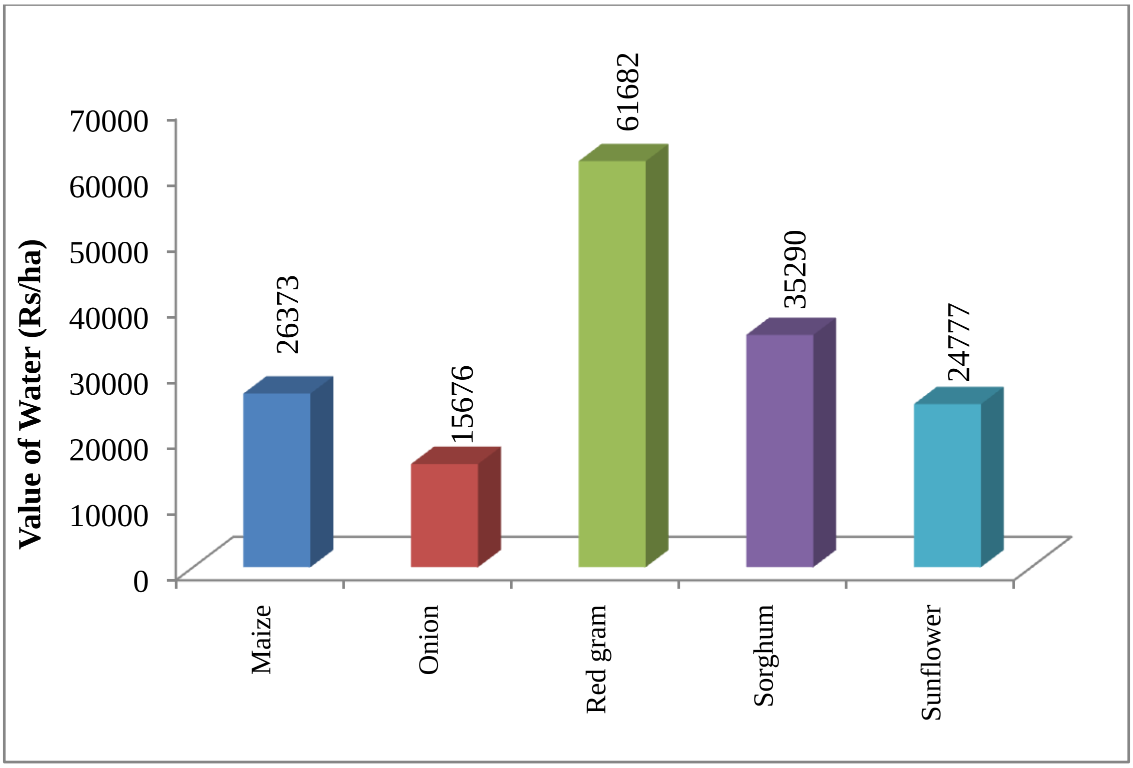

Figure 12: Ecosystem services of water supply in Rantur Microwatershed

Table 24: Farming constraints related land resources of sample households in Rantur Micro-watershed

Sl. no.	Particulars	Per cent
1	Less Rainfall	100.0
2	Lack of good quality seeds	40.0
3	Non availability Fertilizers	50.0
4	High Crop Pests & Diseases	20.0
6	Lack of transportation	90.0
7	Lack of storage	100.0
8	Damage of crops by Wild Animals	100.0
9	Non availability of Plant Protection Chemicals	100.0
10	**Source of loan**	
	Money Leander	100.0
11	**Market for selling**	
	Village market	100.0
12	**Sources of Agri-Technology information**	
	Mobile	30.0
	Newspaper	70.0

The findings of the study would be very much useful to the planners and policy makers of the study area to identify the irrationality in the existing production pattern and to suggest appropriate production plans for efficient utilization of their scarce resources resulting in increased net farm incomes and employment. The study also throws light on future potentialities of increasing net farm income and employment under different situations viz., with existing and recommended technology.