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

CHILKADABETTA-1 (4D3E2J1b) MICROWATERSHED

Gundlupet Taluk, Chamarajanagara 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

ICAR - NBSS & LUP

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 Chilkadabetta-1 Microwatershed, Gundlupet Taluk, Chamarajanagar 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: 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 Chilkadabetta-1 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 the 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 boundries. The soil map shows the geographic distribution and extent, characterstics, classification and use potentials of the soils in the microwartershed.

The present study covers an area of 476 ha in Chilkadabetta-1 microwatershed in Gundlupet taluk of Chamarajanagar district, Karnataka. The climate is semiarid and categorized as drought prone with an average annual rainfall of 734 mm. Maximum of 254 mm precipitation takes place during south–west monsoon period from June to September, the north-east monsoon contributes about 268 mm and prevails from October to early December and the remaining 212 mm takes place during the rest of the year. An area of about 97 per cent is covered by soils and 3 per cent by waterbodies, settlements, forest and others. The salient findings from the land resource inventory are summarized briefly below.

- *The soils belong to 10 soil series and 28 soil phases (management units) and 8 land management units.*
- *The length of crop growing period is about 150 days starting from the 3rd week of June to 3rd week of November.*
- *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 77 per cent area is suitable for agriculture and 23 per cent is not suitable for agriculture but well suited for forestry, pasture, agroforestry, silvi-pasture, recreation, installation of wind mills and as habitat for wildlife.*
- *About 24 per cent of the soils are very deep (>150 cm), 12 per cent moderately deep (75 - 100 cm), 61 per cent moderately shallow to shallow (25-75 cm).*
- *About 32 per cent of the area has clayey soils, 52 per cent loamy soils and 13 per cent sandy soils at the surface.*
- *About 9 per cent of the area has non-gravelly (<15% gravel) soils, 36 per cent gravelly soils (15-35 % gravel) and 52 per cent very gravelly soils (35- 60% gravel).*
- *About 24 per cent of the area has soils that are very high (>200mm/m) in available water capacity and about 73 per cent low (50-100 mm/m) and very low (<50mm/m) available water capacity.*
- *About 74 per cent of the area has gently sloping (3-5%) to very gently sloping (1-3% slope) lands, 15 per cent of the area has moderately sloping (5-10%), 5 per cent of the area has strongly sloping (10-15%) and 3 per cent area has nearly level (0.1%) lands.*
- *An area of about 46 per cent has soils that are slightly eroded (e1), 35 per cent moderately eroded (e2) and 15 per cent area is severely eroded (e3).*

- *An area of about 24 per cent has soils that are neutral in reaction (pH 6.5 to 7.3), 18 per cent slightly alkaline (pH 7.3-7.8), 41 per cent moderately alkaline (pH 7.8 to 8.4) to strongly alkaline (pH 8.4 to 9.0), 5 per cent slightly acid (pH 6.0-6.5) and 9 per cent moderately acid (pH 5.5-6.0).*
- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm^{-1}indicating that the soils are non-saline.*
- *About 26 per cent medium (0.5-0.75%) and 69 per cent low (<0.5%) in organic carbon.*
- *An area of 61 per cent has soils that are low (<23 kg/ha) and an area of 35 per cent medium (23-57 kg/ha) in available phosphorus*
- *About 39 per cent medium (145-337 kg/ha) and 57 per cent high (>337kg/ha) in available potassium.*
- *Available sulphur is low (<10 ppm) in about 96 per cent area and medium (10-20 ppm) in <1 per cent in available sulphur.*
- *Available boron is low (<0.5 ppm) in about 48 per cent area and 48 per cent medium (0.5-1.0 ppm).*
- *About 41 per cent area has soils that are deficient (<4.5 ppm) in available iron and 56 per cent sufficient (>4.5 ppm).*
- *Available manganese and copper are sufficient in all the soils.*
- *Available zinc is deficient in all the soils*
- *The land suitability for 27 major crops (agricultural and horticultural) 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 Chilkadabetta-1 Microwatershed

Crop	Suitability Area in ha (%)			Crop	Suitability Area in ha (%)	
	Highly suitable (S1)	Moderately suitable (S2)			Highly suitable (S1)	Moderately suitable (S2)
Sorghum	82 (17)	186 (39)		Guava	78 (16)	57 (12)
Maize	101 (21)	155 (33)		Mango	78 (16)	23 (5)
Red gram	78(16)	83 (18)		Sapota	78 (16)	57 (12)
Groundnut	35 (7)	221(47)		Jackfruit	78 (16)	23 (5)
Sunflower	70 (15)	77 (16)		Jamun	78 (16)	35 (7)
Cotton	82 (17)	155 (33)		Musambi	78 (16)	35 (5)
Onion	78 (16)	190 (40)		Lime	78 (16)	35 (5)
Beans	78 (16)	190 (40)		Cashew	78 (16)	57 (12)
Potato	78 (16)	178 (37)		Custard apple	78 (16)	193 (40)
Beetroot	78 (16)	178 (37)		Amla	78 (16)	193(40)
Turmeric	78 (16)	178 (37)		Tamarind	78 (16)	35(5)
Horse gram	78 (16)	180 (38)		Marigold	78 (16)	190(40)
Field bean	78 (16)	190 (40)		Chrysanthamum	78 (16)	190(40)
Banana	78 (16)	69 (50)				

Apart from the individual crop suitability, a proposed crop plan has been prepared for the 8 identified LMUs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fibre and horticulture crops that helps in maintaining the ecological balance in the microwatershed.

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 and also in the hillocks, mounds and ridges that are edible, ecological and produce lot of biomass which helps in restoring the ecological balance in the microwatershed.*

Chapter 1

INTRODUCTION

Soil is a finite natural resource that is central to sustainable agriculture and food security. Over the years, this precious resource is faced with problems of erosion, salinity, alkalinity, degradation, depletion of nutrients and even decline in the availability of land for agriculture. It is a known fact, that it takes thousands of years to form a few centimetres of soil; thus, soil is a precious gift of nature. 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 (>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 situation 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 land 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 use 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 the 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 like 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 landuse. An attempt has already made to upscale the soil resource information from 1:250000 and 1:50000 scale to the LEU map in Goa and other states. Here, an attempt is being made to uplink the LRI data generated under Sujala-III project to the Landscape Ecological Units (LEUs) map.

The land resource inventory aims to provide site specific database for Chilkadabetta-1 microwatershed in Gundlupet Taluk, Chamarajanagara 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.

GEOGRAPHICAL SETTING

2.1 Location and Extent

The Chilkadabetta-1 microwatershed (Shivapura subwatershed) is located in the southern part of south Karnataka in Gundlupet Taluk, Chamarajanagar District, Karnataka State (Fig.2.1). It comprises parts of Hullepura, Shivapura, Mangala and Belavadihundi villages. It lies between 11^0 41' to 11^0 42' North latitudes and 76^0 40' to 76^0 42' East longitudes and covers an area of 476 ha. It is surrounded by Hullepura village in the northwest, Shivapura village in the southwest, Mangala village in the south and Belavadihundi village in the east.

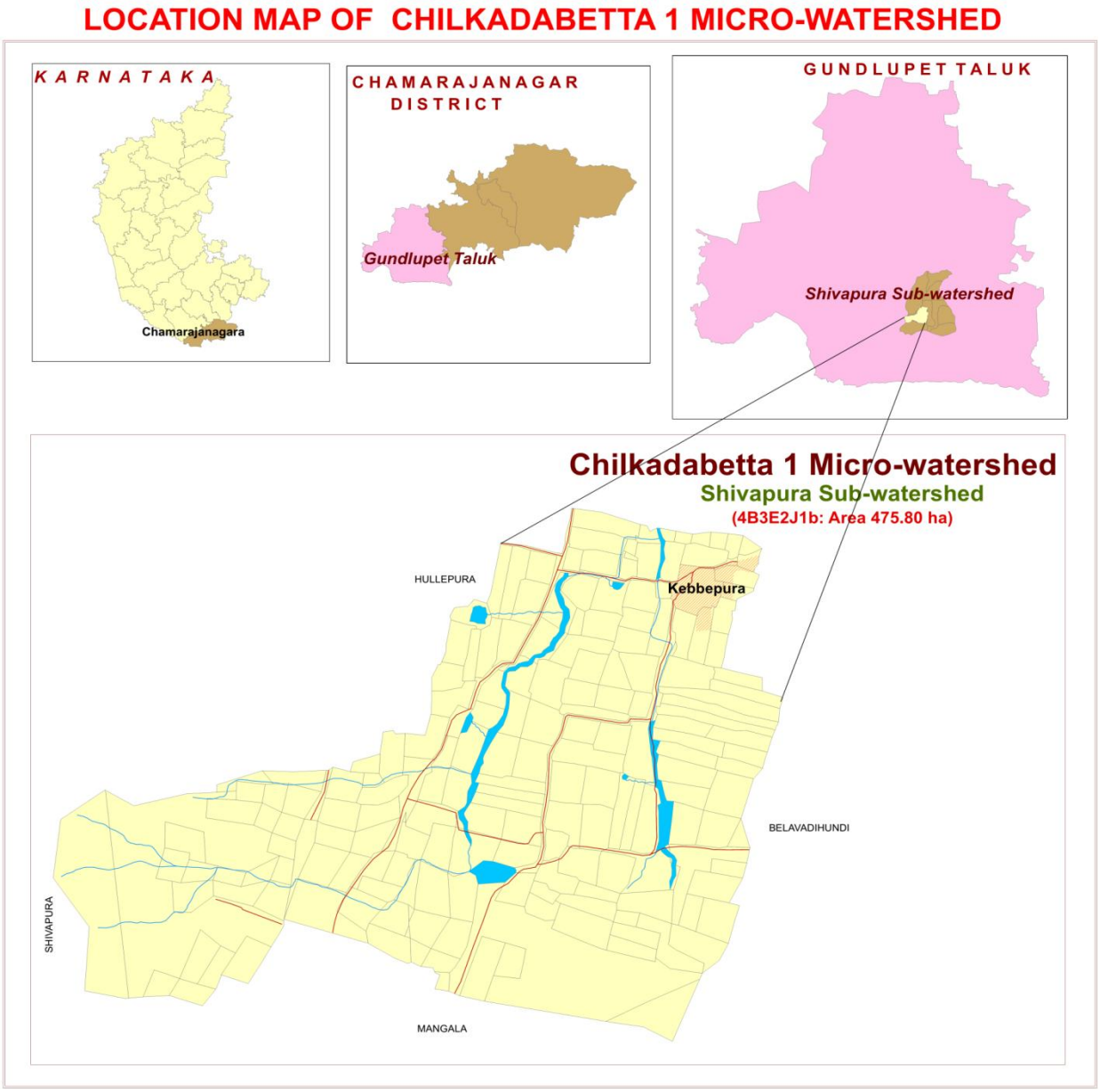


Fig.2.1 Location map of Chilkadabetta-1 Microwatershed

2.2 Geology

Major rock formations observed in the microwatershed are of Archaean age and comprise of (Figs.2.2a and b) granite and gneiss. They are essentially pink to gray granite gneisses. The rocks are coarse to medium grained. They consist primarily of quartz, feldspar, biotite and hornblende. The

gray granite gneisses are highly weatherd, fractured and fissured upto a depth of about 10 m. Dolerite dykes and quartz veins are common with variable width and found to occur in Chilkadabetta-1 village.

Fig.2.2a Granite and granite gneiss rocks

Fig. 2.2b Granite rocks

2.3 Physiography

Physiographically, the area has been identified as granite gneiss landscape based on geology. It has been further divided into three landforms *viz*; mounds/ ridges, uplands and lowlands based on geology, slope and other relief features.They have been further subdivided into four landform units,

viz; summits, side slopes, very gently sloping uplands and lowlands/valleys. The elevation ranges from 857 to 931. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

There are no perennial rivers flowing in Gundlupet taluk. However, the area is drained by several small seasonal streams like Gundluhole along its course. Though, they are not perennial, during rainy season, they carry large quantities of rain water.The microwatershed area has only few small tanks which are not capable of storing water that flows 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 new tanks and recharge structures at appropriate places in the villages, then the drinking and irrigation needs of the area can be easily met. The drainage network is dendritic to subparallel.

2.5 Climate

The district falls under semiarid tract and is categorized as drought-prone with average annual rainfall of 734 mm (Table 2.1). Of the total rainfall, a maximum of 254 mm is received during south–west monsoon period from June to September, north-east monsoon from October to early December contributes about 268 mm and the remaining 212 mm is recived 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 128 mm and varies from a low of 106 mm in November to 165 mm in the month of March. The PET is always higher than precipitation in all the months except in the month of October and parts of September and November. 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 in Gundlupet Taluk, Chamarajanagara District

Sl. no.	Months	Rainfall	PET	1/2 PET
1	JAN	0.80	129.10	64.55
2	FEB	6.80	133.80	66.90
3	MAR	26.90	164.90	82.45
4	APR	73.60	153.80	76.90
5	MAY	103.90	147.20	73.60
6	JUN	56.00	124.60	62.30
7	JUL	50.40	116.40	58.20
8	AUG	55.80	117.10	58.55
9	SEP	92.00	116.80	58.40
10	OCT	164.10	111.10	55.55
11	NOV	80.50	106.20	53.10
12	DEC	23.50	109.90	54.95
Total		734.30	127.57	

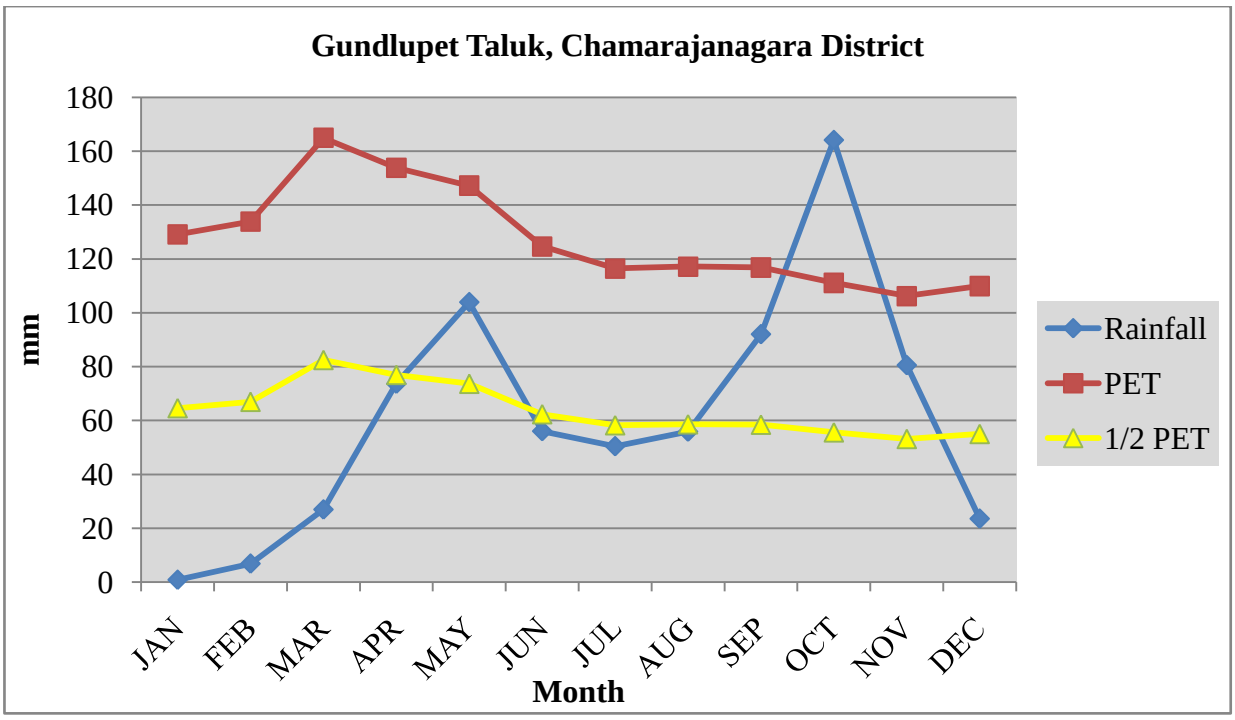


Fig 2.3 Rainfall distribution in Gundlupet Taluk, Chamarajanagara District

2.6 Natural Vegetation

Forests occupy about 32 per cent area in Gundlupet taluk. The major area of these forests is found in Bandipur National Park and Himavad Gopalaswamy Betta (Fig. 2.4). The rest of the area in the taluk has sparse natural vegetation comprising few tree species, shrubs and herbs. The mounds, ridges and boulders 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 microwatershed is causing vegetative degradation of whatever little vegetation is 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 slope, 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.

Fig. 2.4 Natural Vegetation of Chilkadabetta-1 Microwatershed

2.7 Land Utilization

About 48 per cent area (Table 2.2) in Gundlupet taluk is cultivated at present. An area of about 6 per cent is currently barren. Forests occupy an area of about 32 per cent and the tree cover is in a very poor state except in Bandipura National Park and Gopalaswamy Betta. Most of the mounds, ridges and bouldery areas have very poor vegetative cover. Major crops grown in the area are sorghum, maize, cotton, mulberry, onion, sugarcane, safflower, groundnut, red gram, horsegram and sapota. 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 the microwatershed is presented in Figure 2.5. The different crops and cropping systems adopted in the microwatershed is presented in Figures 2.6a and 2.6b. Simultaneously, enumeration of wells (bore wells and open wells) and existing conservation structures in the microwatershed are 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 Chilkadabetta-1 microwatershed is given Fig.2.7.

Table 2.2 Land Utilization in Gundlupet Taluk

Sl. No.	**Agricultural land use**	**Area (ha)**	**Per cent**
1.	Total geographical area	140607	
2.	Total cultivated area	67339	47.84
3.	Area sown more than once	13532	
4.	Trees and grooves	3485	2.47
5.	Forest	44859	31.98
6.	Cultivable wasteland	3265	2.32
7.	Permanent Pasture land	10287	7.31
8.	Barren land	7988	5.68
9.	Non- Agriculture land	3384	2.40

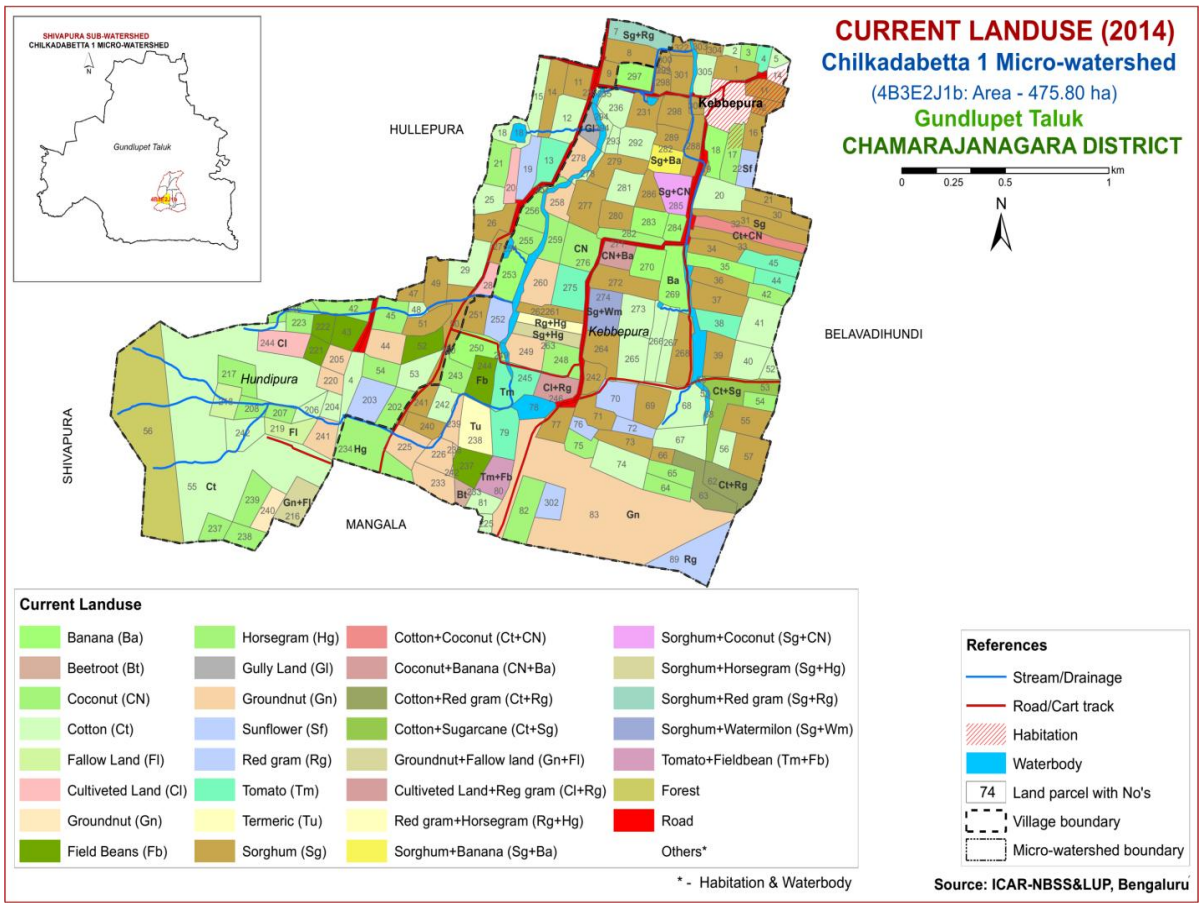


Fig. 2.5 Current Land Use map- Chilkadabetta-1 Microwatershed

Fig. 2.6a. Different Crops and Cropping Systems in Chilkadabetta-1 Microwatershed

Fig. 2.6b. Different Crops and Cropping Systems in Chilkadabetta-1 Microwatershed

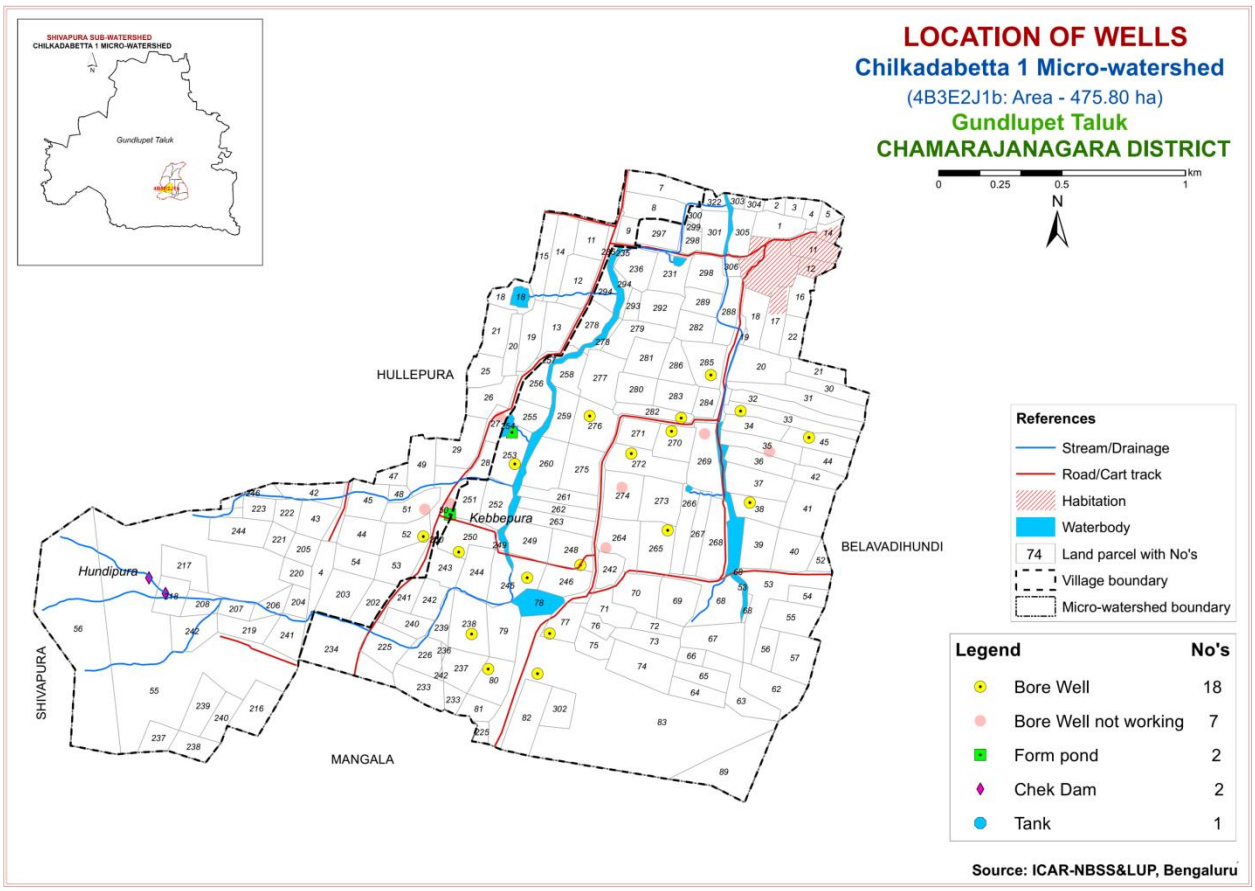


Fig. 2.7 Location of Wells and Conservation Structures- Chilkadabetta-1 Microwatershed

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 Chilkadabetta-1 microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, soil horizons, porosity, soil reaction etc.) and site characteristics (slope of the land, erosion, drainage, occurrence of rock fragments etc.) followed by grouping of similar areas based on soil-site characteristics into homogeneous units (management units) and showing their extent and geographic distribution on the microwatershed cadastral map. The detailed survey at 1:7920 scale was carried out in 476 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 Survey of India topographical map to identify the landscapes, landforms and other surface features. The cadastral map was overlaid on the satellite imagery (Fig.3.2) that helps to identify the parcel boundaries and other permanent 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.3.3). Apart from cadastral maps and images, toposheets of the area (1:50,000 scale) were used for initial traversing, identification of geology and landforms, drainage features, present land use and also for selection of transects in the microwatershed.

3.2 Image Interpretation for Physiography

False Colour Composites (FCCs) of Cartosat-I and LISS-IV merged satellite data covering 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 Granite gneiss landscape. It was divided into three landforms, *viz;* ridges and mounds, uplands and lowlands based on slope and image characteristics. 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 Landform

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)
	G24		Valleys/ lowlands
		G241	Valleys, pink tones
		G242	Valleys gray mixed with pink tones

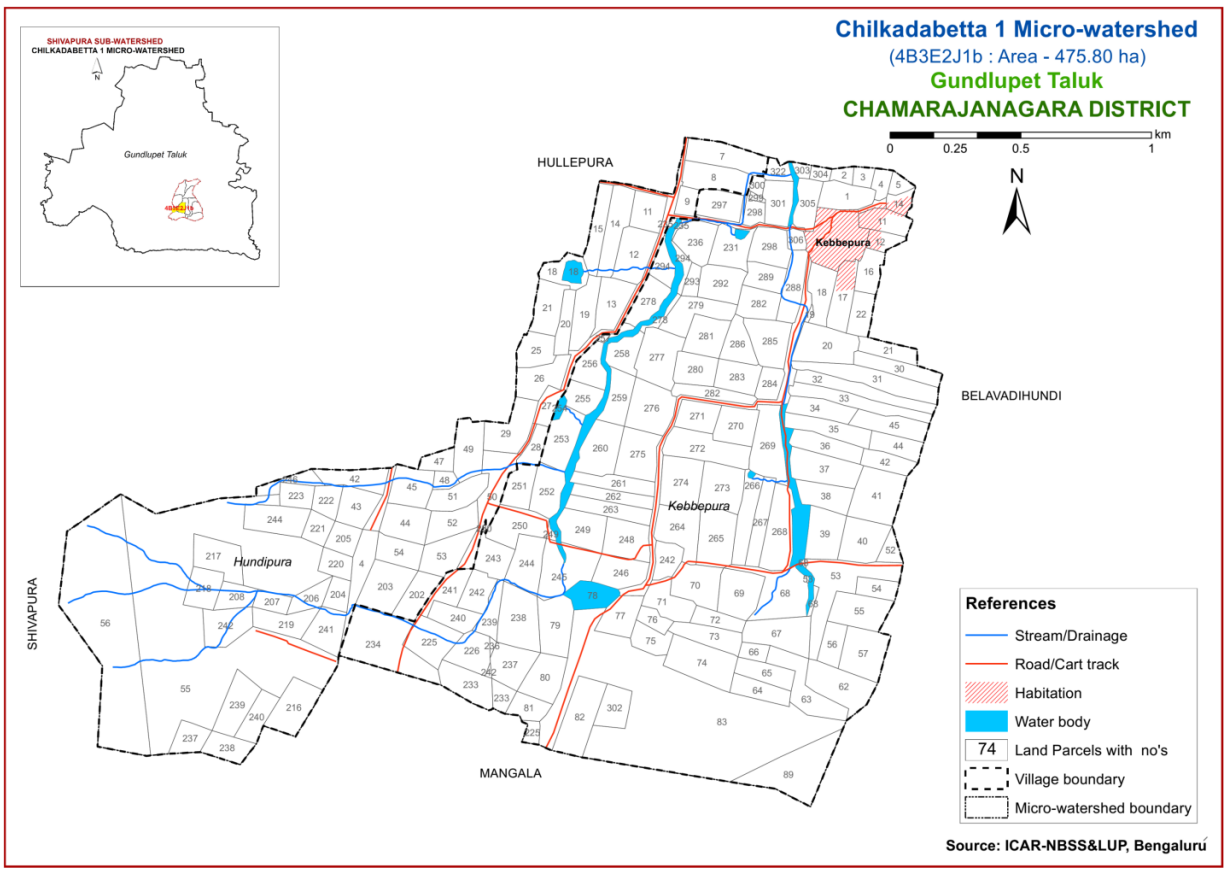


Fig. 3.1 Scanned and Digitized Cadastral map of Chilkadabetta-1 Microwatershed

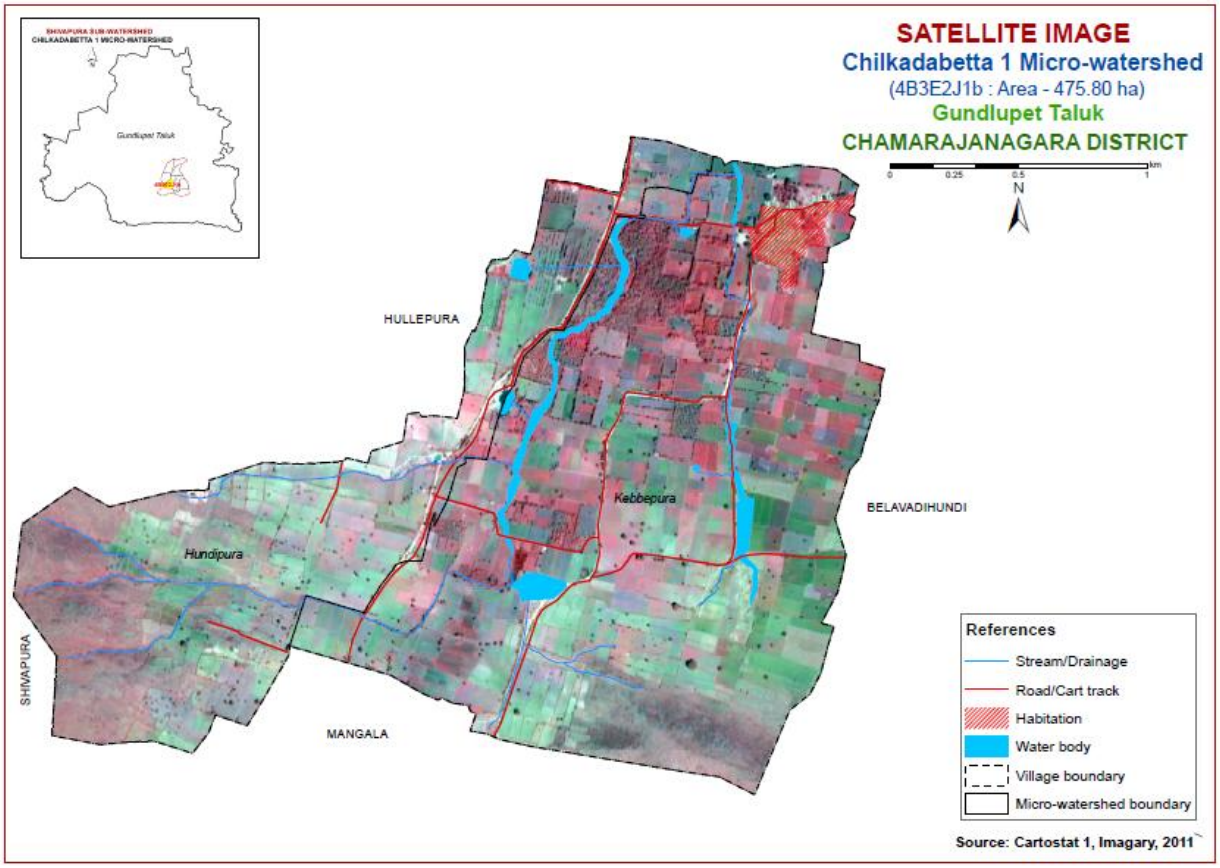


Fig. 3.2 Satellite image of Chilkadabetta-1 Microwatershed

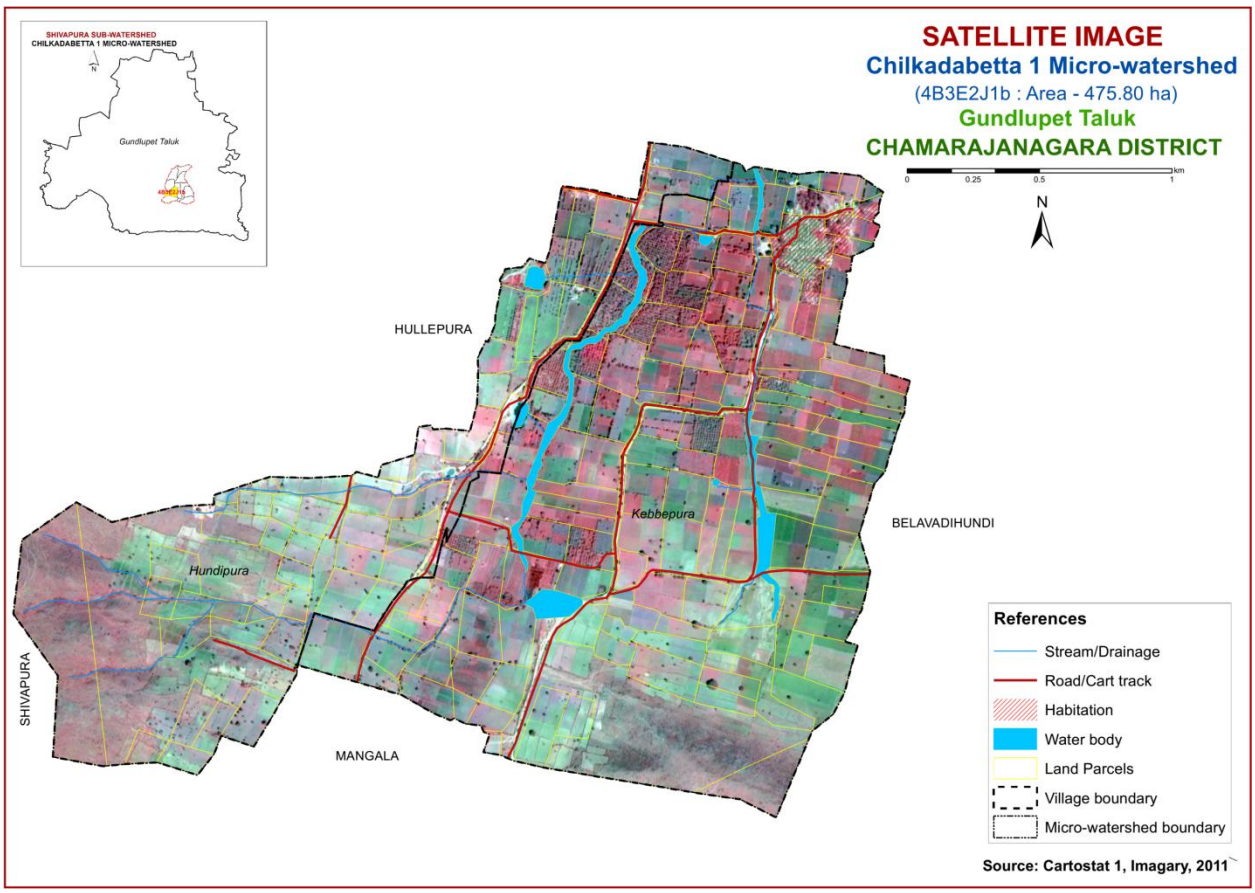


Fig. 3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Chilkadabetta-1 Microwatershed

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 up to 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 the 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-site 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, colour, 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 in the microwatershed are given in Table 3.1. Based on the above characteristics, 10 soil series were identified in Chilkadabetta-1 microwatershed.

Table 3.1 Differentiating Characteristics used for Identifying Soil Series (Characteristics are of series control section)

Sl.no	Soil Series	Depth (cm)	Colour	Texture	Gravel (%)	Horizon sequence
1	ARK (Annurkeri)	>150	2.5YR2.5/2,3/2, 2.5/3,3/3,2.5/4,3/4	sc-c	<15	Ap-Bt
2	BMB (Beemanabeedu)	>150	10YR2/1,2/2,3/1,3/2,4/1	c	-	Ap-Bw
3	DRH (Devarahalli)	50-75	2.5YR 2.5/4, 3/2,3/6	scl-sc	15-35	Ap-Bt-Cr
4	HDR (Hundipura)	25-50	2.5YR2.5/4, 5YR3/2	scl-sc	<15	Ap-Bt-Cr
5	HGH (Honnegaudanahalli)	>150	7.5YR2.5/2, 2.5/3,3/3,2.5/4,3/4	scl	<15	Ap-Bw
6	HPR (Hullipura)	50-75	7.5YR2.5YR2.5/2,3/2	scl-sc	15-35	Ap-Bt-Cr
7	(KDH) (Kalligaudanahalli)	>150	5YR2.5/2,3/2,3/32.5YR3/2	sc-c	<15	AP-Bt
8	(KNG) (Kannigala)	75-100	2.5YR2.5/4,3/4,3/6	scl-sc	>35	Ap-Bt-Cr
9	(MGH) (Magoonahalli)	50-75	2.5YR2.5/4,3/4	scl	>35	Ap-Bt-Cr
10	SPR (Shivapura)	25-50	2.5YR2.5/4,3/4	scl-sc	>35	Ap-Bt-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 (67) collected from farmer's fields 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 krigging 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.3.3) in the form of symbols. During the survey about 21 profile pits and few minipits representing different landforms occurring in the microwatersheds were studied. 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 mapping units representing 10 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 28 phases mapped in the microwatersheds. 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 10 soil phases identified and mapped in the microwatershed were regrouped into 8 Land Management Units (LMU's) for the purpose of preparing a proposed land use 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 choosen for identification and delineation of LMUs. For Chilkadabetta-1 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.

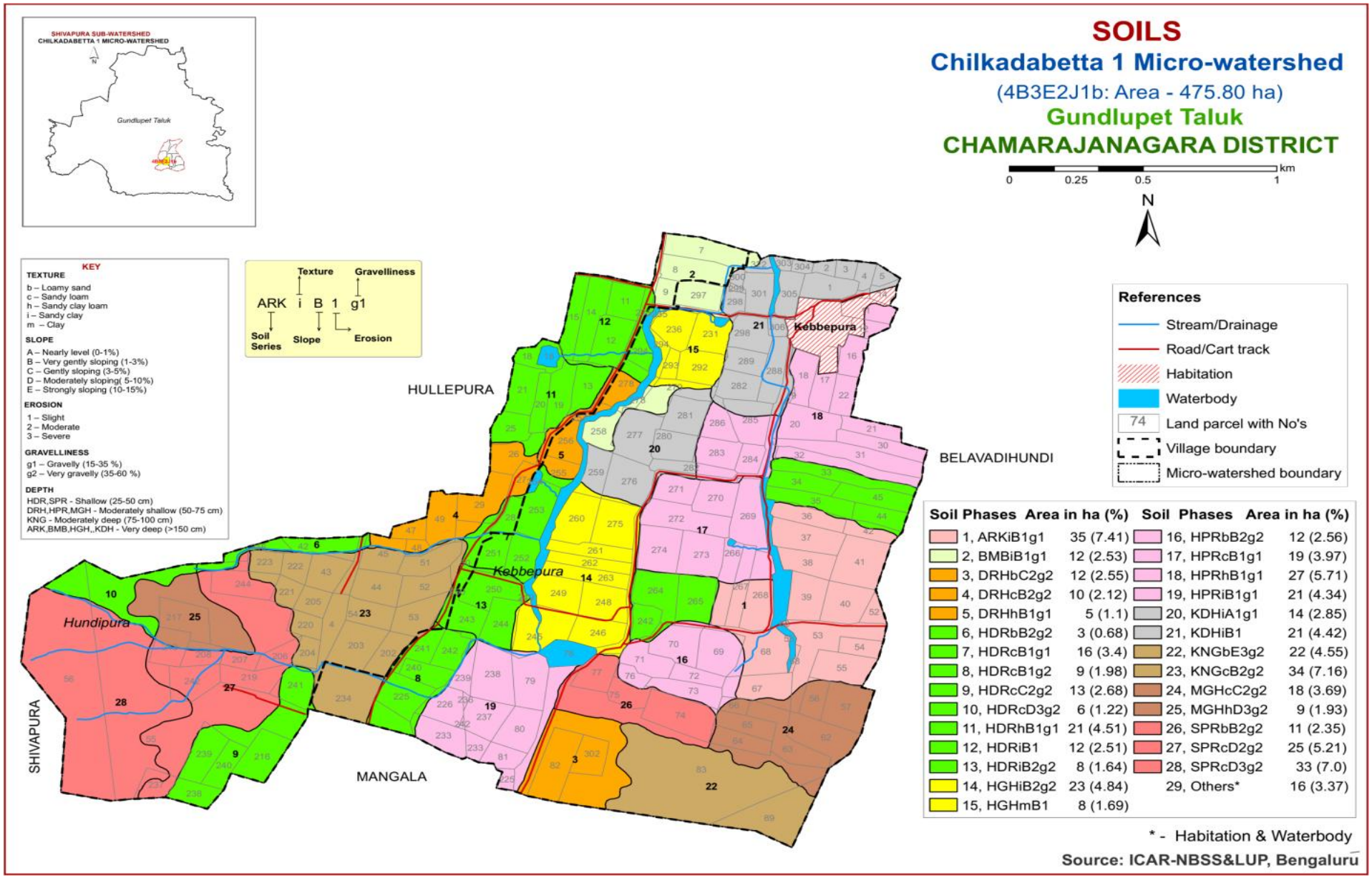


Fig. 3.4 Soil Phase or Management Units- Chilkadabetta-1 Microwatershed

Table 3.2 Soil Map Unit Description of Chilkadabetta-1 Microwatershed

Series	Map symbol	Soil map unit	Description	Area in ha
SOILS OF GRANITE GNEISS LANDSCAPE				
ARK	Annurkeri soils are very deep (>150 cm), well drained, have dark reddish brown to very dusky red sandy clay to clay soils occurring on very gently sloping uplands under cultivation.			**35.24 (7.41)**
	1.	ARKiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	35.24 (7.41)
BMB	Beemanabeedu soils are very deep (>150 cm), moderately well drained, have very dark greyish brown to dark grey and very dark brown clayey soils occurring on nearly level to very gently sloping lowlands under cultivation			**12.04 (2.53)**
	2.	BMBiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	12.04 (2.53)
DRH	Devarahalli soils are moderately shallow (50-75 cm), well drained, have dark red to reddish brown and dusky red gravelly sandy clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation			**27.47 (5.77)**
	3.	DRHbC2g2	Loamy sand surface, slope 3-5%, moderate erosion, very gravelly (35-60%)	12.15 (2.55)
	4.	DRHcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	10.08 (2.12)
	5.	DRHhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	5.24 (1.10)
HDR	Hundipur soils are shallow (25-50 cm), well drained, have dark reddish brown to dusky red sandy clay loam to sandy clay soils occurring on very gently sloping uplands and moderately sloping mounds and ridges			**88.57 (18.62)**
	6.	HDRbB2g2	Loamy sand surface, slope 1-3 %, moderate erosion, very gravelly (35-60 %)	3.23 (0.68)
	7.	HDRcB1g1	Sandy loam surface, slope 1-3 %, slight erosion, gravelly (15-35 %)	16.18 (3.40)
	8.	HDRcB1g2	Sandy loam surface, slope 1-3 %, slight erosion, very gravelly (35-60%)	9.41 (1.98)
	9.	HDRcC2g2	Sandy loam surface, slope 3-5 %, moderate erosion, very gravelly (35-60%)	12.76 (2.68)
	10.	HDRcD3g2	Sandy loam surface, slope 5-10 %, severe erosion, very gravelly (35-60%)	5.80 (1.22)
	11.	HDRhB1g1	Sandy clay loam surface, slope 1-3 %, slight erosion, gravelly (15-35%)	21.45 (4.51)
	12.	HDRiB1	Sandy clay surface, slope 1-3%, slight erosion	11.94 (2.51)
	13.	HDRiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	7.80 (1.64)
HGH	Honnegaudanahalli soils are very deep (>150 cm), well drained, have very dark brown to brown and dark reddish brown sandy clay loam soils occurring on very gently sloping uplands under cultivation.			**31.08 (6.53)**
	14.	HGHiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	23.02 (4.84)
	15.	HGHmB1	Clay surface, slope 1-3%, slight erosion	8.06 (1.69)

HPR	Hullipura soils are moderately shallow (50-75 cm), well drained, have dark brown to very dark brown gravelly sandy clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation			**78.92 (16.58)**
	16.	HPRbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	12.20 (2.56)
	17.	HPRcB1g1	Sandy loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	18.88 (3.97)
	18.	HPRhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	27.18 (5.71)
	19.	HPRiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	20.66 (4.34)
KDH	Kalligaudanahalli soils are very deep (>150 cm), well drained, have dark red to dark reddish brown and dark brown sandy clay to clay soils occurring on very gently sloping uplands under cultivation.			**34.61 (7.27)**
	20.	KDHiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35%)	13.57 (2.85)
	21.	KDHiB1	Sandy clay surface, slope 1-3%, slight erosion	21.04 (4.42)
KNG	Kannigala soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red gravelly sandy clay loam to sandy clay soils occurring on very gently sloping uplands and strongly sloping mounds and ridges.			**55.73 (11.71)**
	22.	KNGbE3g2	Loamy sand surface, slope 10-15%, severe erosion, very gravelly (35-60%)	21.67 (4.55)
	23.	KNGcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	34.06 (7.16)
MGH	Magoonahalli soils are moderately shallow (50-75 cm), well drained, have very dark brown to dark brown gravelly sandy clay loam soils occurring on very gently sloping uplands and moderatly sloping mounds and ridges			**26.77 (5.62)**
	24.	MGHcC2g2	Sandy loam surface, slope 3-5%, moderate erosion, very gravelly (35-60%)	17.57 (3.69)
	25.	MGHhD3g2	Sandy clay loam surface, slope 5-10%, severe erosion, very gravelly (35-60%)	9.20 (1.93)
SPR	Shivapura soils are shallow (25-50 cm), well drained, have dark reddish brown gravelly sandy clay loam to sandy clay soils occurring on very gently sloping uplands and very strongly sloping hills, mounds and ridges.			**69.34 (14.56)**
	26.	SPRbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	11.20 (2.35)
	27.	SPRcD2g2	Sandy loam surface, slope 5-10%, moderate erosion, very gravelly (35-60%)	24.81 (5.21)
	28.	SPRcD3g2	Sandy loam surface, slope 5-10%, severe erosion, very gravelly (35-60%)	33.33 (7.00)
MISCELLANEOUS LANDS				
	29.	Others		16.05 (3.37)

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Chilkadabetta-1 microwatershed is provided in this chapter. The microwatershed area has been identified as granite gneiss landscape based on geology. In all, 10 soil series were identified in different landforms. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. In the granite gneiss landform, it is by parent material, relief and climate.

A brief description of each of the 10 soil series identified followed by the soil phases (management units) mapped under each series 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 characteristics 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, ersion, 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 Landscape

In this landscape, 10 soil series are identified and mapped. Of these, Hundipura (HDR) soil series occupies maximum area of about 89 ha (19%) followed by Hullipur (HPR) 79 ha (17%) area. Brief description of each series identified in the microwatershed area is given below.

4.1.1 Annurkeri (ARK) Series: Annurkeri soils are very deep (>150 cm), well drained, have dark reddish brown to very dusky red sandy clay to clay soils. They are developed from weathered granite gneiss and occur on very gently sloping uplands.

The thickness of the solum ranges from 150 to 200 cm. The thickness of A horizon ranges from 11 to 18 cm. Its colour is in 5YR and 2.5 YR hue with value 3 and chroma 3 to 4. The texture varies from sandy clay to clay with 10 to 15 per cent gravel. The thickness of B horizon is more than 150 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 2 to 4. Texture is dominantly sandy clay to clay with less than 15 per cent gravel. The available water capacity is very high (>200 mm/m).

Only one phase was identified:

ARKiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)

Landscape and Soil Profile characteristics of Annurkeri (ARK) Series

4.1.2 Beemanabeedu (BMB) Series: Beemanabeedu soils are very deep (>150 cm), moderately well drained, have very dark greyish brown to dark grey and very dark brown clayey soils. They are developed from weathered granite gneiss and occur on very gently sloping lowlands.

The thickness of the solum ranges from 150 to 200 cm. The thickness of A horizon ranges from 12 to 17 cm. Its colour is in 10 YR and 7.5 YR hue with value 2.5 to 4 and chroma 2 to 4. The texture varies from sandy clay to clay with 10 to 15 per cent gravel. The thickness of B horizon is more than 150 cm. Its colour is in 10 YR hue with value 2 to 4 and chroma 1 to 2. Texture is clay and is nongravelly. The available water capacity is very high (>200 mm/m).

Only one phase was identified:

BMBiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)

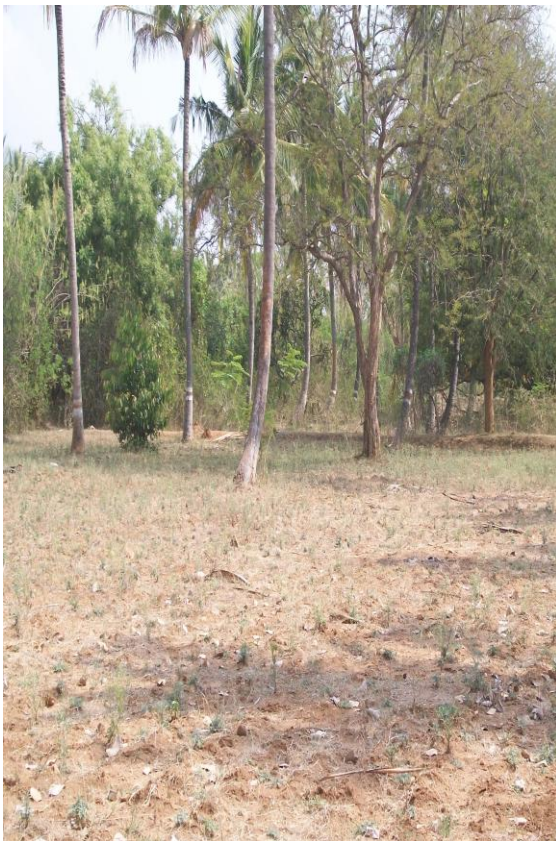
Landscape and Soil Profile characteristics of Beemanabeedu (BMB) Series

4.1.3 Devarahalli (DRH) Series: Devarahalli soils are moderately shallow (50-75 cm), well drained, have dark red to reddish brown and dusky red sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on very gently to gently sloping uplands.

The thickness of the solum ranges from 52 to 73 cm. The thickness of A horizon ranges from 7 to 15 cm. Its colour is in 7.5 YR and 5YR hue with value 3 to 4 and chroma 2 to 6. The texture varies from loamy sand to clay with 10 to 25 per cent gravel. The thickness of B horizon ranges from 45 to 58 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 4 to 6. Its texture is gravell sandy clay loam to gravelly sandy clay with gravel content of 15 to 35 per cent. The available water capacity is low (51-100 mm/m).

Three phases were identified:

DRHbC2g2	Loamy sand surface, slope 3-5%, moderate erosion, very gravelly (35-60%)
DRHcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)
DRHhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)



Landscape and Soil Profile characteristics of Devarahalli (DRH) Series

4.1.4 Hundipura (HDR) Series: Hundipura soils are shallow (25-50 cm), well drained, have dark reddish brown to dusky red sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on very gently to moderately sloping uplands.

The thickness of the solum ranges from 35 to 46 cm. The thickness of A horizon ranges from 7 to 18 cm. Its colour is in 7.5 YR and 5 YR hue with value 3 and chroma 3 to 4. The texture varies from loamy sand to clay with 10 to 20 per cent gravel. The thickness of B horizon ranges from 19 to 31 cm. Its colour is in 2.5 YR and 5 YR hue with value 2.5 to 3 and chroma 2 to 4. Its texture is sandy clay loam to sandy clay with gravel content of < 15 per cent. The available water capacity is very low (<50 mm/m).

Eight phases were identified:

HDRbB2g2	Loamy sand surface, slope 1-3 %, moderate erosion, very gravelly (35-60 %)
HDRcB1g1	Sandy loam surface, slope 1-3 %, slight erosion, gravelly (15-35 %)
HDRcB1g2	Sandy loam surface, slope 1-3 %, slight erosion, very gravelly (35-60%)
HDRcC2g2	Sandy loam surface, slope 3-5 %, moderate erosion, very gravelly (35-60%)
HDRcD3g2	Sandy loam surface, slope 5-10 %, severe erosion, very gravelly (35-60%)
HDRhB1g1	Sandy clay loam surface, slope 1-3 %, slight erosion, gravelly (15-35%)
HDRiB1	Sandy clay surface, slope 1-3%, slight erosion
HDRiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)

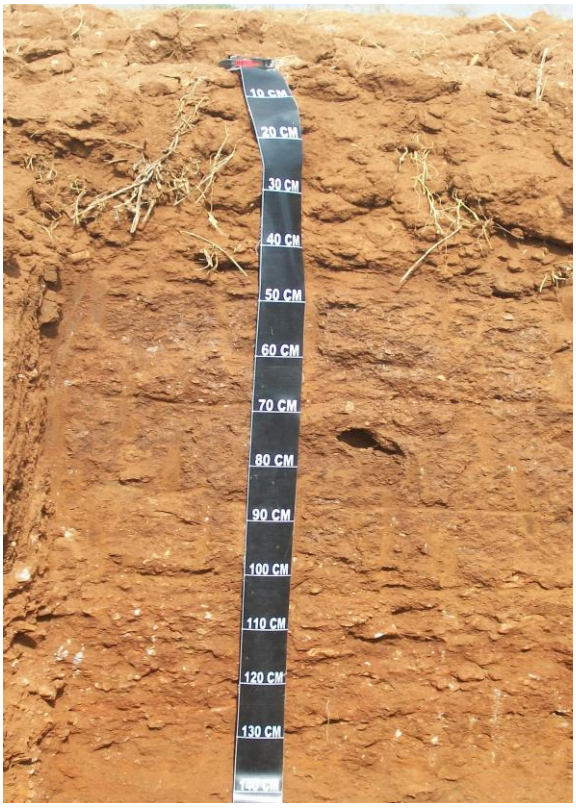
Landscape and Soil Profile characteristics of Hundipura (HDR) Series

4.1.5 Honnegaudanahalli (HGH) Series: Honnegaudanahalli soils are very deep (>150 cm), well drained, have very dark brown to brown and dark reddish brown sandy clay loam soils. They are developed from weathered granite gneiss and occur on very gently sloping uplands under cultivation.

The thickness of the solum ranges from 150-200 cm. The thickness of A horizon ranges from 14 to 19 cm. Its colour is in 7.5 YR hue with value 2.5 to 4 and chroma 2 to 6. The texture varies from sandy loam to clay with 10 to 15 per cent gravel. The thickness of B horizon is more than 150 cm. Its colour is in 7.5 YR hue with value 2.5 to 3 and chroma 2 to 4. Texture is sandy clay loam with 35 to 50 per cent gravel. The available water capacity is very high (>200mm/m).

Two phases were identified:

HGHiB2g2	Sandy clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)
HGHmB1	Clay surface, slope 1-3%, slight erosion



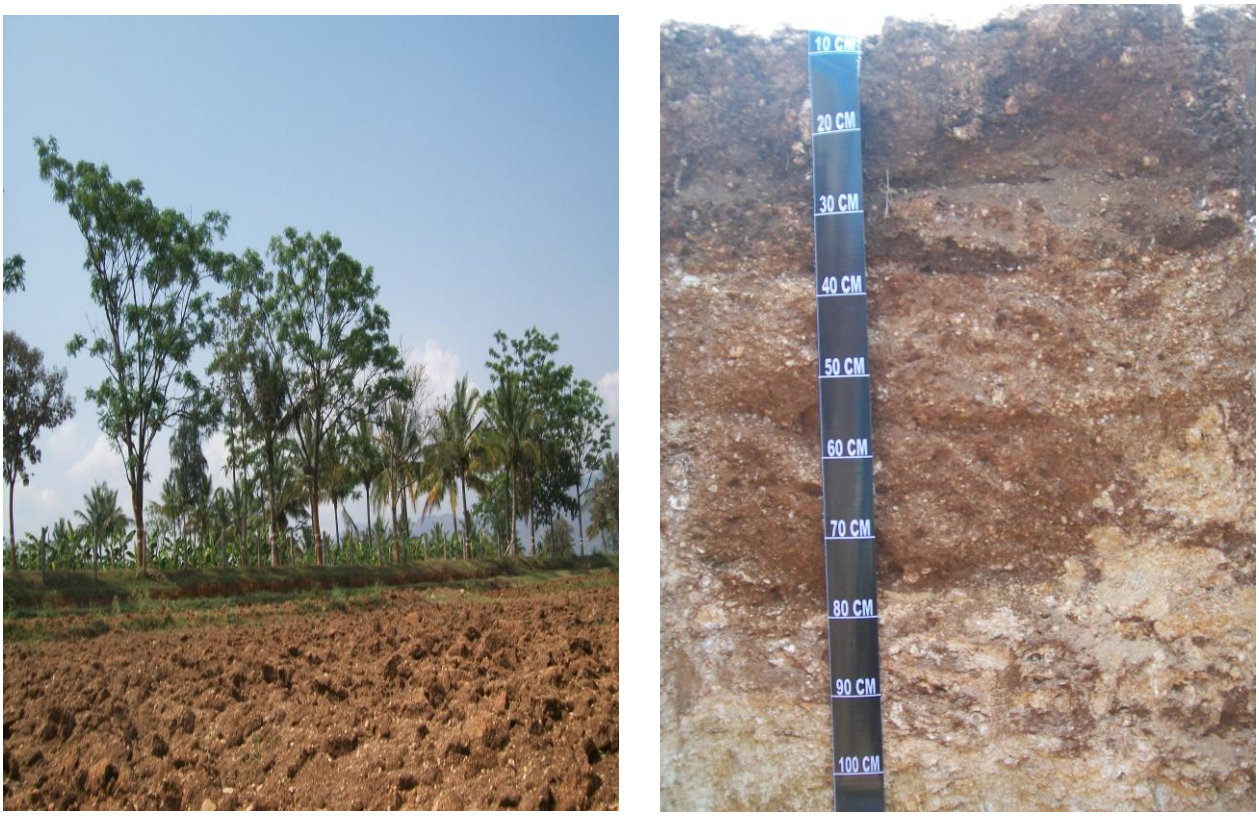
Landscape and Soil Profile characteristics of Honnegaudanahalli (HGH) Series

4.1.6 Hullipura (HPR) Series: Hullipura soils are moderately shallow (50-75 cm), well drained, have dark brown to very dark brown sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on very gently to gently sloping uplands.

The thickness of the solum ranges from 51 to 71 cm. The thickness of A horizon ranges from 13 to 18 cm. Its colour is in 7.5YR and 10 YR hue with value 2.5 to 3 and chroma 2 to 4. The texture varies from gravelly sandy loam to gravelly clay with 15 to 25 per cent gravel. The thickness of B horizon ranges from 38 to 52 cm. Its colour is in 2.5 YR and 7.5 YR hue with value 2.5 to 3 and chroma 2. Its texture is gravelly sandy clay loam to gravelly sandy clay with gravel content of 15 to 35 per cent. The available water capacity is low (51-100 mm/m).

Four phases were identified:

HPRbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, very gravelly (35-60%)
HPRcB1g1	Sandy loam surface, slope 1-3%, slight erosion, gravelly (15-35%)
HPRhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)
HPRiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)



Landscape and Soil Profile characteristics of Hullipura (HPR) Series

4.1.7 Kalligaudanahalli (KDH) Series: Kalligaudanahalli soils are very deep (>150 cm), well drained, have dark red to dark reddish brown and dark brown sandy clay to clay soils. They are developed from weathered granite gneiss and occur on very gently sloping uplands under cultivation.

The thickness of the solum ranges from 150-200cm. The thickness of A horizon ranges from 13 to 19 cm. Its colour is in 7.5 YR, 5 YR and 2.5 YR hue with value 3 and chroma 2 to 6. Texture varies from sandy clay loam to clay with 10 to 15 per cent gravel. The thickness of B horizon is >150 cm. Its colour is in 2.5 YR and 5 YR hue with value 2.5 to 3 and chroma 2 to 3. Texture is sandy clay to clay with less than 15 per cent gravel. The available water capacity is very high (>200 mm/m).

Two phases were identified:

KDHiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35%)
KDHiB1	Sandy clay surface, slope 1-3%, slight erosion

Landscape and Soil Profile characteristics of Kalligaudanahalli (KDH) Series

4.1.8 Kannigala (KNG) Series: Kannigala soils are moderately deep (75-100 cm), 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 very gently to strongly sloping uplands.

The thickness of the solum ranges from 78 to 94 cm. The thickness of A horizon ranges from 12 to 15 cm. Its colour is in 5YR, 2.5 YR and 7.5 YR hue with value 3 and chroma 3 to 4. The texture varies from gravelly loamy sand to clay with 15 to 25 per cent gravel. The thickness of B horizon ranges from 69 to 80 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 4 to 6. Texture varies from gravelly sandy clay loam to gravelly sandy clay with 40 to 60 per cent gravel. The available water capacity is very low (<50 mm/m).

Two phases were identified:

KNGbE3g2	Loamy sand surface, slope 10-15%, severe erosion, very gravelly (35-60%)
KNGcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)

4.1.9 Magoonahalli (MGH) Series: Magoonahalli soils are moderately shallow (50-75 cm), well drained, have very dark brown to dark brown sandy clay loam soils. They have developed from granite gneiss and occur on very gently to moderately sloping uplands.

The thickness of the solum ranges from 53 to 74 cm. The thickness of A horizon ranges from 15 to 18 cm. Its colour is in 7.5 YR and 5 YR hue with value 3 to 4 and chroma 2 to 6. The texture varies from gravelly sandy loam to gravelly clay with 15 to 25 per cent gravel. The thickness of B horizon ranges from 44 to 52 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 4. Its

texture is gravelly sandy clay loam with gravel content of >35 per cent. The available water capacity is very low (50 mm/m).

Two phases were identified:

MGHcC2g2	Sandy loam surface, slope 3-5%, moderate erosion, very gravelly (35-60%)
MGHhD3g2	Sandy clay loam surface, slope 5-10%, severe erosion, very gravelly (35-60%)

Landscape and Soil Profile characteristics of Magoonahalli (MGH) Series

4.1.10 Shivapura (SPR) Series: Shivapura soils are shallow (25-50 cm), well drained, have dark reddish brown sandy clay loam to sandy clay soils. They have developed from granite gneiss and occur on very gently to very strongly sloping uplands.

The thickness of the solum ranges from 26 to 46 cm. The thickness of A horizon ranges from 9 to 17 cm. Its colour is in 7.5 YR and 2.5 YR hue with value 3 to 4 and chroma 3 to 6. The texture varies from sandy loam to sandy clay with 15 to 25 per cent gravel. The thickness of B horizon ranges from 18 to 40 cm. Its colour is in 2.5 YR hue with value 2.5 to 3 and chroma 4. Its texture is gravelly sandy clay loam to gravelly sandy clay with gravel content of >35 per cent. The available water capacity is very low (<50 mm/m).

Three phases were identified:

SPRbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, very gravelly (35-60%)
SPRcD2g2	Sandy loam surface, slope 5-10%, moderate erosion, very gravelly (35-60%)
SPRcD3g2	Sandy loam surface, slope 5-10%, severe erosion, very gravelly (35-60%)

Landscape and Soil Profile characteristics of Shivapura (SPR) Series

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 gathered through land resource inventory and several thematic maps are generated. These would help in identifying the areas suitable for growing crops and conservation 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

Soil characteristics: Soil depth, soil texture, coarse fragments, soil reaction, available water capacity, calcareousness, salinity/alkali *etc*.

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: The soil map units have few or very few limitations that restrict their use.

Class II: The soil map units have moderate limitations that reduce the choice of crops or that require moderate conservation practices.

Class III: The soil map units have severe limitations that reduce the choice of crops or that require special conservation practices.

Class IV: The soil map units have very severe limitations that reduce the choice of crops or that require very careful management.

Class V: Soils in the mapping units are not likely to erode, but have other limitations that are impractical to remove and as such not suitable for agriculture.

Class VI: The lands have severe limitations that make them generally unsuitable for cultivation.

Class VII: The lands have very severe limitations that make them unsuitable for cultivation.

Class VIII: Soil and other miscellaneous areas that have very severe limitations that nearly preclude their use for any crop production.

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 or slopes, “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 subwatersheds have been classified upto land capability subclass level.

The 28 soil map units identified in Chilkadabetta-1 microwatershed in Gundlupet taluk have been grouped under 4 land capability classes and 7 land capability subclasses (Fig 5.1). About 77 per cent area is suitable for agriculture and remaining 23 per cent is not suitable for agriculture.

Good cultivable lands (Class II) cover a maximum area of about 46 per cent and are distributed in all the part of the micowatershed with minor problems of soil, wetness and erosion. Moderately good cultivable lands (Class III) cover an area of about 26 per cent and are distributed in the southwestern, northwestern and small area of southeastern and central part of the microwatershed with moderate problems of erosion and soil. The fairly good cultivable lands (class IV) cover a very small area of about 5 per cent. They have severe limitations of erosion and soil and are distributed in the southwestern and southern part of the microwatershed. An area of 20 per cent is occupied by non agricultural lands (Class VI) and is distributed in the southwestern and southern part of the microwatershed. They have very severe limitations of erosion and soil.

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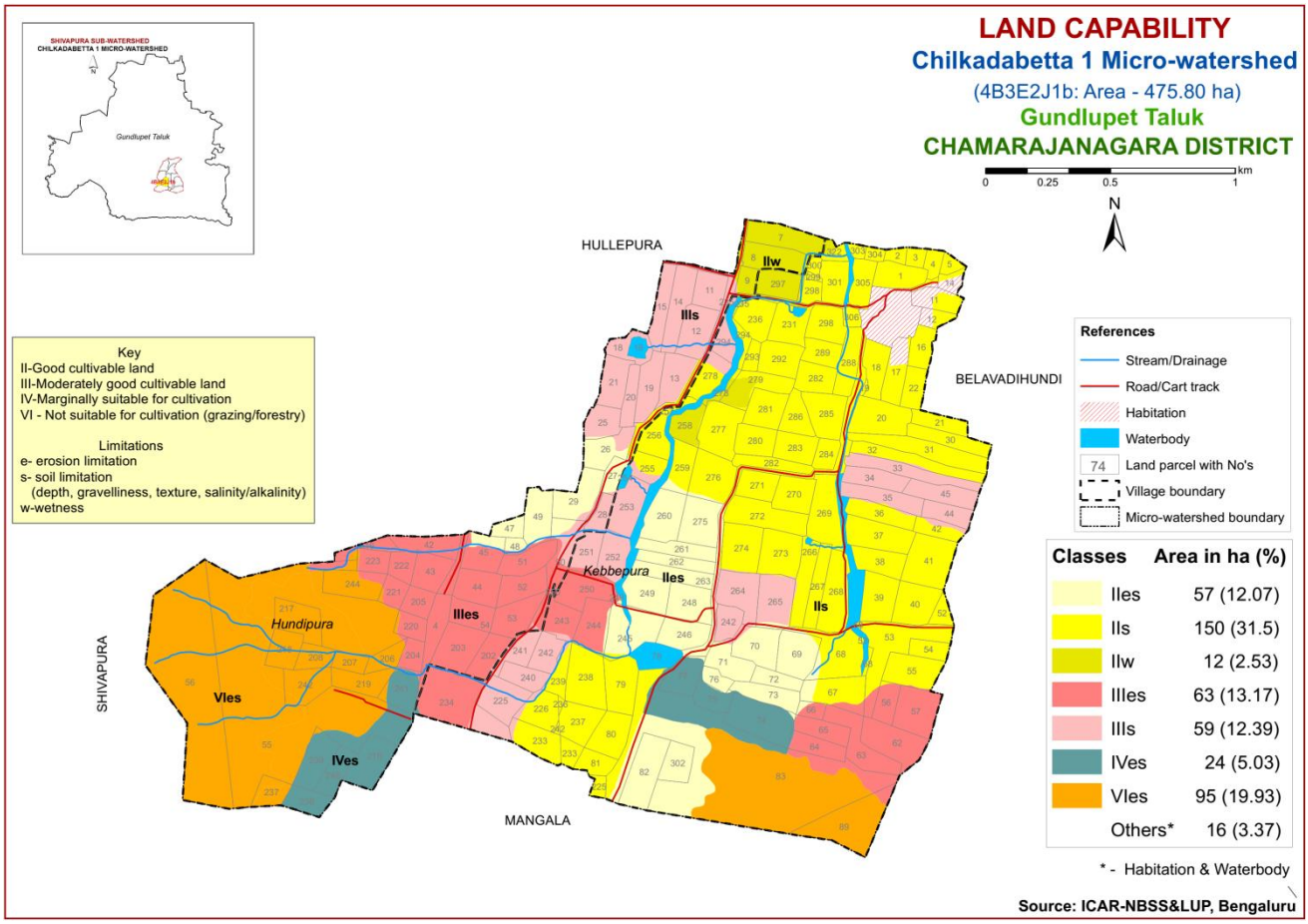


Fig. 5.1 Land Capability map of Chilkadabetta-1 Microwatershed

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. The area extent and geographical distribution in the microwatershed is shown in the Figure 5.2.

Very deep soils (>150 cm) occur in an area of about 113 ha (24%) and are distributed in the eastern, northern and central part of the microwatershed. Moderately deep (75-100 cm) soils occupy an area of about 56 ha (12%) and are distributed in the southern and southwestern part of the microwatershed. Moderately shallow (50-75 cm) soils occupy an area about 133 ha (28%) and are distributed in the southern, central, southeastern and northeastern part of the microwatershed. Shallow soils (25-50 cm) occupy a maximum area of about 158 ha (33%) in the southwestern, central and northwestern part of the microwatershed.

The most productive lands 113 ha (24%) with respect to soil rooting depth where all climatically adapted annual and perennial crops can be grown are very deep (>150 cm depth) occurring in the northern, central and eastern part of the microwatershed.

The most problem lands with a maximum area of about 158 ha (33%) having shallow (25-50 cm) rooting depth occur in the southwestern, central and northwestern 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.

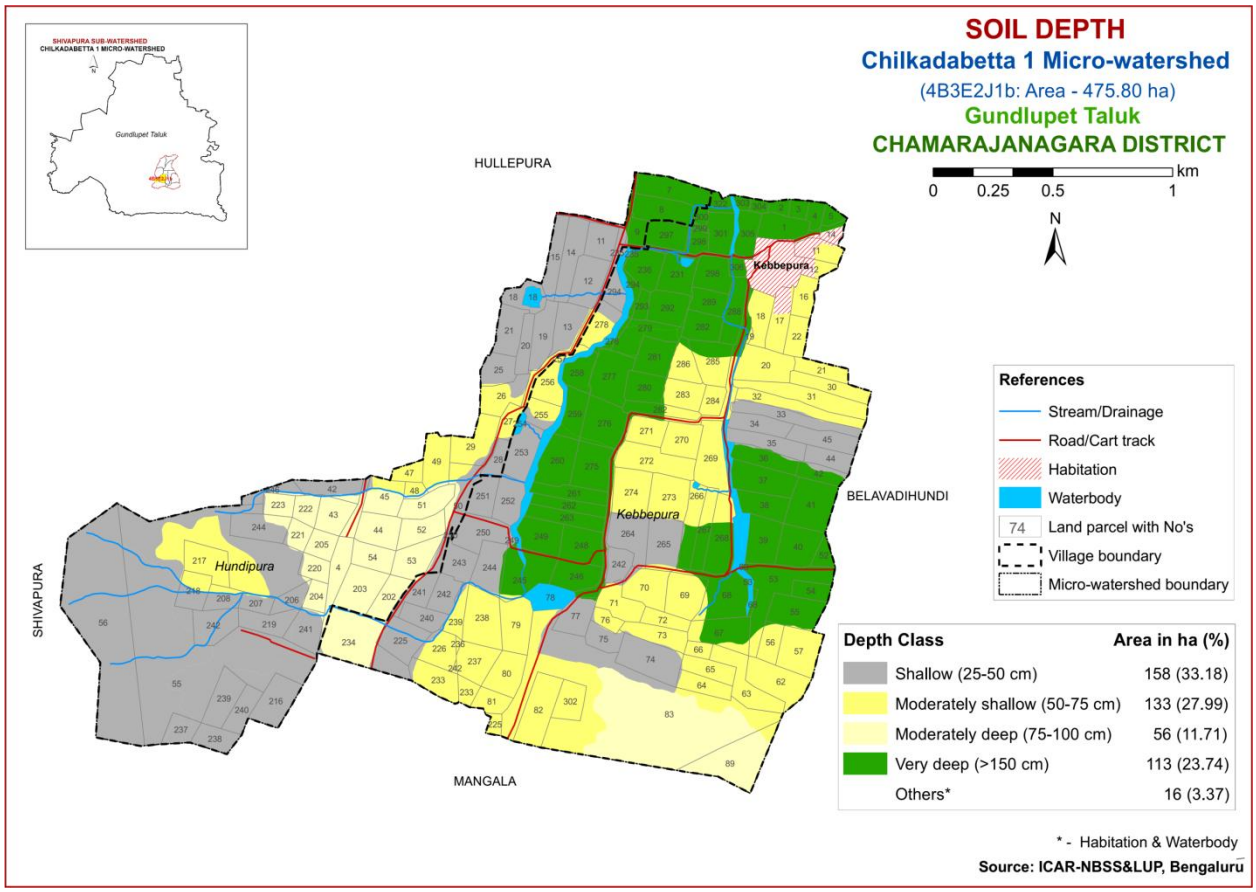


Fig. 5.2 Soil Depth map of Chilkadabetta-1 Microwatershed

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. The textural classes used for LRI were used to classify and a surface soil texture map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.3.

Maximum area of 246 ha (52%) has soils that are loamy at the surface and are distributed in all parts of the microwatershed. Clayey soil covers an area of about 153 ha (32%) and is distributed in the southern, central, northern and eastern part of the microwatershed. An area of about 60 ha (13%) has soils that are sandy at the surface and are distributed in the southern part of the microwatershed.

The most productive lands (32%) with respect to surface soil texture are the 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. The other most productive lands (52%) are loamy soils which have high potential for AWC, nutrient availability but have no drainage or other physical problem. The most problem soils (13%) with respect to surface soil texture are the sandy soils that have poor soil water retention and availability and nutrient retention and availability, but have better rain water infiltration, less runoff and soil moisture conservation, less capillary rise and less evaporation losses.

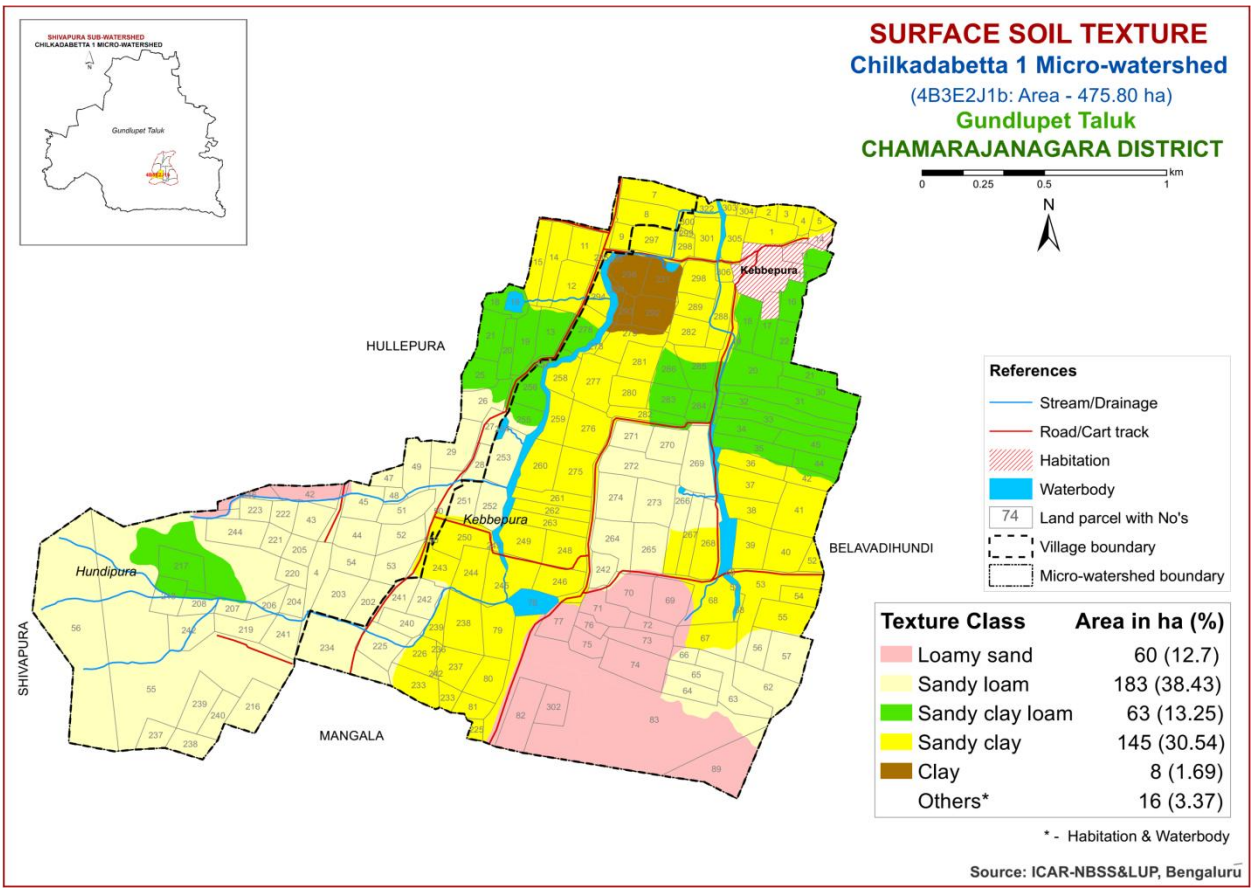


Fig. 5.3 Surface Soil Texture map of Chilkadabetta-1 Microwatershed

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 the 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. The gravelliness classes used in LRI were used to classify the soils and using these classes a gravelliness map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.4.

Maximum area in the microwatershed has soils that are very gravelly (35-60%) covering about 248 ha (52%) and are distributed in all parts of the microwatershed (Fig. 5.4) followed by soils that are gravelly (15-35%) covering about 170 ha (36%) and are distributed in the northeastern, southern, northern, northwestern and central part of the microwatershed. The soils that are non gravelly (<15%) covering a small area of about 41 ha (9%) are distributed in the northern part of the microwatershed.

The most productive lands with respect to gravelliness are found to be 9 %. They are non-gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops. The problem soils (52%) that are very gravelly (35-60%) where only short duration crops can be grown.

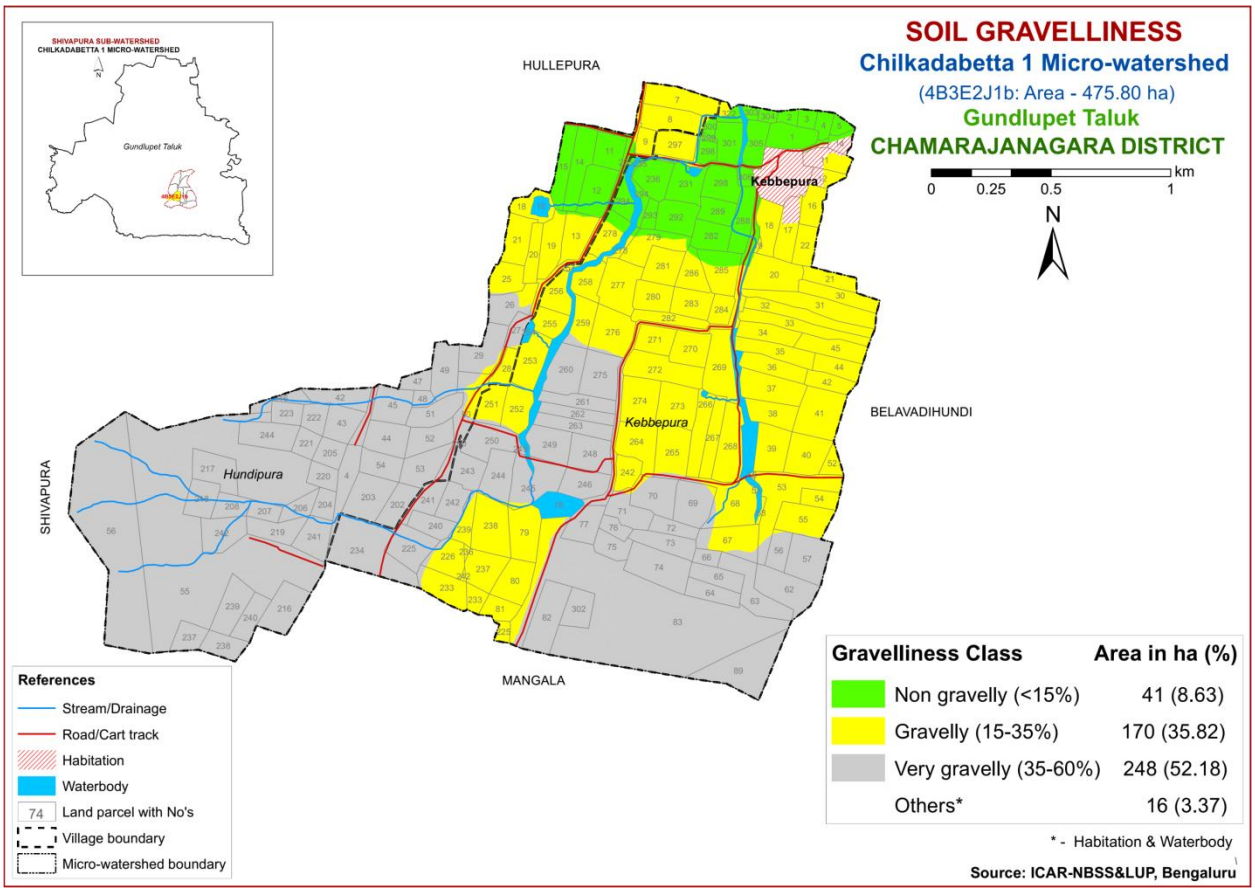


Fig. 5.4 Soil Gravelliness map of Chilkadabetta-1 Microwatershed

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) were estimated by considering the soil texture, mineralogy, soil depth and gravel content (Sehghal *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 accordingly an AWC map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.5.

Major area of about 240 ha (51%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and are distributed in all parts of the microwatershed. An area of about 106 ha (22%) has soils that are low (51-100 mm/m) in available water capacity and are distributed in the central, southern, northeastern and western part of the microwatershed. An area of 113 ha (24%) has soils that have very high (>200 mm/m) available water capacity and are distributed in the northern, eastern and central part of the microwatershed.

An area of about 113 ha (24%) has soils that have high potential (>200 mm/m) with regard to available water capacity where all climatically adapted long duration crops can be grown successfully.

About 240 ha (51%) area 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.

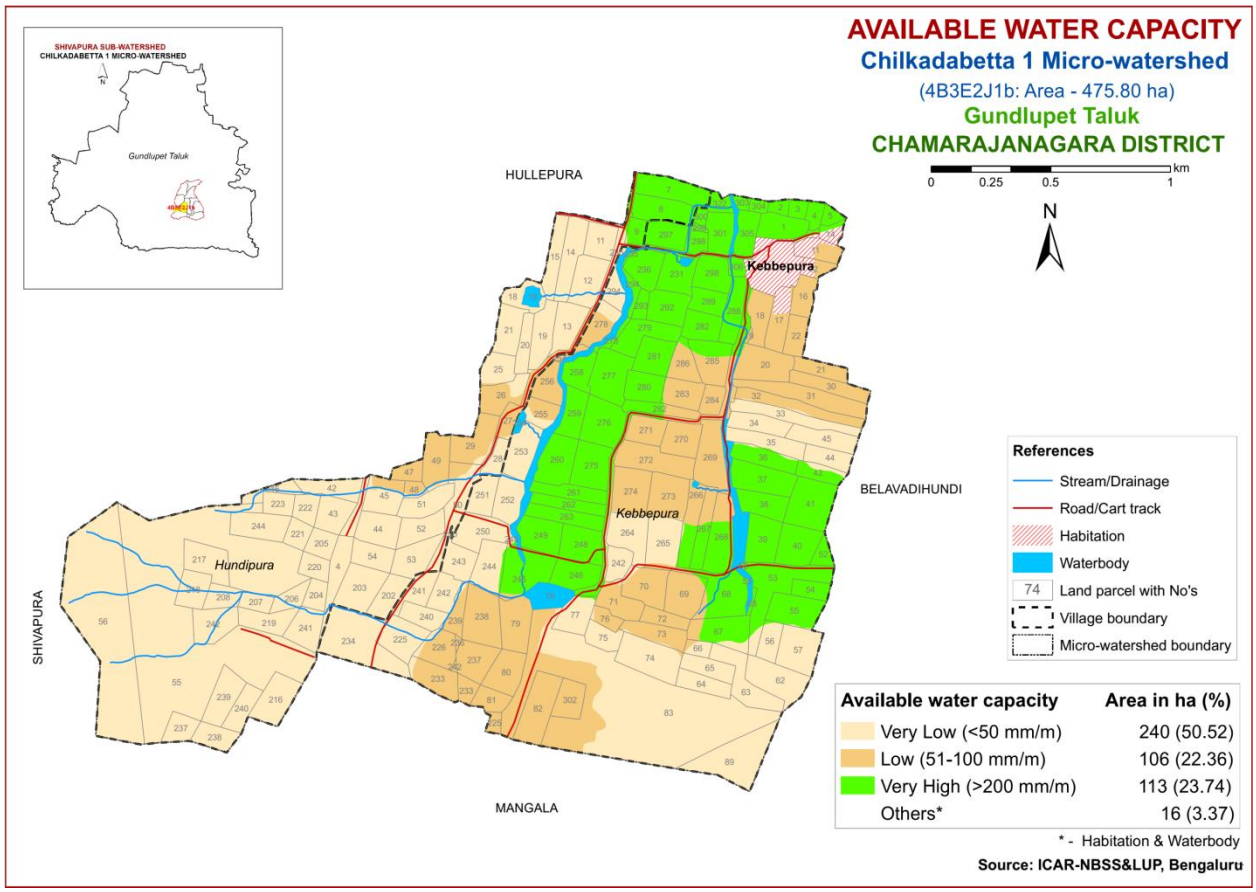


Fig. 5.5 Available Water Capacity map of Chilkadabetta-1 Microwatershed

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. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.6.

Major area of about 309 ha (65%) falls under very gently sloping (1-3% slope) lands and are distributed in all parts of the microwatershed followed by a moderately sloping (5-10% slope) lands. It covers an area of about 73 ha (15%) and is distributed in the southwestern part of the microwatershed. An area of about 42 ha (9%) falls under gently sloping (3-5% slope) lands and are distributed in the southeastern parts of the microwatershed. A small area of about 22 ha (5%) falls under strongly sloping (10-15% slope) lands and are distributed in the southeastern part of the

microwatershed. A minor area of about 14 ha (3%) falls under nearly level (0-1% slope) lands and are distributed in the central part of the microwatershed.

An area of about 323 ha (68%) in the microwatershed has soils that have high potential in respect of soil slopes. In these areas, all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

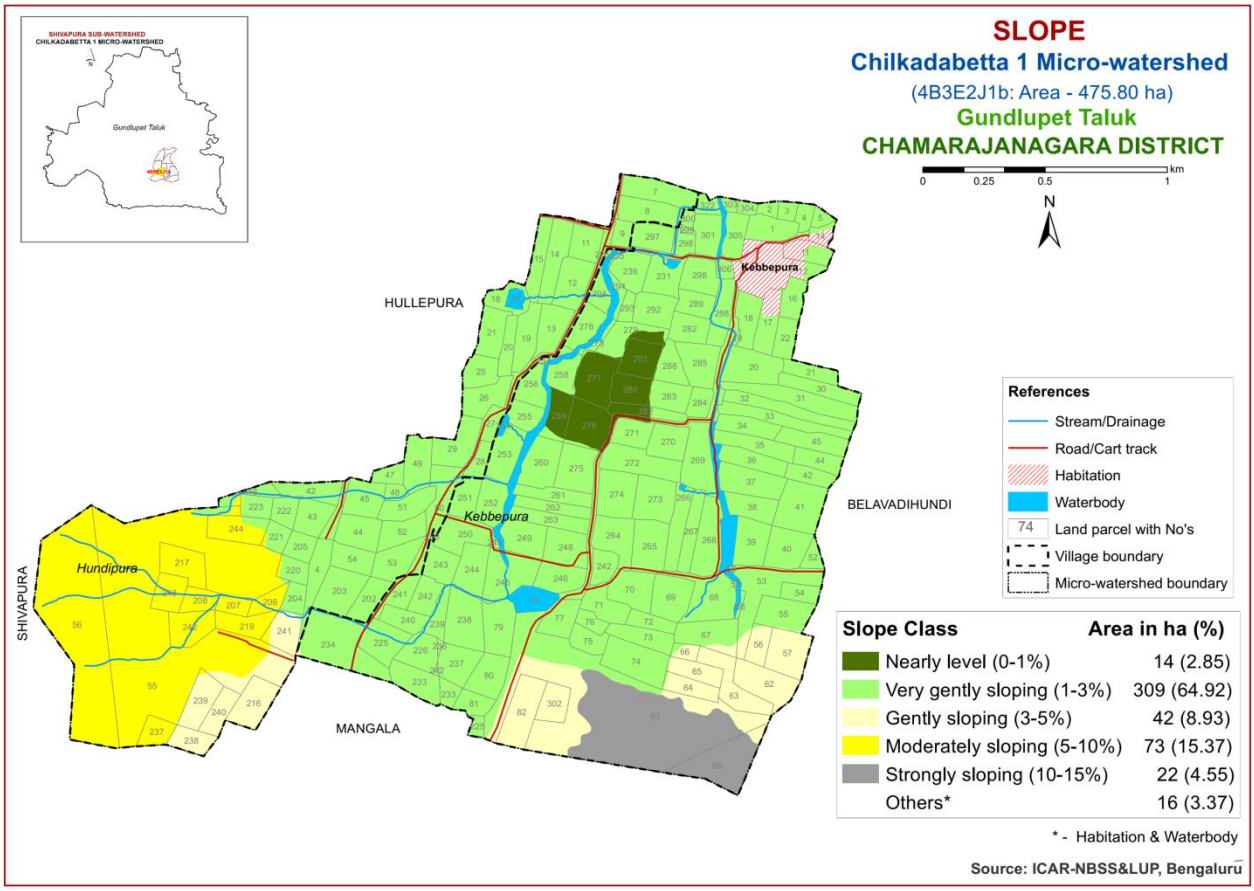


Fig. 5.6 Soil Slope map of Chilkadabetta-1 Microwatershed

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 different microwatersheds is given in Figure 5.7.

Soils that are slightly eroded (e1 class) cover a maximum area of about 221 ha (46%) in the microwatershed. They are distributed in all parts of the microwatershed. Moderately eroded (e2 class) soils cover an area of about 169 ha (35%) and are distributed in the central, southwestern and southeastern part of the microwatershed. Soils that are severely eroded (e3 class) cover an area of about 70 ha (15%). They are distributed in southwestern and southeastern part of the microwatershed.

About 239 ha (50%) in the microwatershed is problematic in respect of erosion and top priority is to be given to these areas for taking up soil and water conservation and other land development measures.

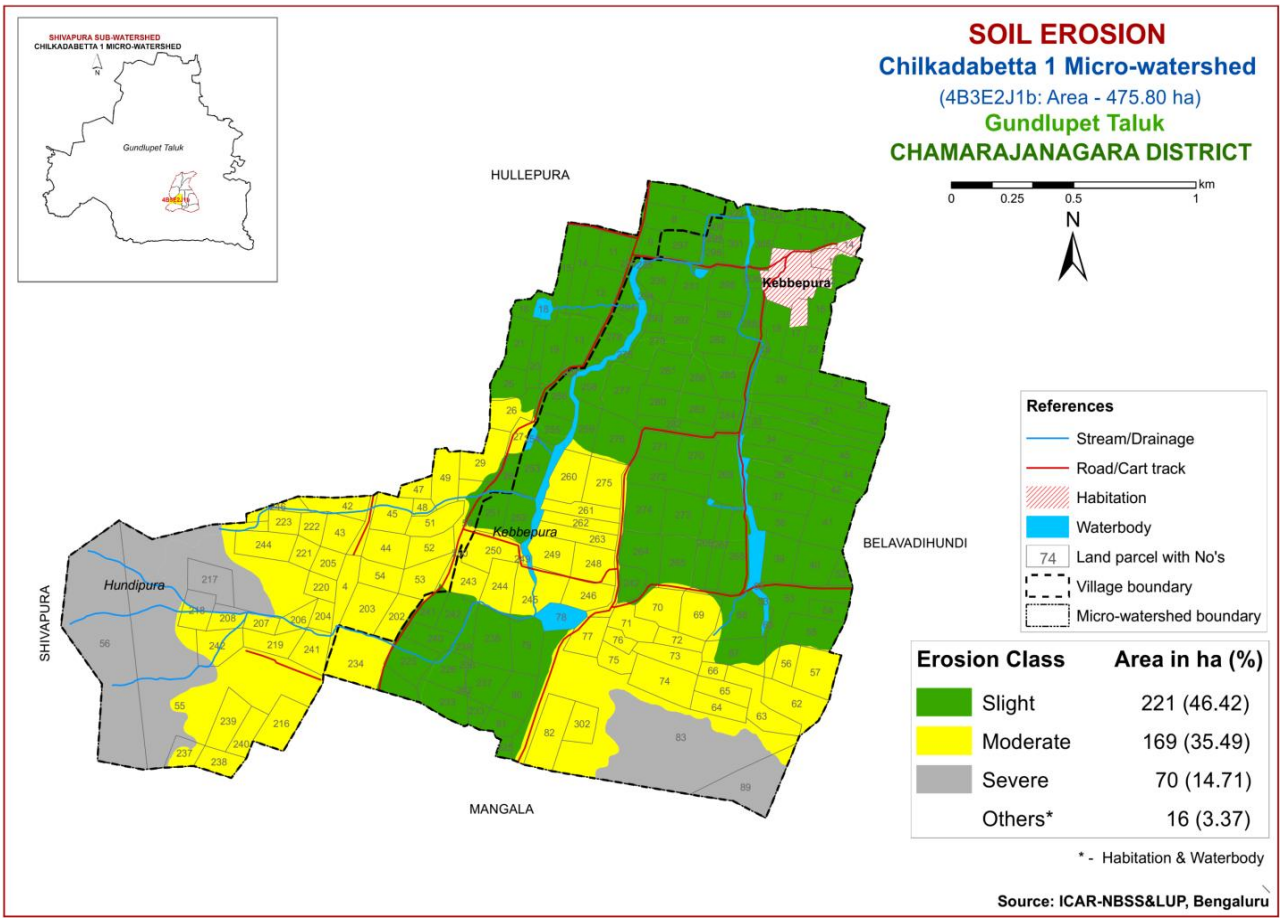


Fig. 5.7 Soil Erosion map of Chilkadabetta-1 Microwatershed

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. 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 (67 samples) from the grid points (one soil sample at every 250 m interval) all over the watersheds through land resource inventory in the year 2015 were analysed for pH, ECe, organic carbon, available phosphorus and potassium and for micronutrients like zinc, 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 Chilkadabetta-1 microwatershed for soil reaction (pH) showed that maximum area of about 128 ha (27%) is moderately alkaline (pH 7.8-8.4) and is distributed in the central, northern and western part of the microwatershed. An area of about 86 ha (18%) is slightly alkaline (pH 7.3-7.8) and is distributed in the southern, western and central part of the microwatershed. An area of about 43 ha (9%) is moderately acid (pH 5.5-6.0) and is distributed in the southwestern part of the microwatershed followed by an area of about 24 ha (5%) is slightly acid (pH 6.0-6.5) and is distributed in the southwestern part of the microwatershed. An area of about 66 ha (14%) is under strongly alkaline (pH 8.4-9.0) and is distributed in the northern and central part of the microwatershed. An area of about 112 ha (24%) is under neutral (pH 6.5-7.3) and is distributed in the southeastern, eastern and southwestern part of the microwatershed (Fig.6.1).

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 the soils are nonsaline.

6.3 Organic Carbon

The soil organic carbon content in the soils of the microwatershed is low (<0.5%) covering maximum area of about 330 ha (69%) and is distributed in all parts of the microwatershed followed by an area of 124 ha (26%) medium (0.5-0.75%) in organic carbon and is distributed in the southern, northern and southwestern part of the microwatershed. A very small area of about 6 ha (1%) is high (>0.75%) in organic carbon and is distributed in the southern part of the microwatershed (Fig.6.3).

6.4 Available Phosphorus

The soil analysis revealed that available phosphorus (Fig.6.4) is medium (23-57kg/ha) in an area of about 167 ha (35%) and is distributed in the central, southern, western and eastern part of the microwatershed. Maximum area of about 292 ha (61%) is low (<23 kg/ha) and is distributed in all parts of the microwatershed.There is an urgent need to increase the dose of phosphorous for all the crops by 25 per cent over the recommended dose to realize better crop performance.

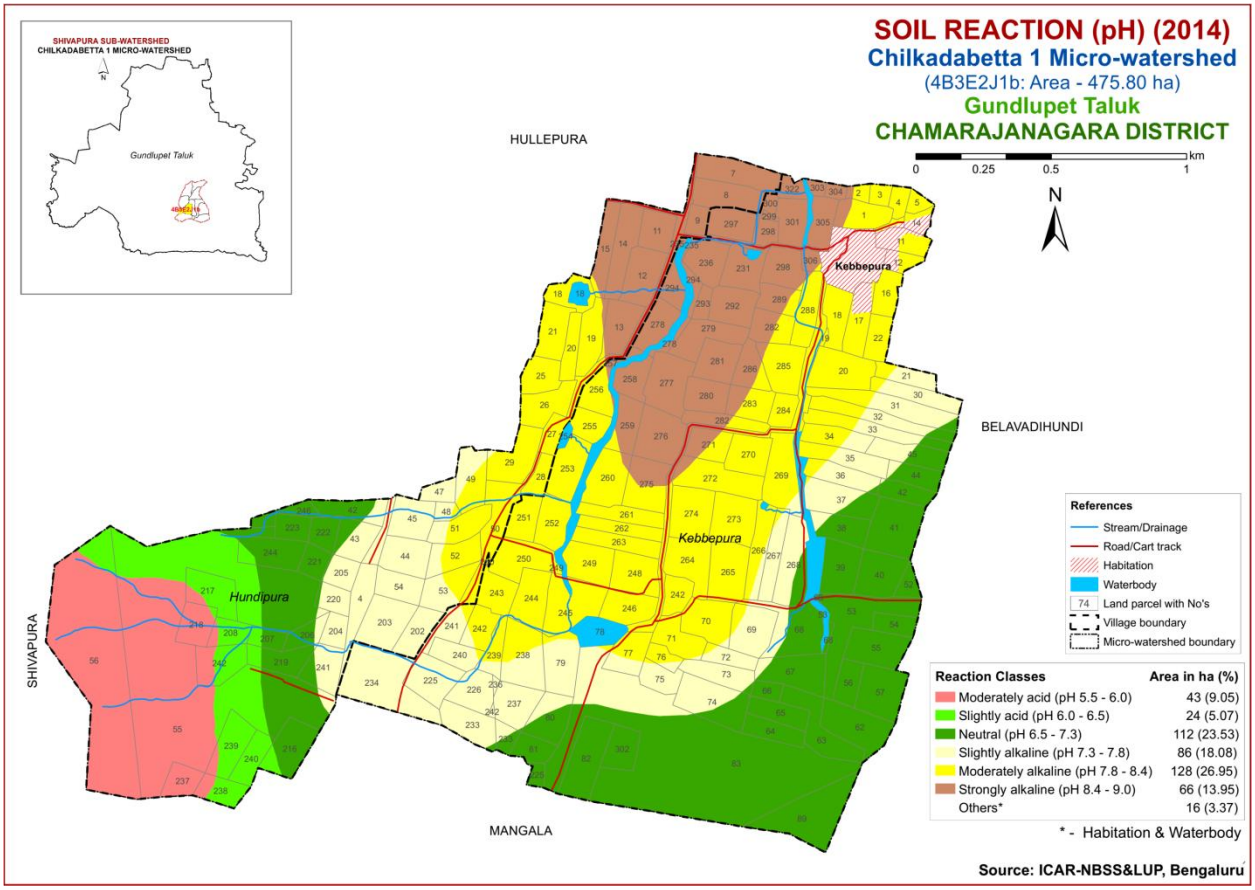


Fig. 6.1 Soil Reaction (pH) map of Chilkadabetta-1 Microwatershed

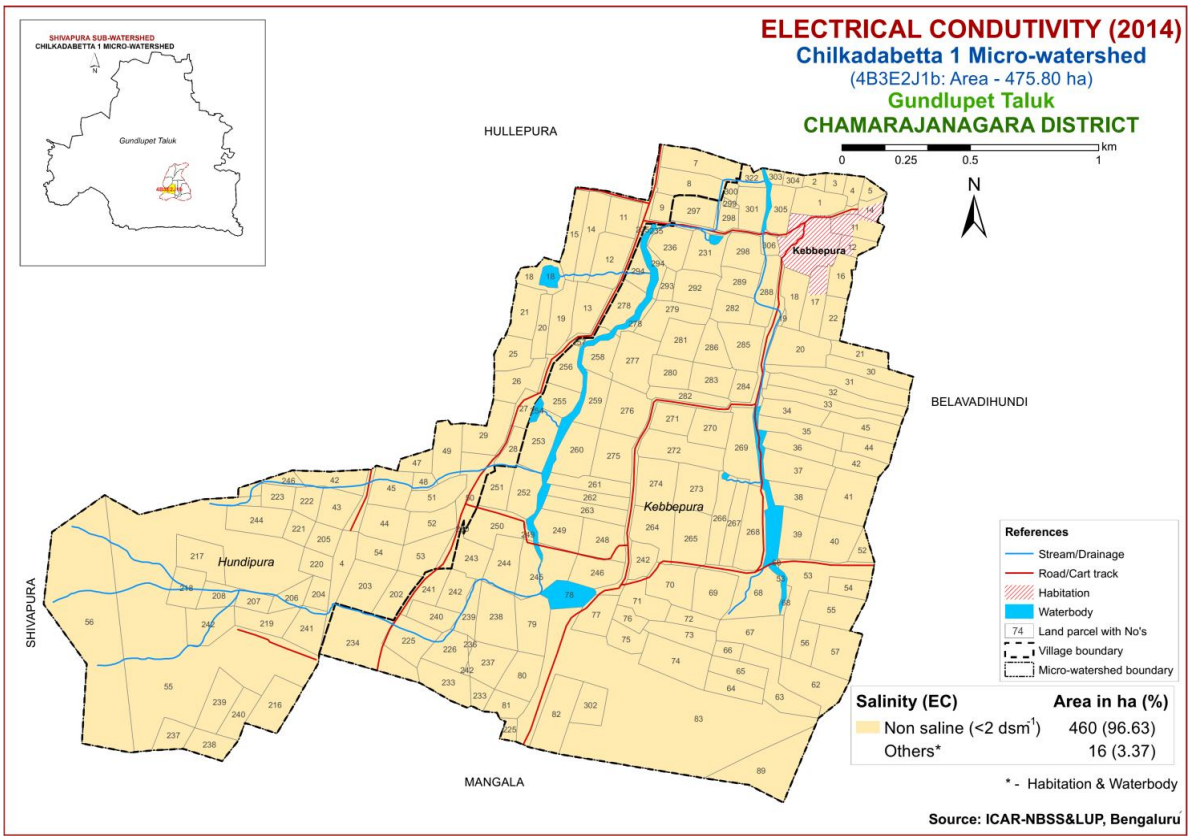


Fig. 6.2 Electrical Conductivity (EC) map of Chilkadabetta-1 Microwatershed

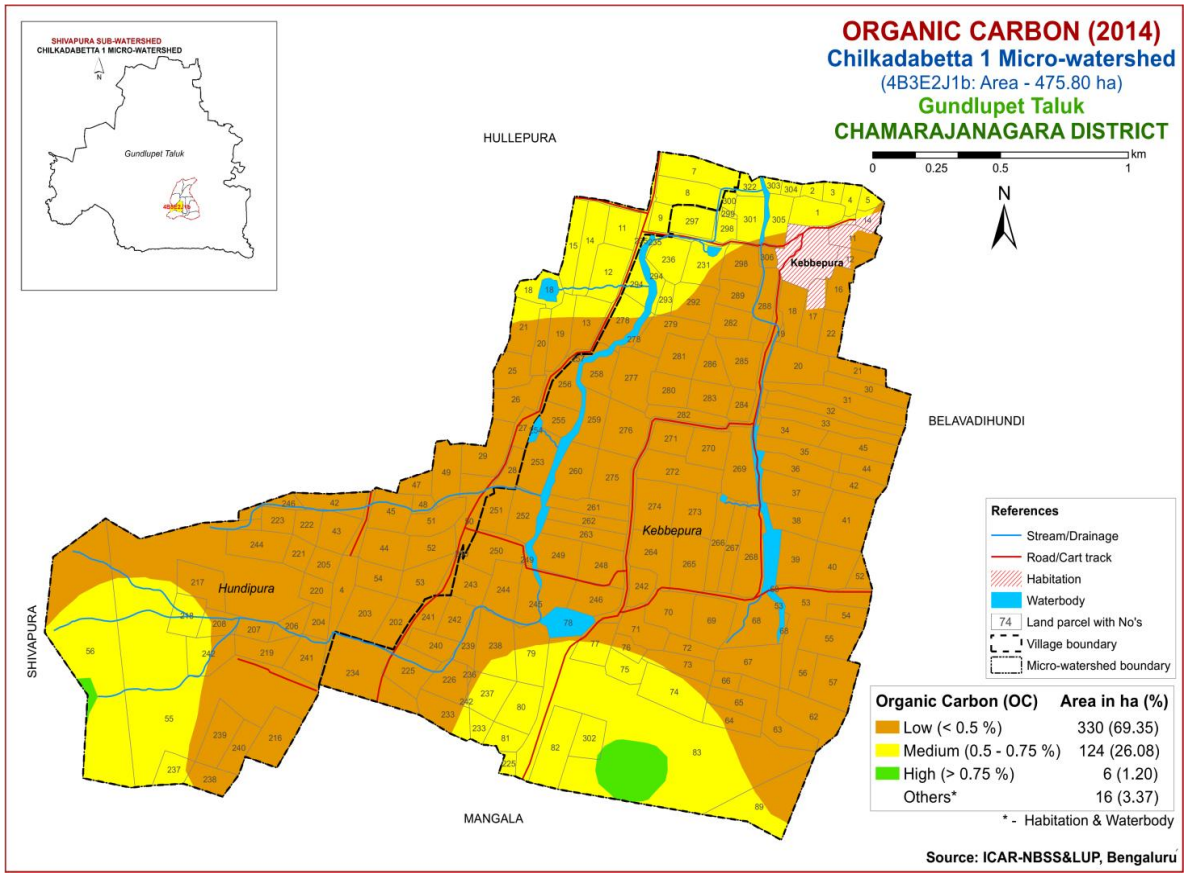


Fig.6.3 Soil Organic Carbon map of Chilkadabetta-1 Microwatershed

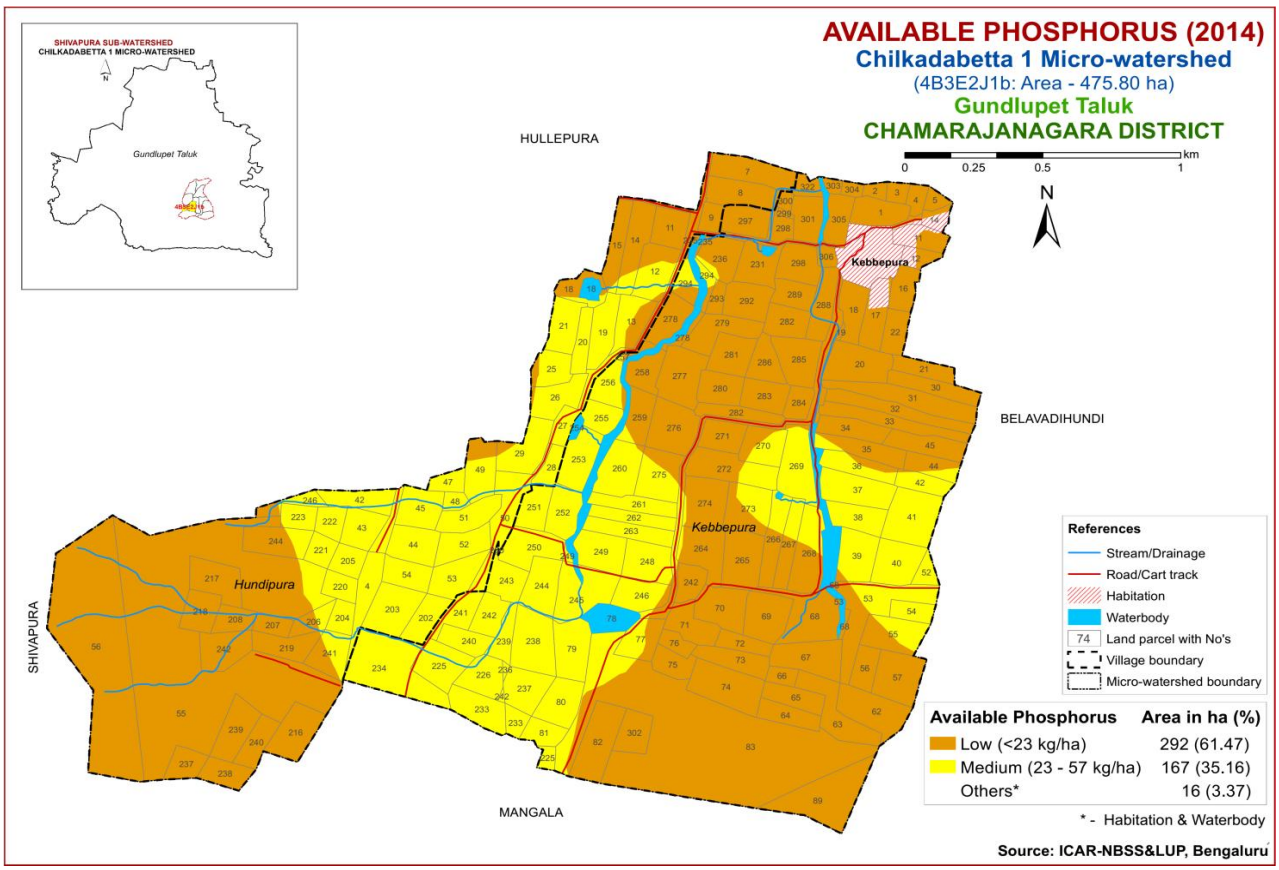


Fig.6.4 Soil available Phosphorus map of Chilkadabetta-1 Microwatershed

6.5 Available Potassium

Available potassium is high (>337 kg/ha) in maximum area of about 273 ha (40%) and is distributed in all parts of the microwatershed (Fig.6.5). The available potassium content is medium (145-337 kg/ha) in an area of 187 ha (39%) and is distributed in the southwestern and southeastern part of the microwatershed.

6.6 Available Sulphur

Available sulphur content is low (<10 ppm) in maximum area of about 457 ha (96%) in the microwatershed and is distributed in all parts of the microwatershed. A minute area of about 3 ha (<1%) is medium (10-20 ppm) in available sulphur and is distributed in the western part of the microwatershed (Fig.6.6).

6.7 Available Boron

Available boron content (Fig 6.7) is low (<0.5 ppm) in an area of about 229 ha (48%) and are distributed in the southwestern, central, eastern and northern part of the microwatershed. Available boron content is medium (0.5-1.0 ppm) in maximum area of about 231 ha (48%) and is distributed in the central, southern, western, northern, southwestren and eastern part of the microwatershed.

6.8 Available Iron

Available iron is deficient (<4.5 ppm) in an area of 194 ha (41%) and is distributed in the northern, central and eastern part of the microwatershed and maximum area of about 266 ha (56%) is

sufficient in available iron and is distributed in the southern and western part of the microwatershed (Fig 6.8).

6.9 Available Manganese

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

6.10 Available Copper

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

6.11 Available Zinc

Available zinc is deficient (<0.6 ppm) in the entire microwatershed area (Fig 6.11).

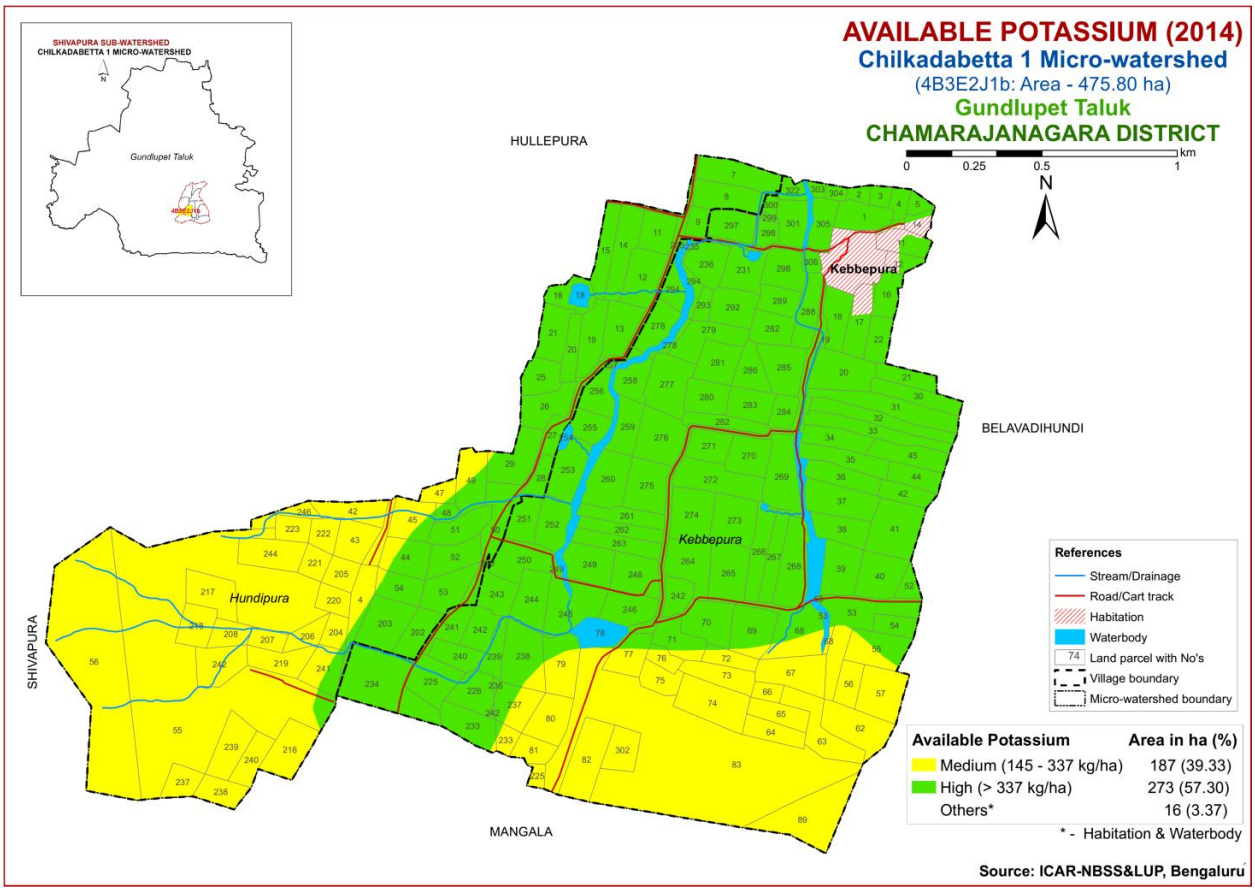


Fig.6.5 Soil available Potassium map of Chilkadabetta-1 Microwatershed

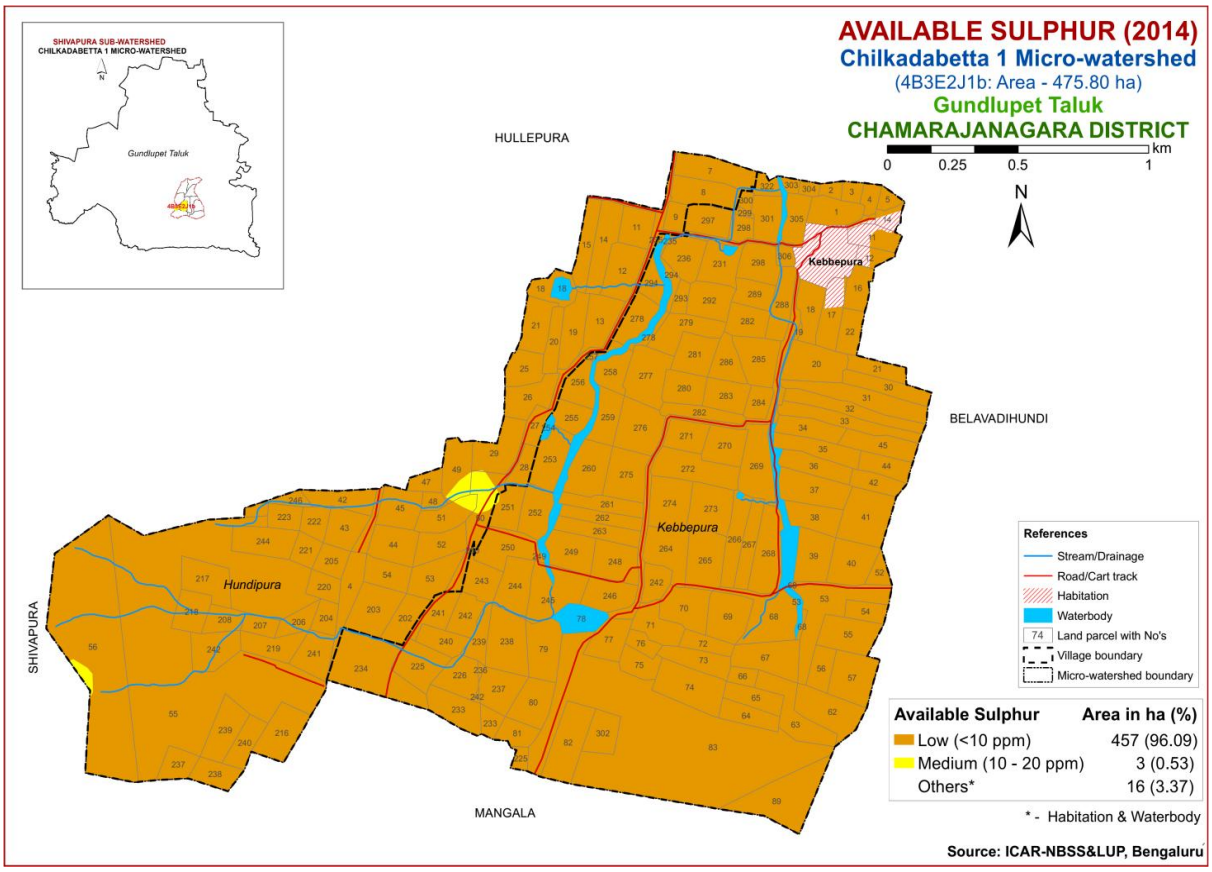


Fig.6.6 Soil available Sulphur map of Chilkadabetta-1 Microwatershed

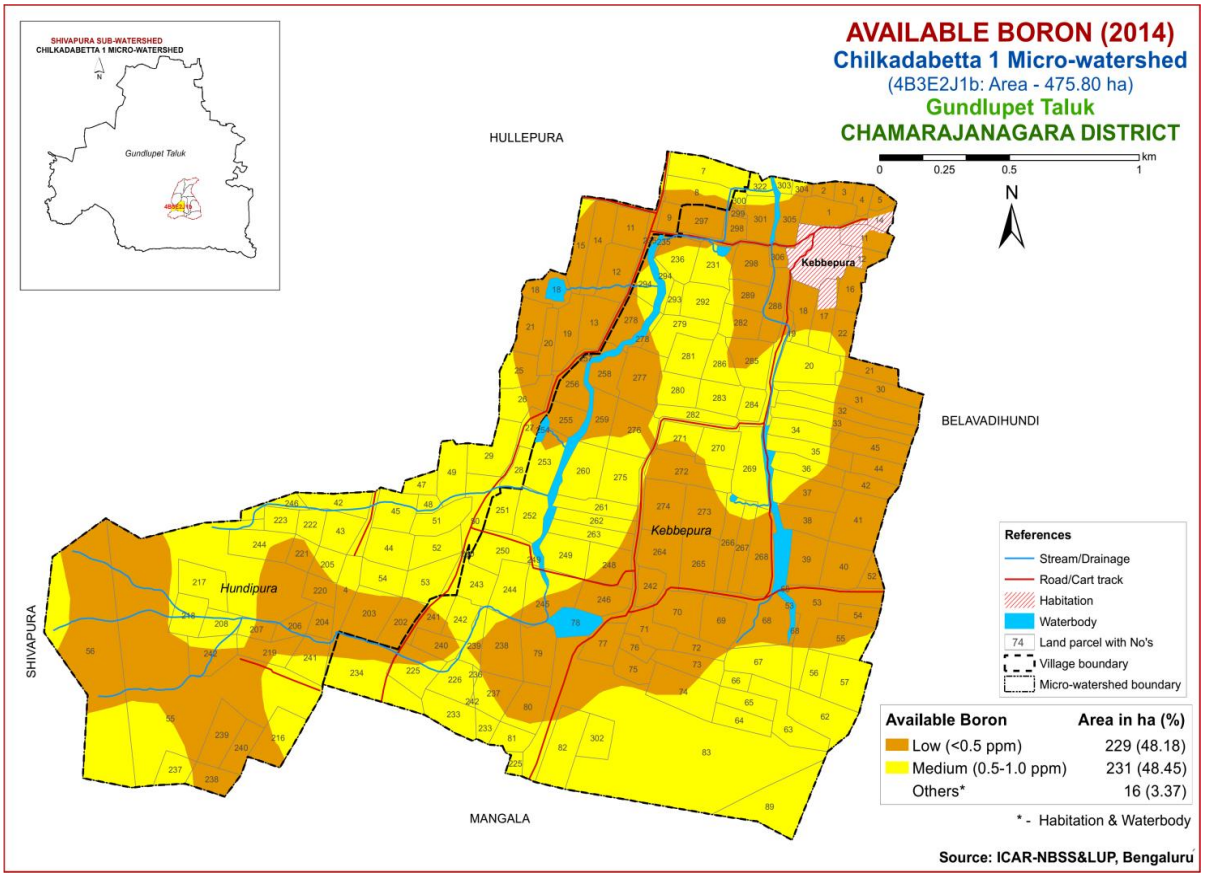


Fig.6.7 Soil available Boron map of Chilkadabetta-1 Microwatershed

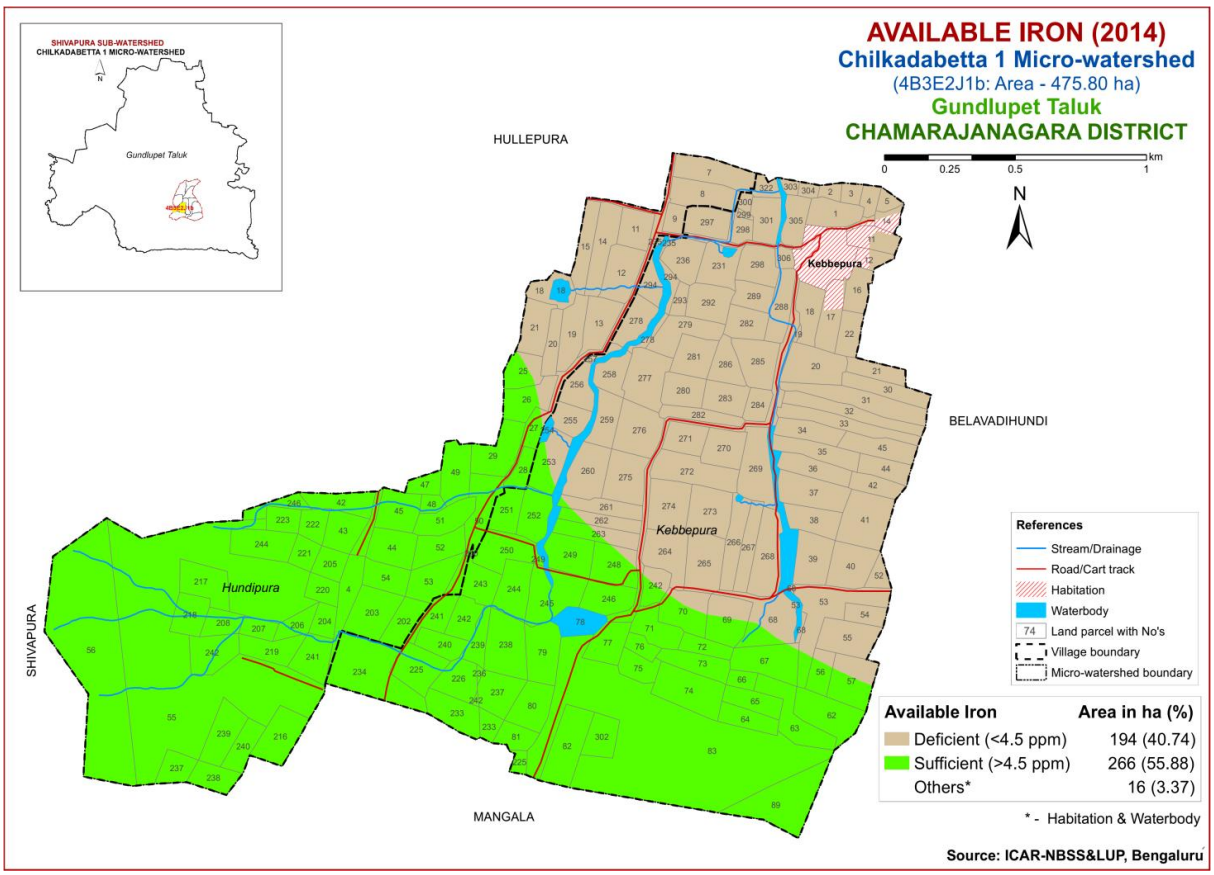


Fig.6.8 Soil available Iron map of Chilkadabetta-1 Microwatershed

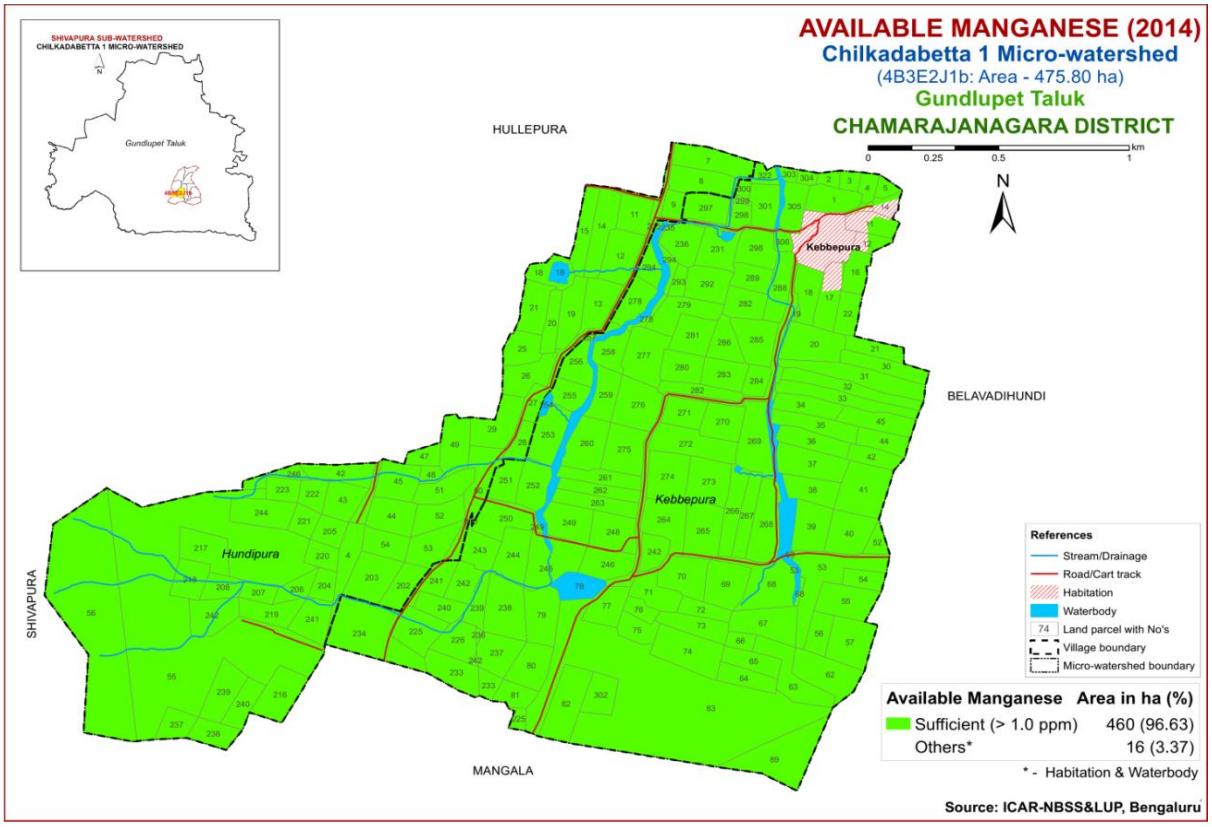


Fig.6.9 Soil available Manganese map of Chilkadabetta-1 Microwatershed

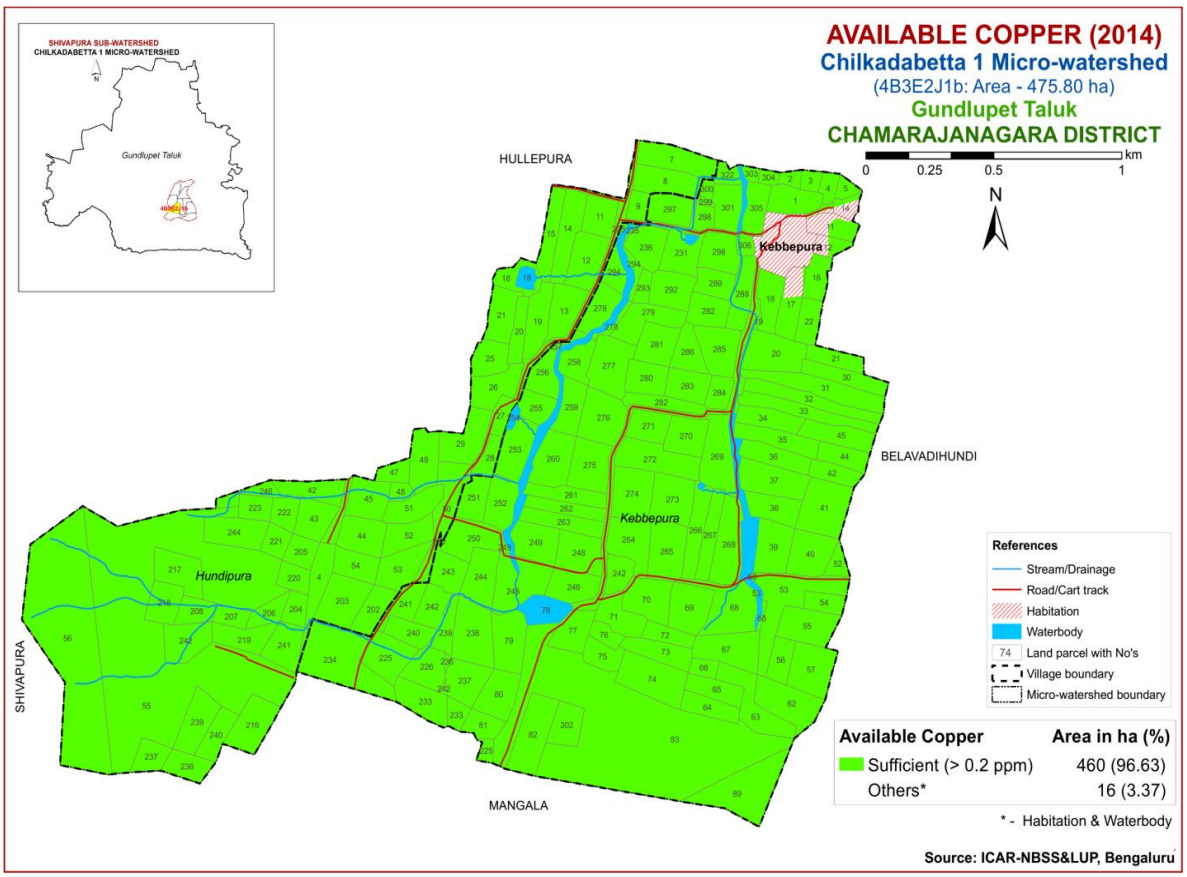


Fig.6.10 Soil available Copper map of Chilkadabetta-1 Microwatershed

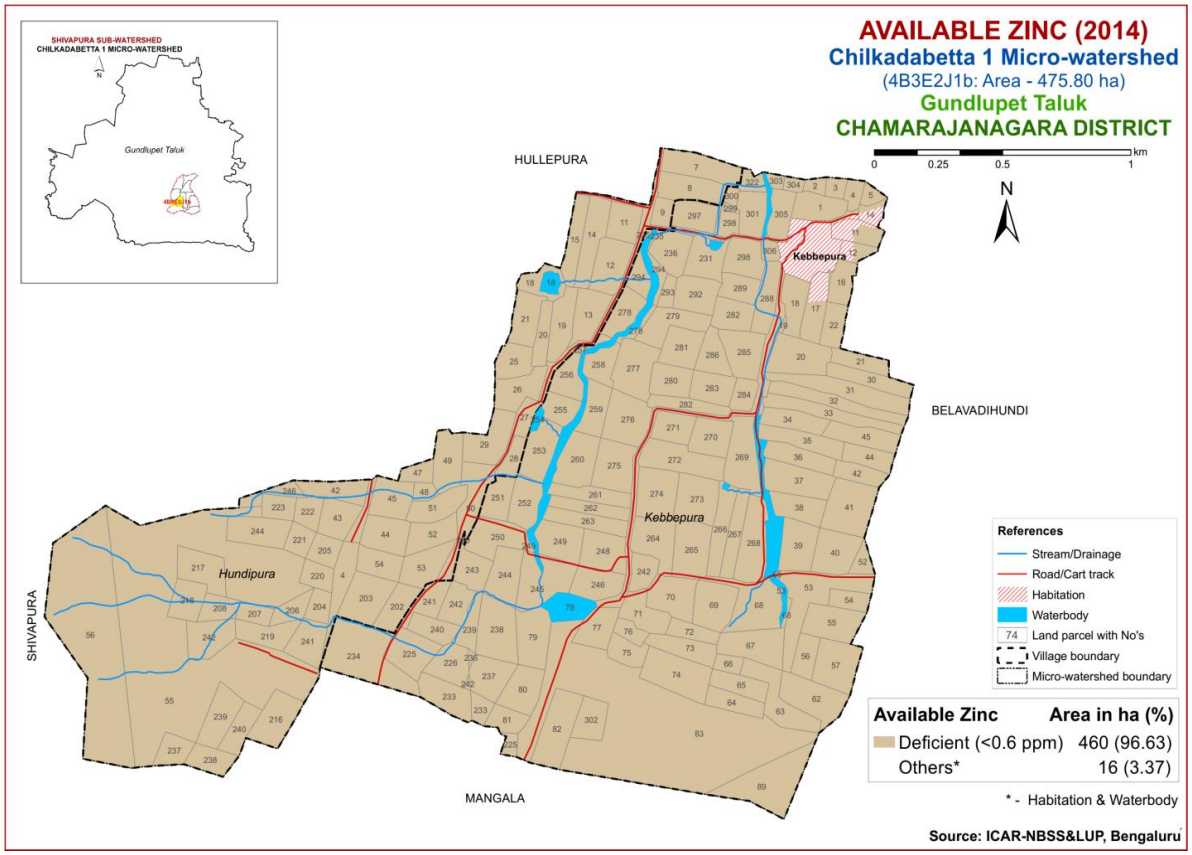


Fig.6.11 Soil available Zinc map of Chilkadabetta-1 Microwatershed

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Chilkadabetta-1 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 kind 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 excess salt/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 are 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 27 major annual and perennial 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 bicolar*)

Sorghum is one of the major crops grown in Karnataka in an area of 11.02 lakh ha in Bijapur, Gulbarga, Raichur, Bidar, Belgaum, Dharwad, Bellary, Chitradurga, Mysore and Chamarajnagar 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 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.

An area of about 82 ha (17%) in the microwatershed has soils that are highly suitable (Class S1) for growing sorghum crop. They have minor or no limitations for growing sorghum and are distributed in the eastern, central and northern part of the microwatershed. Maximum area of about 186 ha (39%) is moderately suitable (Class S2) for growing sorghum and are distributed in the southern, southwestern, central and northeastern part of the microwatershed.

Table 7.1 Soil-Site Characteristics of Chilkadabetta-1 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drai-nage class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	p H	EC	ESP	CEC Cmol $(p^+)kg^{-1}$	BS (%)
					Surf-ace	Subsu-rface	Sur-face (%)	Subsur-face (%)								
ARKiB1g1	734	150	wd	>150	sc	sc-c	15-35	<15	>200	1-3	Slight					
BMBiB1g1	734	150	wd	>150	sc	c	15-35	<15	>200	1-3	Slight					
DRHbC2g2	734	150	wd	50-75	ls	scl-sc	35-60	15-35	51-100	3-5	Moderate					
DRHcB2g2	734	150	wd	50-75	sc	scl-sc	35-60	15-35	51-100	1-3	Moderate					
DRHhB1g1	734	150	wd	50-75	sc	scl-sc	15-35	15-35	51-100	1-3	Slight					
HDRbB2g2	734	150	wd	25-50	ls	scl-sc	35-60	<15	<50	1-3	Moderate					
HDRcB1g1	734	150	wd	25-50	sl	scl-sc	15-35	<15	<50	1-3	Slight					
HDRcB1g2	734	150	wd	25-50	sl	scl-sc	35-60	<15	<50	1-3	Slight					
HDRcC2g2	734	150	wd	25-50	sl	scl-sc	35-60	<15	<50	3-5	Moderate					
HDRcD3g2	734	150	wd	25-50	sl	scl-sc	35-60	<15	<50	5-10	Severe					
HDRhB1g1	734	150	wd	25-50	sc	scl-sc	15-35	<15	<50	1-3	Slight					
HDRiB1	734	150	wd	25-50	sc	scl-sc	-	<15	<50	1-3	Slight					
HDRiB2g2	734	150	wd	25-50	sc	scl-sc	35-60	<15	<50	1-3	Moderate					
HGHiB2g2	734	150	wd	>150	sc	scl	35-60	<15	>200	1-3	Moderate					
HGHmB1	734	150	wd	>150	c	scl	-	<15	>200	1-3	Slight					
HPRbB2g2	734	150	wd	50-75	ls	scl-sc	35-60	15-35	51-100	1-3	Moderate					
HPRcB1g1	734	150	wd	50-75	sl	scl-sc	15-35	15-35	51-100	1-3	Slight					
HPRhB1g1	734	150	wd	50-75	scl	scl-sc	15-35	15-35	51-100	1-3	Slight					
HPRiB1g1	734	150	wd	50-75	sc	scl-sc	15-35	15-35	51-100	1-3	Slight					
KDHiA1g1	734	150	wd	>150	sc	sc-c	15-35	<15	>200	0-1	Slight					
KDHiB1	734	150	wd	>150	sc	sc-c	-	<15	>200	1-3	Slight					
KNGbE3g2	734	150	wd	75-100	ls	scl-sc	35-60	>35	<50	10-15	Severe					
KNGcB2g2	734	150	wd	75-100	sl	scl-sc	35-60	>35	<50	1-3	Moderate					
MGHcC2g2	734	150	wd	50-75	sl	scl	35-60	>35	51-100	3-5	Moderate					

MGHhD3g2	734	150	wd	50-75	sc	scl	35-60	>35	51-100	5-10	Severe					
SPRbB2g2	734	150	wd	25-50	ls	scl-sc	35-60	>35	<50	1-3	Moderate					
SPRcD2g2	734	150	wd	25-50	sl	scl-sc	35-60	>35	<50	5-10	Moderate					
SPRcD3g2	734	150	wd	25-50	sl	scl-sc	35-60	>35	<50	5-10	severe					

They have minor limitations of gravelliness, texture, topography and rooting depth. Marginally suitable lands (Class S3) for growing sorghum occupy an area of about 171 ha (38%) and mainly occur in the southwestern, northwestern and central part of the microwatershed. They have moderate limitations of rooting depth, topography and gravelliness. A small area of about 22 ha (5%) is not suitable (Class N) for growing sorghum and occur in the southeastern part of the microwatershed. They have severe limitations of topography and gravelliness.

Table 7.2 Land suitability criteria for Sorghum

Crop requirement		Rating			
Soil site characteristics	unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	<3	3-8	8-15	>15
LGP	Days	120-150	120-90	<90	
Soil drainage	class	Well to mod. 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
Sub Surface soil texture	Class	C, cl, sicl, sc	l, sil, sic	l, ls	S, fragmental skeletal
Soil depth	Cm	100-75	50-75	30-50	<30
Gravel content	% vol.	<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

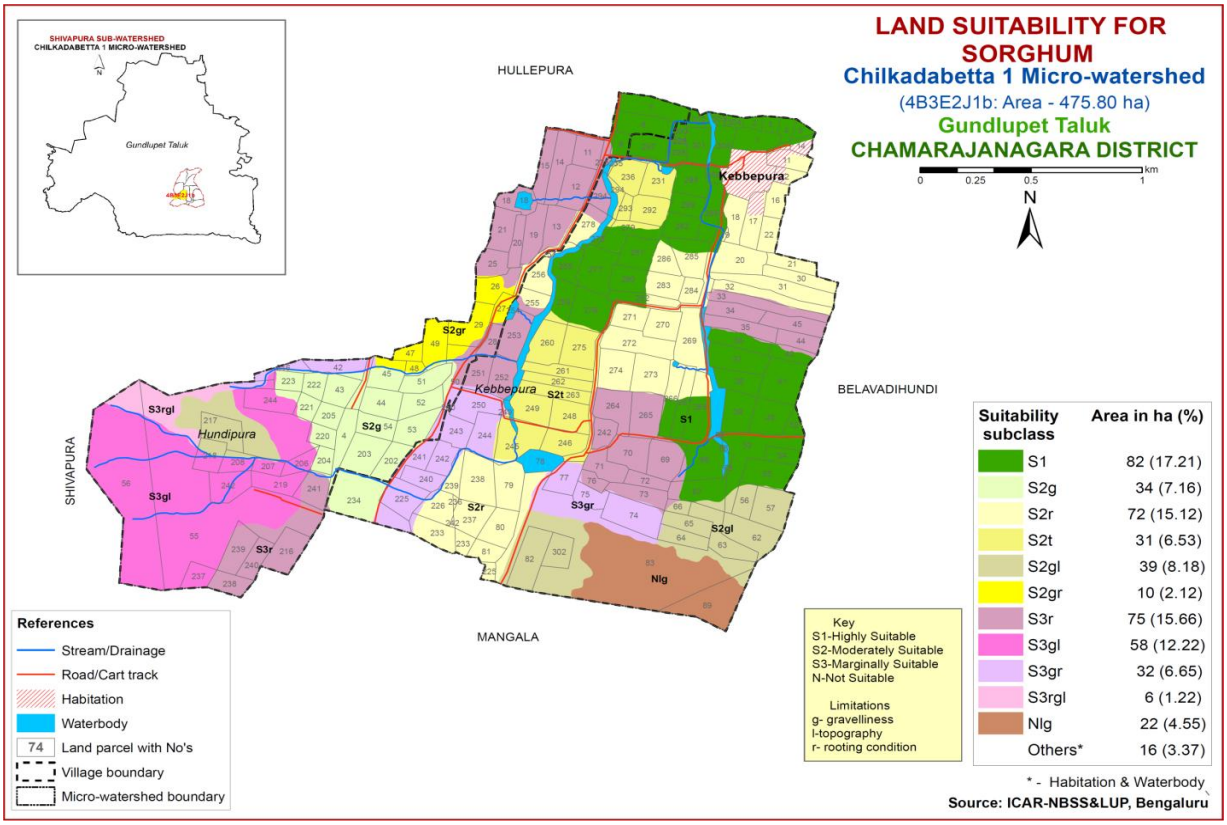


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea maize*)

Maize is the most important food crop grown in an area of 13.73 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) of soils of the microwatershed and a land suitability map for growing maize was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.2.

An area of about 101 ha (21%) in the microwatershed has soils that are highly suitable (Class S1) for growing maize crop. They have minor or no limitations for growing maize and are distributed in the eastern, central and northern part of the microwatershed. An area of about 155 ha (33%) is moderately suitable (Class S2) for growing maize and are distributed in the southern, southwestern, central, northeastern and southeastern part of the microwatershed. They have minor limitations of gravelliness, topography and rooting depth. Marginally suitable (Class S3) lands cover a major area of about 183 ha (38%) and occur in the southwestern, central, northwestern and southeastern part of the microwatershed. They have moderate limitations of gravelliness, topography and rooting depth. A small area of about 22 ha (5%) is not suitable (Class N) for growing maize and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.3 Land 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	
Sub Surface soil texture	Class	l, cl, scl, sil	sicl, sic,c	C(s-s), ls, sl	
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	

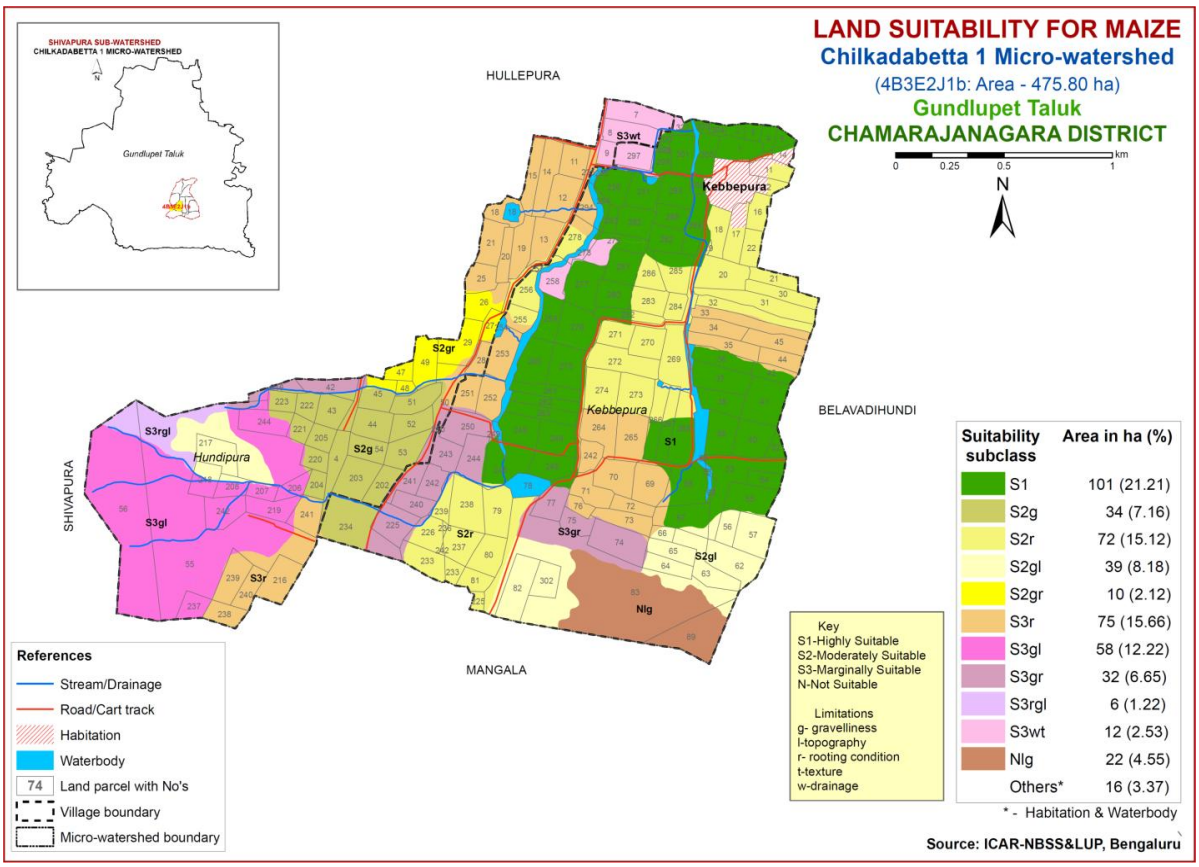


Fig. 7.2 Land Suitability map of Maize

7.3 Land Suitability for Redgram (*Cajanus cajan*)

Redgram is the most important pulse crop grown in an area of 8.23 lakh ha in almost all the districts of the State. The crop requirements for growing redgram (Table 7.4) were matched with the soil-site characteristics (Table 7.1) of soils of the microwatershed and a land suitability map for growing redgram was generated. The area extent and geographical distribution of different suitability subclasses in microwatershed is given in Figure 7.3.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing redgram crop. They have minor or no limitations for growing redgram and are distributed mainly in the eastern, central and northern part of the microwatershed. An area of about 83 ha (18%) is moderately suitable (Class S2) for redgram. They are distributed in the southwestern and central part of the microwatershed. They have minor limitations of gravelliness, wetness, topography and rooting depth. Marginally suitable (Class S3) lands cover an area of about 107 ha (22%) and occur in the southern, northeastern and central part of the microwatershed. They have moderate limitations of gravelliness, topography and rooting depth. Major area of about 208 ha (40%) is not suitable (Class N) for growing redgram and occur in the western, central, northwestern, southern and northeastern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

Table 7.4 Land suitability criteria for Redgram

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	>210	180-210	150-180	<150
Soil drainage	class	Well drained	Mod. well drained	Imperfectly drained	Poorly drained
Soil reaction	pH	6.5-7.5	5.0-6.5 7.6-8.0	8.0-9.0	>9.0
Sub Surface soil texture	Class	l, scl, sil, cl, sl	sicl, sic, c(m)	ls	
Soil depth	Cm	>100	75-100	50-75	<50
Gravel content	% vol.	<15	15-35	3-60	>60
Salinity (EC)	dsm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

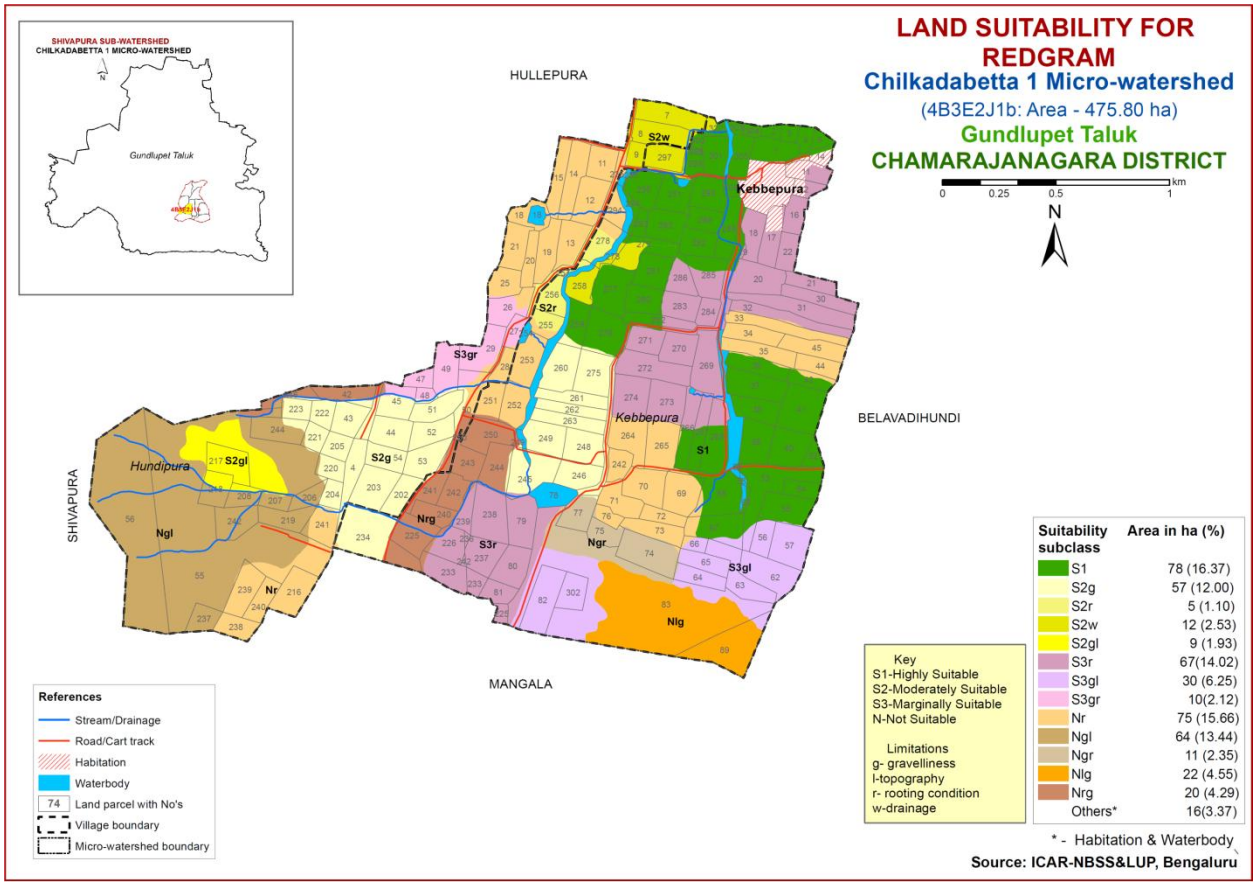


Fig. 7.3 Land Suitability map of Redgram

7.4 Land suitability for Horsegram (*Marcotyloma uniflorum*)

Horsegram is the most important pulse crop grown in an area of 1.8 lakh ha in almost all the districts of the State. The crop requirements (Table 7.5) for growing horsegram were matched with the soil-site characteristics and a land suitability map for growing horsegram was generated. The area and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.4.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing horsegram. They have minor or no limitations for growing horsegram and are distributed in the southern, central and northern part of the microwatershed. Maximum area of about 180 ha (38%) is moderately suitable (Class S2) for growing horsegram and are distributed in the southern, central, southwestern and northeastern part of the microwatershed. They have minor limitations of gravelliness, topography, wetness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 170 ha (36%) and occur in the southwestern, central, northwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing horsegram and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.5 Land suitability criteria for Horsegram

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				
Soil drainage	class	Well drained/mod. well drained	imperfectly drained	Poorly drained	Very Poorly drained
Soil reaction	pH	6.0-8.5	8.5-9.0 5.5-5.9	9.1-9.5 5.0-5.4	>9.5
Sub Surface soil texture	Class	l, sl, scl, cl, sc	ls,sic, sicl, c, ls	Heavy clays (>60%), ls	
Soil depth	Cm	50-75	25-50	<25	
$CaCO_3$ in root zone	% vol.	<15	15-25	25-30	>30
Salinity (EC)	dsm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

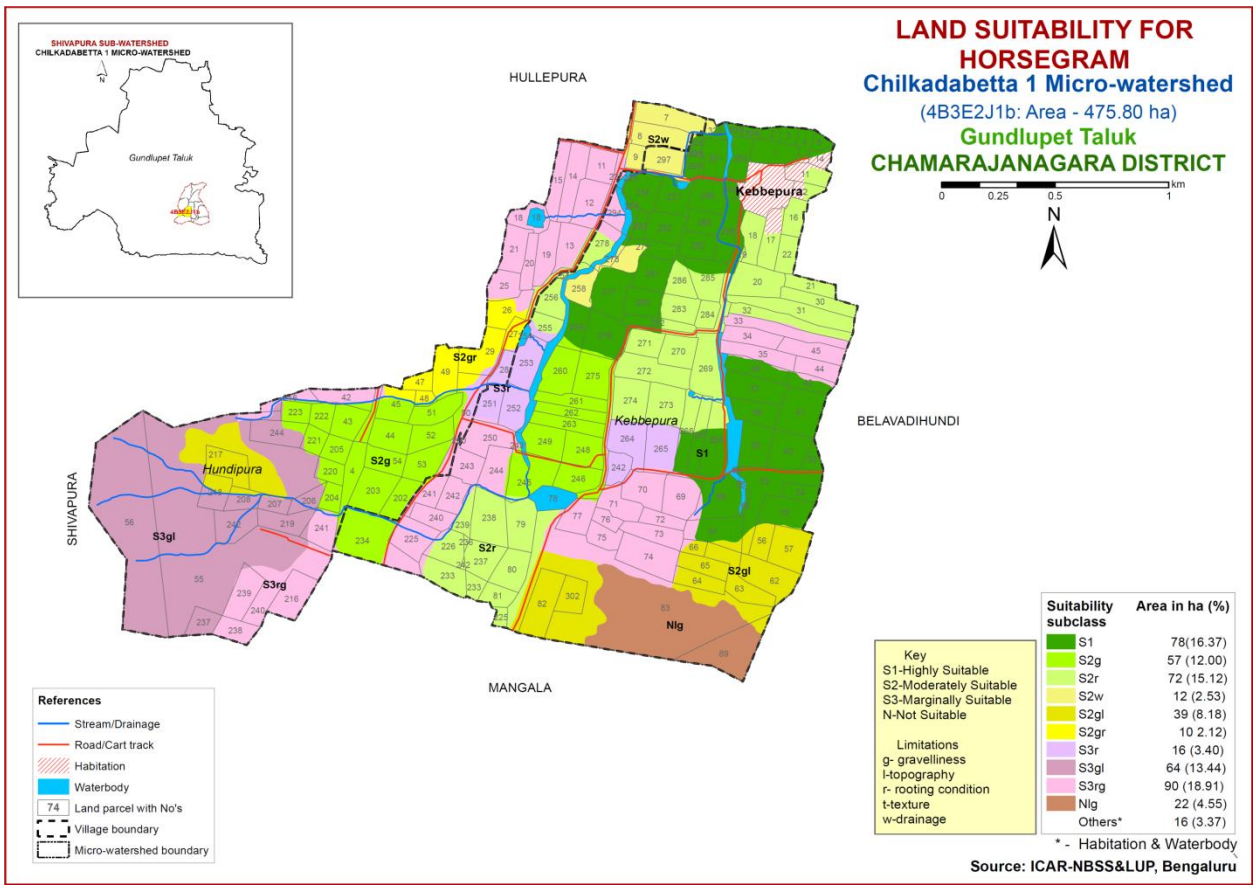


Fig. 7.4 Land Suitability map of Horsegram

7.5 Land suitability for Field bean (*Dolichos lablab*)

Field bean is the most important pulse crop grown in an area of 0.68 lakh ha in almost all the districts of the State. The crop requirements (Table 7.6) for growing field bean were matched with the soil-site characteristics and a land suitability map for growing field bean was generated. The area and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.5.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing field bean. They have minor or no limitations for growing field bean and are distributed in the southern, central and northern part of the microwatershed. Maximum area of about 190 ha (40%) is moderately suitable (Class S2) for growing field bean and are distributed in the southern, central, southwestern and northeastern part of the microwatershed. They have minor limitations of gravelliness, topography, wetness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 164 ha (36%) and occur in the southwestern, central, northwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing field bean and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.6 Land suitability criteria for Field Bean

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	>120	90-120	70-90	<70
Soil drainage	class	Well drained/mod. well drained	imperfectly drained	Poorly drained	Very Poorly drained
Soil reaction	pH	6.0-8.5	8.5-9.0 5.5-5.9	9.1-9.5 5.0-5.4	>9.5
Sub Surface soil texture	Class	l, sl, scl, cl, sc	sic, sicl, c	Heavy clays (>60%), ls	s
Soil depth	Cm	>75	50-75	25-50	<25
$CaCO_3$ in root zone	% vol.	<15	15-35	35-50	>50
Salinity (EC)	dsm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	15-20	>20

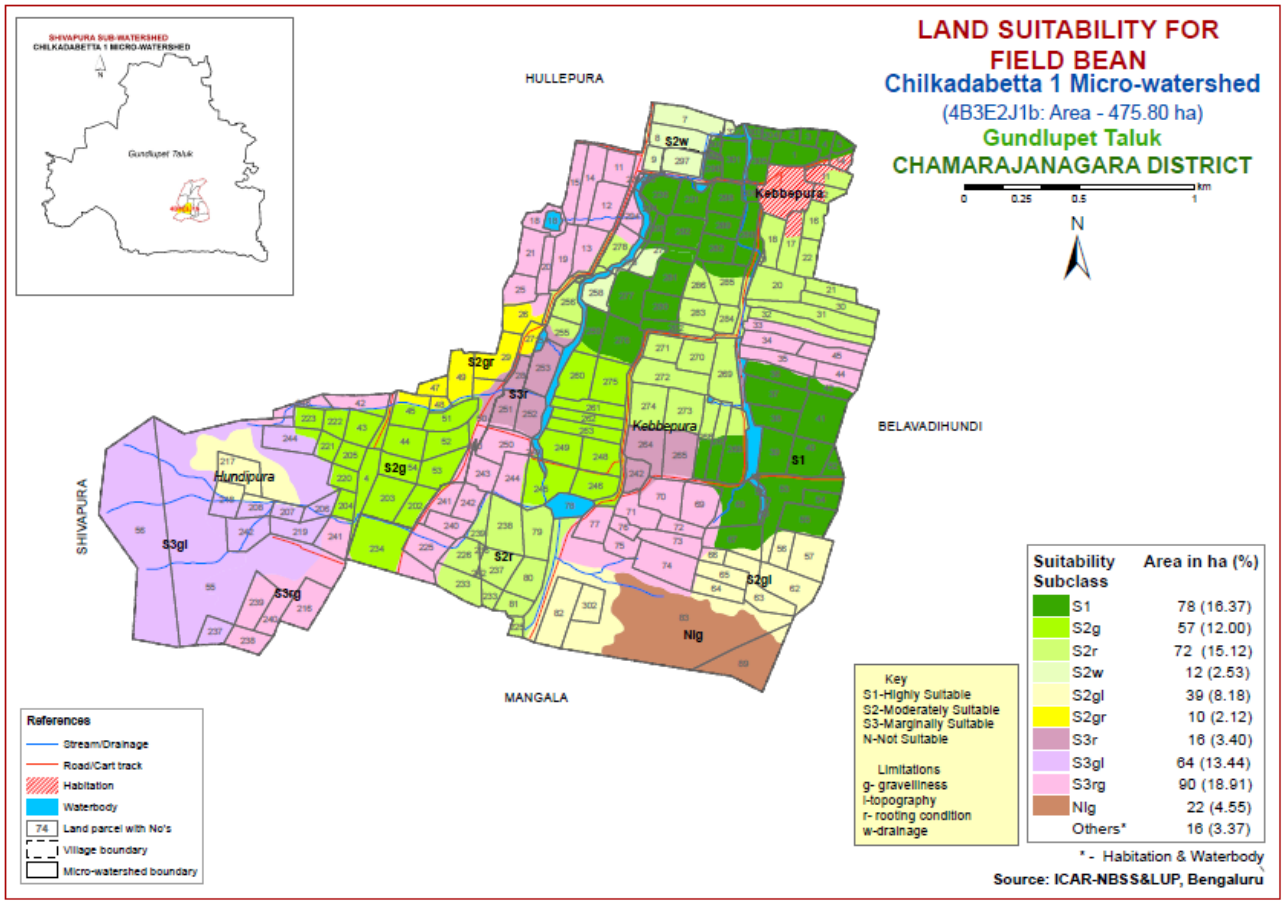


Fig. 7.5 Land Suitability map of Field bean

7.6 Land suitability for Groundnut (*Arachis hypogaea*)

Groundnut is the most important oilseed crop grown in an area of 6.5 lakh ha in almost all the districts of the State. The crop requirements for growing groundnut (Table 7.7) were matched with the soil-site characteristics (Table 7.1) of soils of the microwatershed and a land suitability map for growing groundnut was generated The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in (Fig. 7.6).

A small area of about 35 ha (7%) in the microwatershed has soils that are highly suitable (Class S1) for growing groundnut crop. They have minor or no limitations for growing groundnut and are distributed in the central and northern part of the microwatershed. A maximum area of about 221 ha (47%) is moderately suitable (Class S2) for growing groundnut and are distributed in all parts of the microwatershed. They have minor limitations of gravelliness, texture, topography and rooting depth. Marginally suitable (Class S3) lands cover an area of about 182 ha (38%) and occur in the southwestern, central and northwestern part of the microwatershed. They have moderate limitations of gravelliness, wetness, texture and rooting depth. An area of about 22 ha (5%) is not suitable (Class N) for growing groundnut and occur in the southwestern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.7 Land 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	
Sub Surface soil texture	Class	l, cl, sil, scl, sicl	Sc, sic, c,sl	S, ls, c (>60%)	
Soil depth	Cm	>75	50-75	25-50	<25
Gravel content	% vol.	<35	35-50	>50	
$CaCO_3$ in root zone	%	low	Medium	high	
Salinity (EC)	dsm^{-1}	<2.0	2.0-4.0	4.0-8.0	
Sodicity (ESP)	%	<5	5-10	>10	

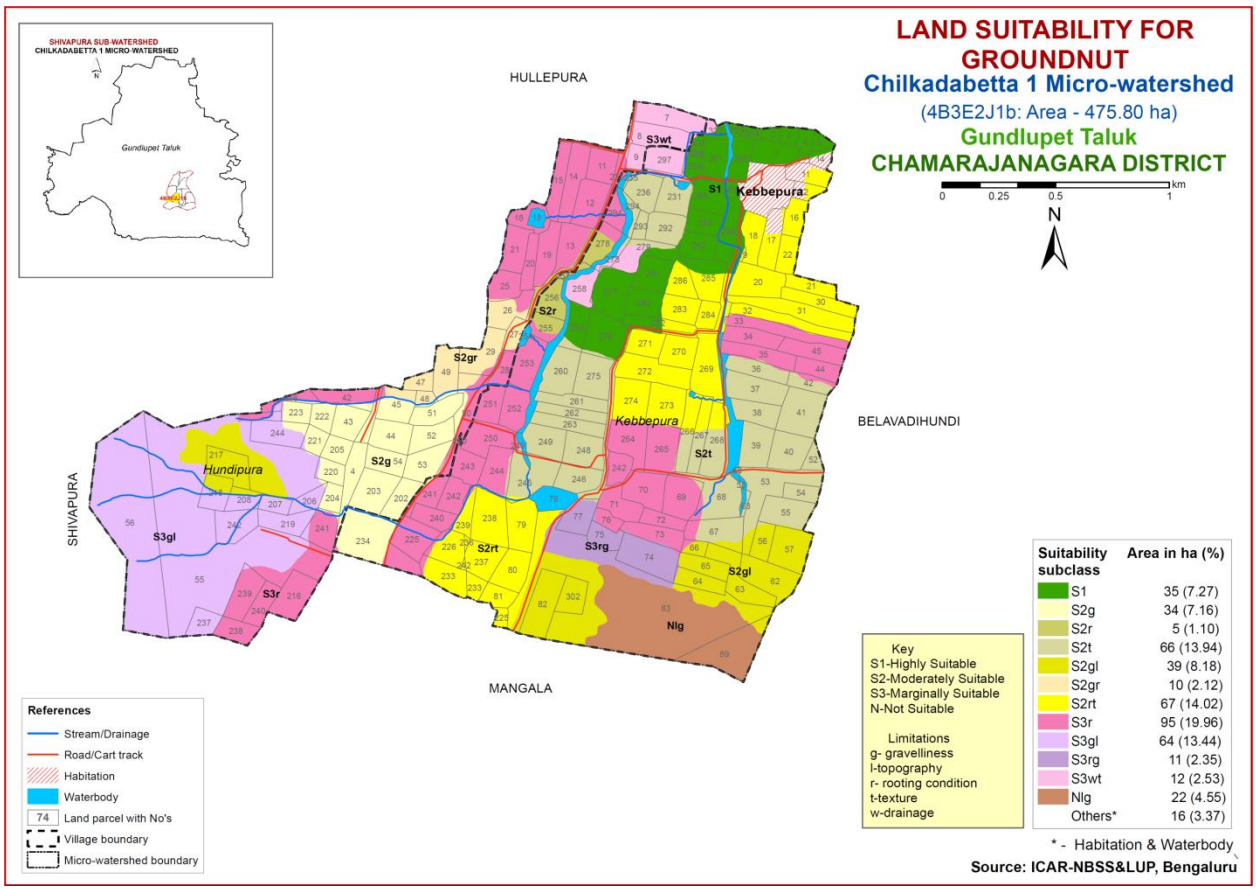


Fig. 7.6 Land Suitability map of Groundnut

7.7 Land suitability for Sunflower (*Helianthus annus*)

Sunflower is the most important oil seed crop grown in an area of 4.1 lakh ha in almost all the districts of the State. The crop requirements (Table 7.8) for growing sunflower were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sunflower was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.7.

An area of about 70 ha (15%) in the microwatershed has soils that are highly suitable (Class S1) for growing sunflower crop. They have minor or no limitations for growing sunflower and are distributed in the central, eastern and northern part of the microwatershed. An area of about 77 ha (16%) is moderately suitable (Class S2) for growing sunflower and are distributed in the northwestern and northern part of the microwatershed. They have minor limitations of gravelliness, wetness and texture. Marginally suitable (Class S3) lands cover an area of about 121 ha (25%) and occur in the southern, southeastern, central and northeastern part of the microwatershed. They have moderate limitations of gravelliness, topography and rooting depth. Maximum area of about 192 ha (40%) is not suitable (Class N) for growing sunflower and occur in the southwestern, northwestern, northeastern and central part of the microwatershed. They have very severe limitations of gravelliness, rooting depth and topography.

Table 7.8 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	

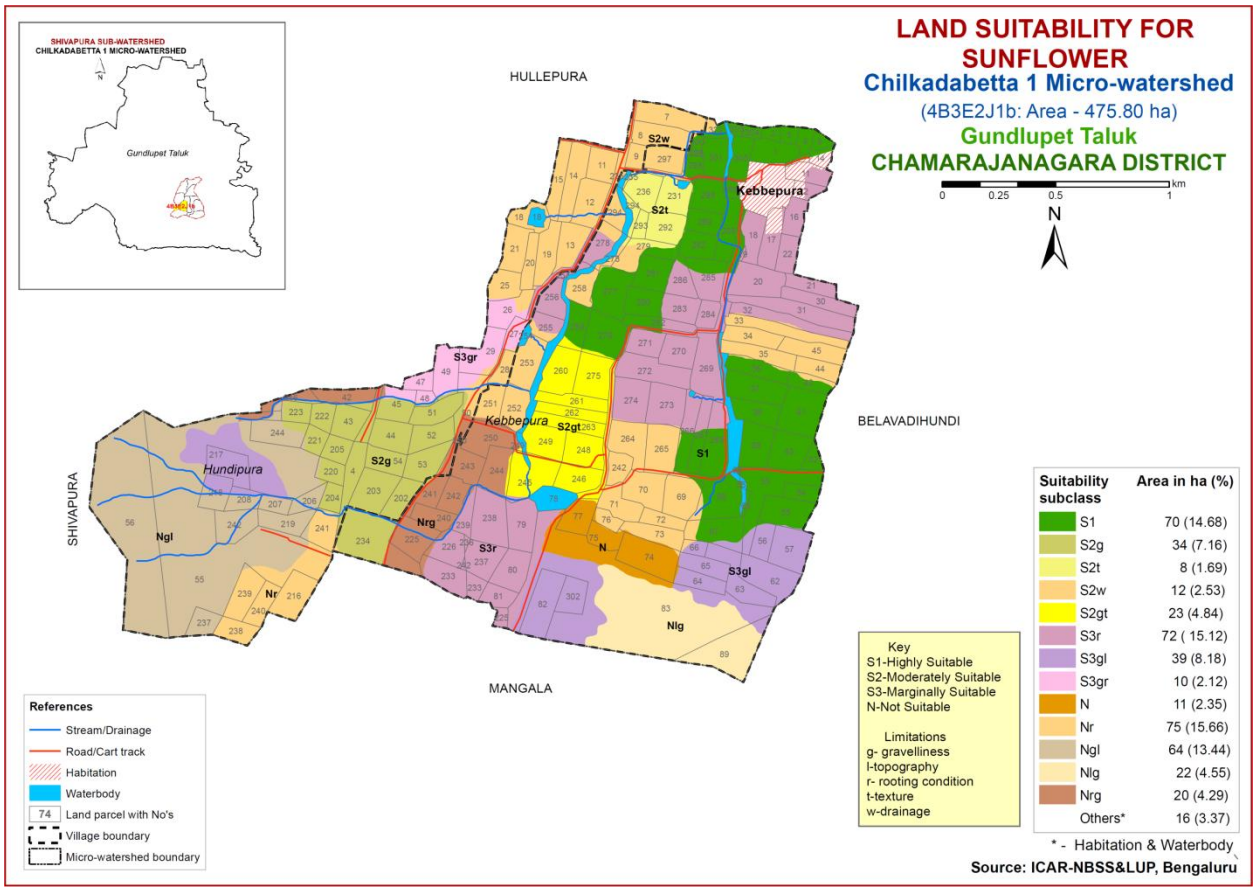


Fig. 7.7 Land Suitability map of Sunflower

7.8 Land suitability for Cotton (*Gossypium hirsutum*)

Cotton is the most important fibre crop grown in the State in about 6.6 lakh ha in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and Chamarajnagar districts. The

crop requirements (Table 7.9) for growing cotton were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing cotton was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.8.

An area of about 82 ha (17%) in the microwatershed has soils that are highly suitable (Class S1) for growing cotton crop. They have minor or no limitations for growing cotton and are distributed in the central, eastern and northern part of the microwatershed. An area of about 155 ha (33%) is moderately suitable (Class S2) for growing cotton and are distributed in the southern, central, southwestern, southeastern and northeastern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and topography. Marginally suitable (Class S3) lands cover a major area of about 202 ha (42%) and occur in the western, northeastern, northwestren, southwestern and central part of the microwatershed. They have moderate limitations of gravelliness, texture and topography and rooting depth. An area of about 22 ha (5%) is not suitable (Class N) for growing cotton and occur in the southeastern part of the microwatershed. They have very severe limitations of gravelliness and topography.

Table 7.9 Land 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 moderately well	imperfectly drained	Poor somewhat excessive	Stagnant/e xcessive
Soil reaction	pH	6.5-7.5	7.6-8.0	8.1-9.0	>9.0>6.5
Sub Surface soil texture	Class	Sic, c	Sicl, cl	Si, sil, sc, scl, l	Sl, s,ls
Soil depth	Cm	100-150	75-100	50-75	<50
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

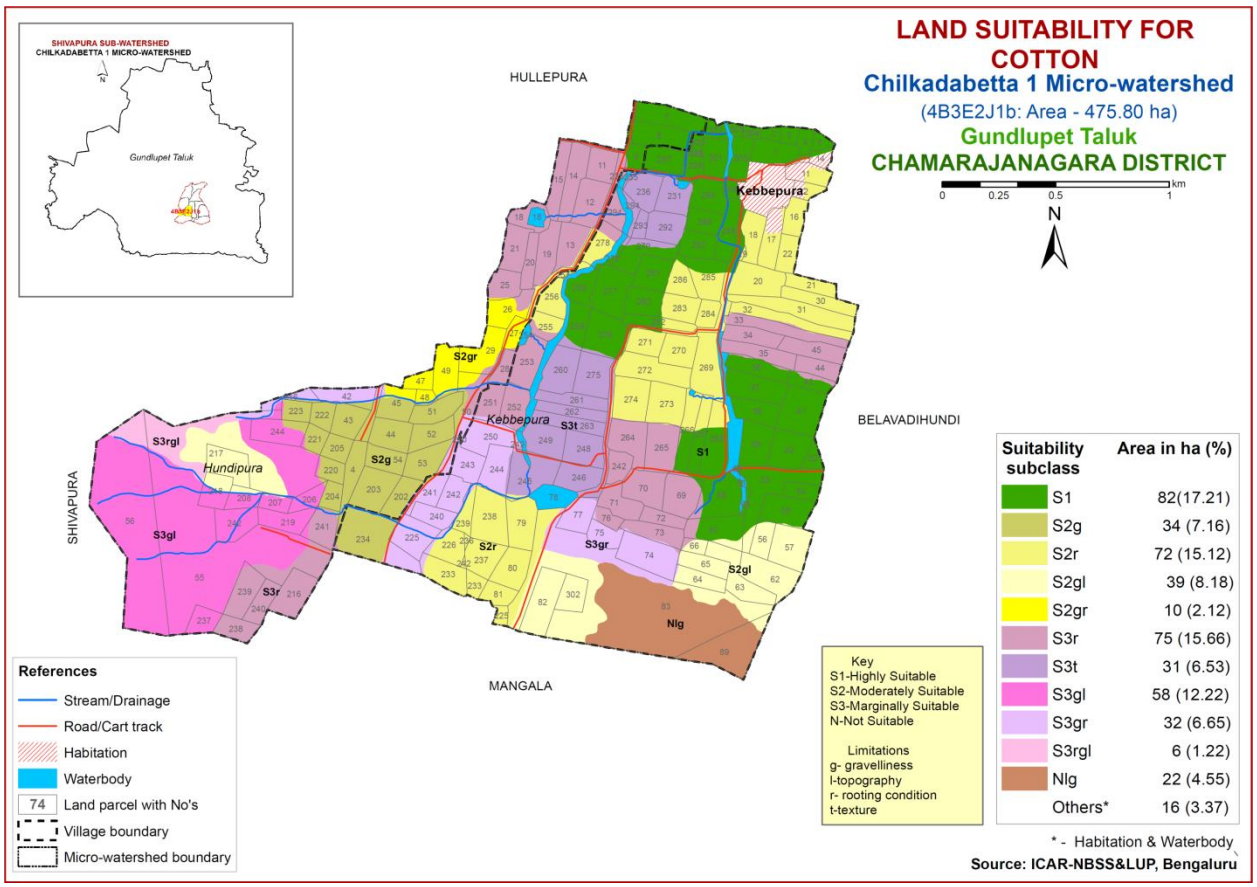


Fig. 7.8 Land Suitability map of Cotton

7.9 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 (Table 7.10) for growing onion were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing onion was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.9.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing onion crop. They have minor or no limitations for growing onion and are distributed in the eastern, central and northern part of the microwatershed. A maximum area of about 190 ha (40%) is moderately suitable (Class S2) for growing onion and are distributed in the southern, central, southwestern, southeastern and northeastern part of the microwatershed. They have minor limitations of gravelliness, wetness, texture, topography and rooting depth. Marginally suitable (Class S3) lands cover an area of about 171 ha (36%) and occur in the southwestern, central and northwestern part of the microwatershed. They have moderate limitations of gravelliness, topography and rooting depth. An area of about 22 ha (5%) is not suitable (Class N) for growing onoin and occur in the southeastern part of the microwatershed. They have very severe limitations of gravelliness and topography.

Table 7.10 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 drainage	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	<4
Salinity (EC)	dsm^{-1}	<1.0	1.0-2.0	2.0-4.0	<4
Sodicity (ESP)	%	<5	5-10	10-15	>15

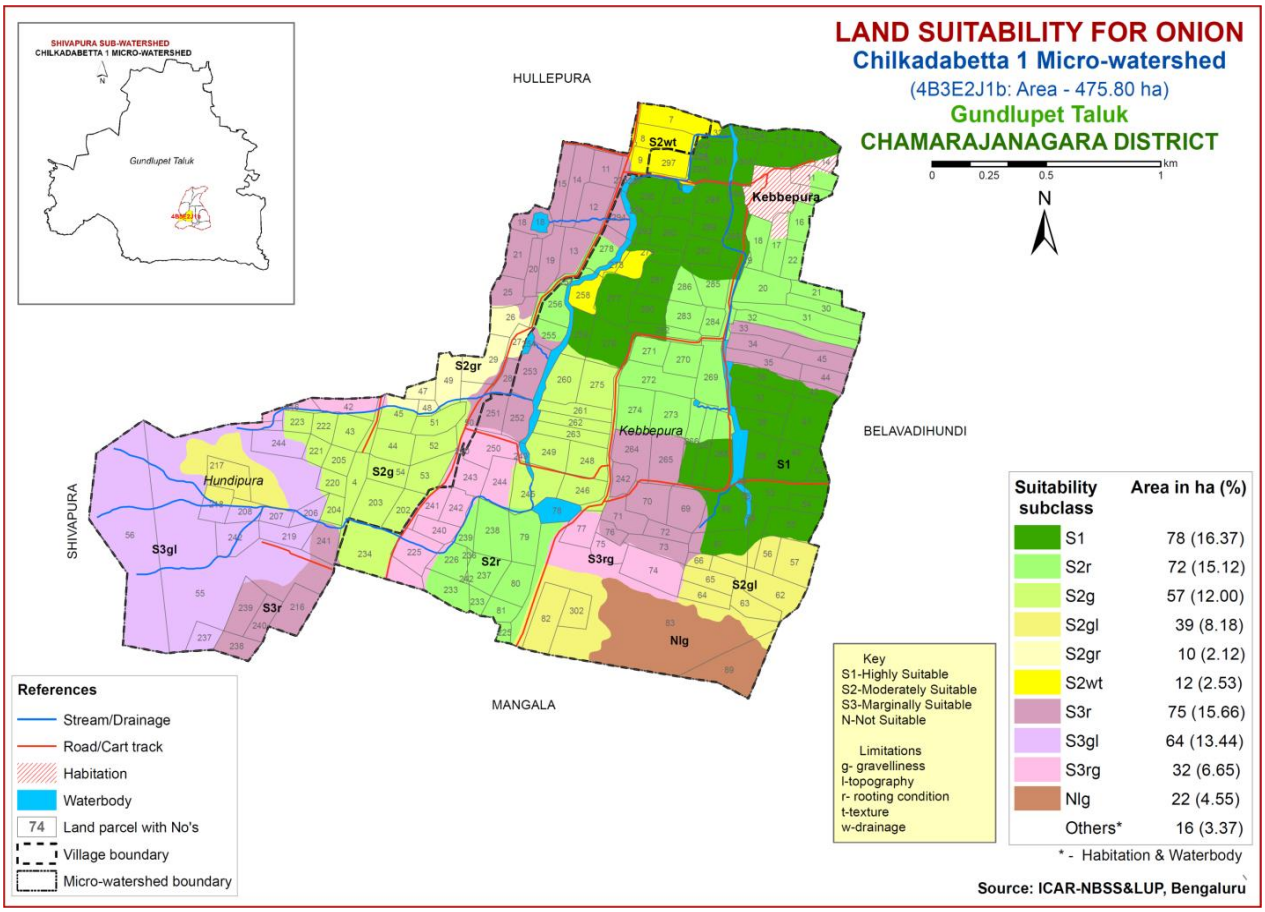


Fig. 7.9 Land Suitability map of Onion

7.10 Land suitability for Potato (*Solanum tuberosum*)

Potato is one of the major vegetable crop grown in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga, Chikkaballapur, Kolar, Chikkamangalore and Chamarajanagar districts. The crop requirements (Table 7.11) for growing potato were matched with the soil-site characteristics of the soils of the microwatershed and land suitability map for growing potato was prepared. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.10.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing potato crop. They have minor or no limitations for growing potato and are distributed in the eastern, central and northern part of the microwatershed. An area of about 178 ha (37%) is moderately suitable (Class S2) for growing potato and are distributed in the southwestern, central, northern and northeastern part of the microwatershed. They have minor limitations of gravelliness, topography and rooting depth. Marginally suitable (Class S3) lands cover maximum area of about 182 ha (38%) and occur in the southwestern, central and northwestern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness, wetness, texture and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing potato and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.11 Land suitability criteria for Potato

Crop requirement			Rating			
Soil –site characteristics		unit	Highly suitable S1	Moderately Suitable S2	Marginally suitable S3	Not suitable N
Slope	Hills	%	<5	5-10	10-15	>15
	Plains	%	<3	3-5	5-8	>8
Mean temperature in growing season		^{0}c	16-25	26-30 13-15	31-32 10-12	>32 <10
Soil drainage		class	Well drained	Moderately /imperfectly	Poor drained	Very poorly drained
Soil reaction		pH	5.5-6.5	6.6-8.2 5.0-5.4	>8.2 <5.0	-
Surface soil texture		Class	Scl, sil	S, sil	s	
Soil depth		Cm	75-100	50-75	25-50	<25
Stoniness		%	0-10	10-15	15-35	>35
Salinity (ECe)		dsm^{-1}	<1.0	1.0-2.0	2.0-4.0	>4.0
Sodicity (ESP)		%	<10	10-15	>15	-

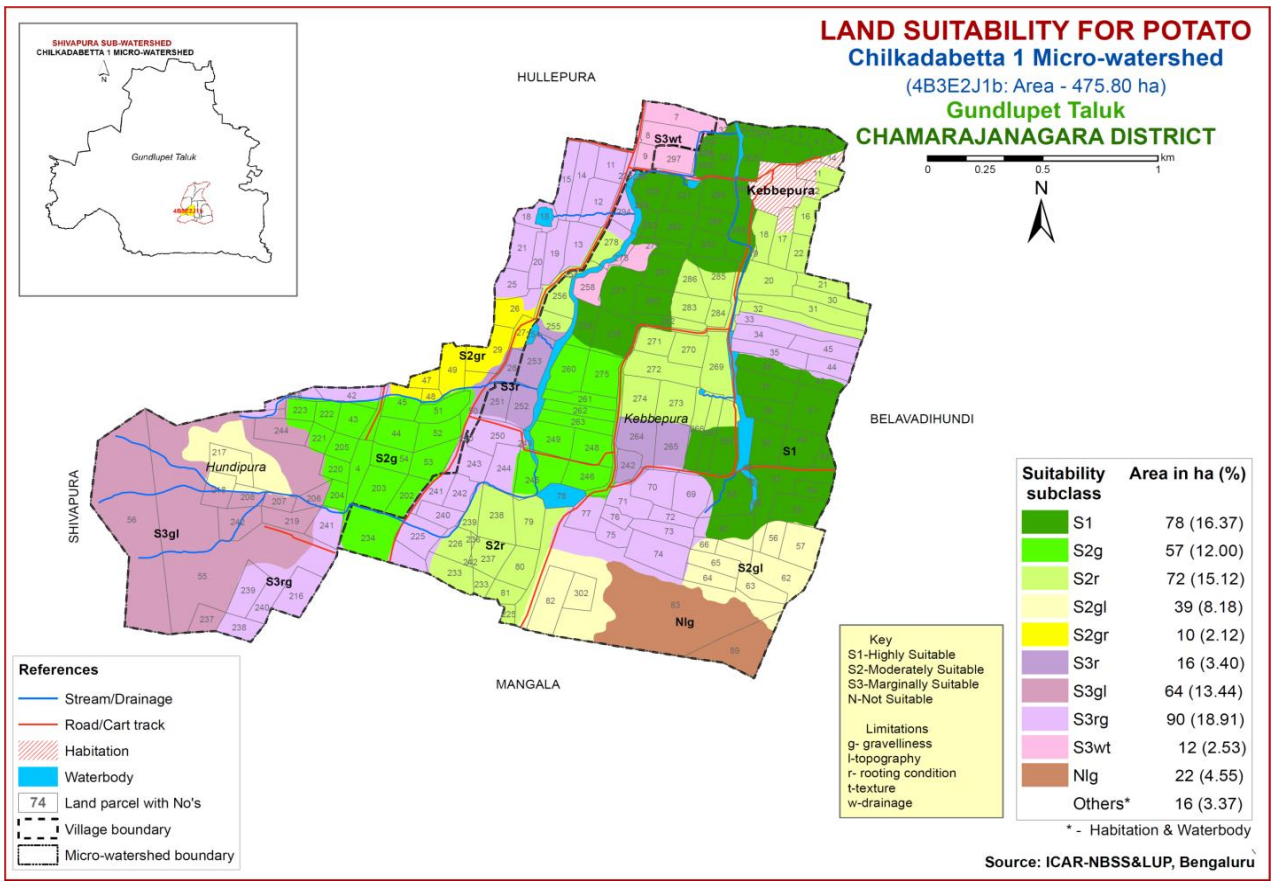


Fig. 7.10 Land Suitability map of Potato

7.11 Land suitability for Beans (*Phaseolus vulgaris*)

A bean is the most important pulse and vegetable crop grown in almost all the districts of Karnataka. The crop requirements for growing beans were matched with the soil-site characteristics of the soils of the microwatershed and land suitability map for growing beans was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure7.11.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing beans crop. They have minor or no limitations for growing bean and are distributed in the eastern, central and northern part of the microwatershed. A maximum area of about 190 ha (40%) is moderately suitable (Class S2) for growing bean and are distributed in all parts of the microwatershed. They have minor limitations of gravelliness, wetness, texture, topography and rooting depth. Marginally suitable (Class S3) lands cover an area of about 171 ha (36%) and occur in The southwestern, central and northwestern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing beans and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

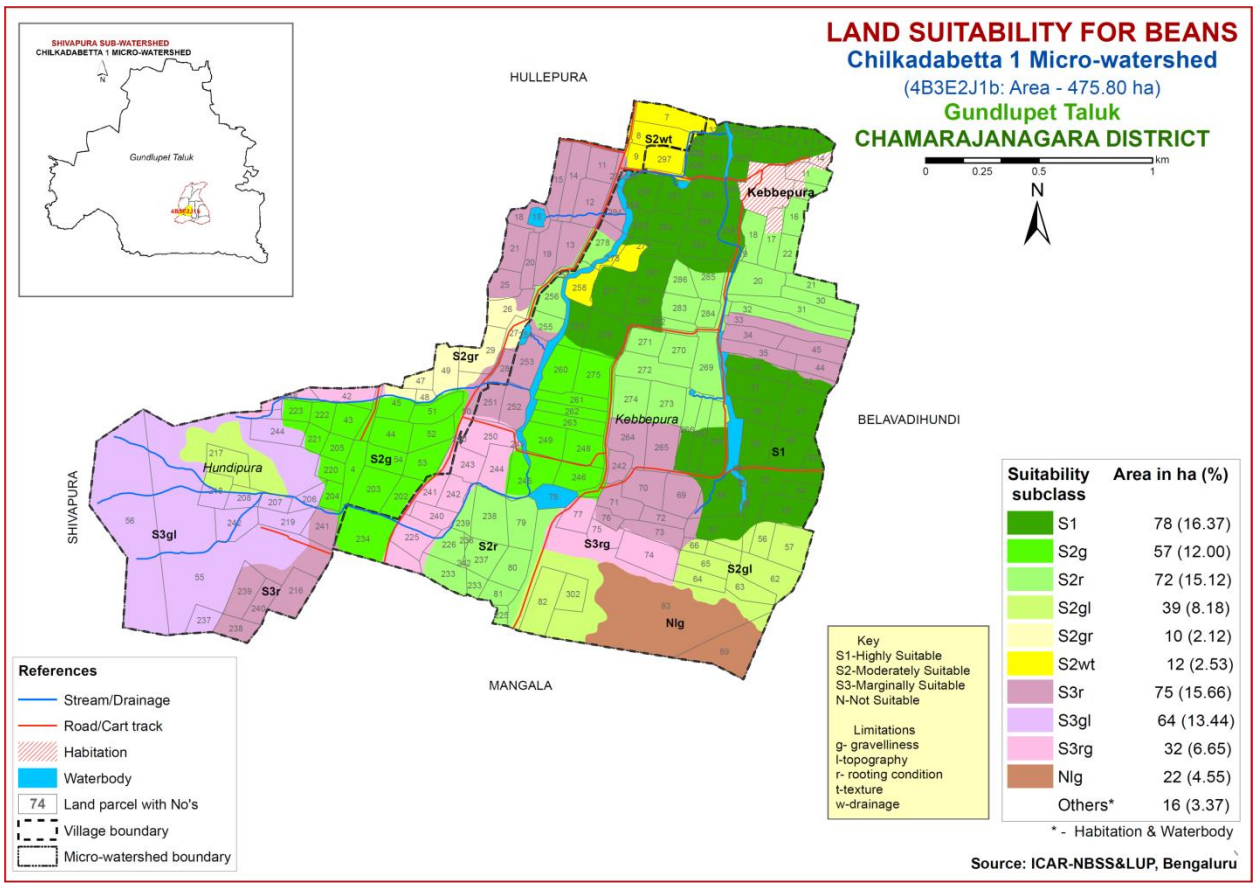


Fig. 7.11 Land Suitability map of Beans

7.12 Land suitability for Beetroot (*Beta vulgaris*)

Beetroot is one of the major vegetable crops grown in almost all the districts of Karnataka. The crop requirements for growing beetroot were matched with the soil-site characteristics of the soils of the microwatershed and land suitability map for growing beetroot was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.12.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing beetroot crop. They have minor or no limitations for growing beetroot and are distributed in the southern, central and northern part of the microwatershed. An area of about 178 ha (37%) is moderately suitable (Class S2) for growing beetroot and are distributed in the southern, central and southwestern part of the microwatershed. They have minor limitations of gravelliness, topography and rooting depth. Marginally suitable (Class S3) lands cover major area of about 182 ha (36%) and occur in the southwestern, central, northern and northwestern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness, wetness, texture and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing beetroot and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

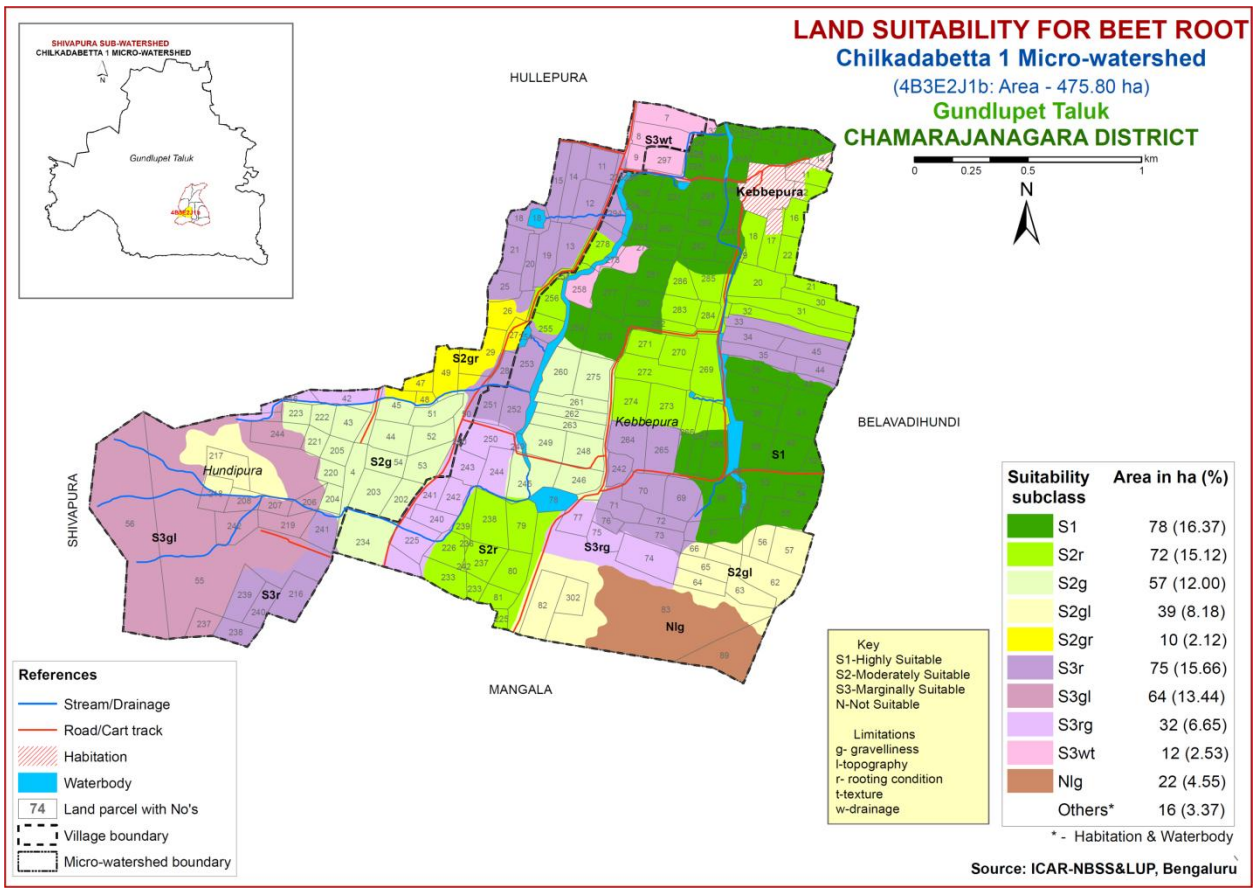


Fig. 7.12 Land Suitability map of Beetroot

7.13 Land suitability for Mango (*Mangifera indica*)

Mango is the most important fruit crop grown in an area of 18.53 lakh ha in almost all the districts of the State. The crop requirements (Table 7.12) for growing mango were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing mango was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.13.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing mango. They have minor or no limitations for growing mango and are distributed in the eastern, central and northern part of the microwatershed. A small area of about 23 ha (5%) is moderately suitable (Class S2) for growing mango and are distributed in the central part of the microwatershed. They have minor limitations of gravelliness. Marginally suitable (Class S3) lands cover an area of about 46 ha (10%) and occur in the southwestern and northern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness, texture and wetness. A major area of about 313 ha (66%) is not suitable (Class N) for growing mango and occur in all parts of the microwatershed. They have severe limitations of gravelliness and rooting depth.

Table 7.12 Land suitability criteria for Mango

Crop requirement			Rating			
		unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
climate	Tempin 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 imperfectly 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	8.6-9.0;4.0-4.9	>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	Nongravelly	<15	15-35	>35
	Hard pans	cm	>250	150-250	100-150	<100
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	

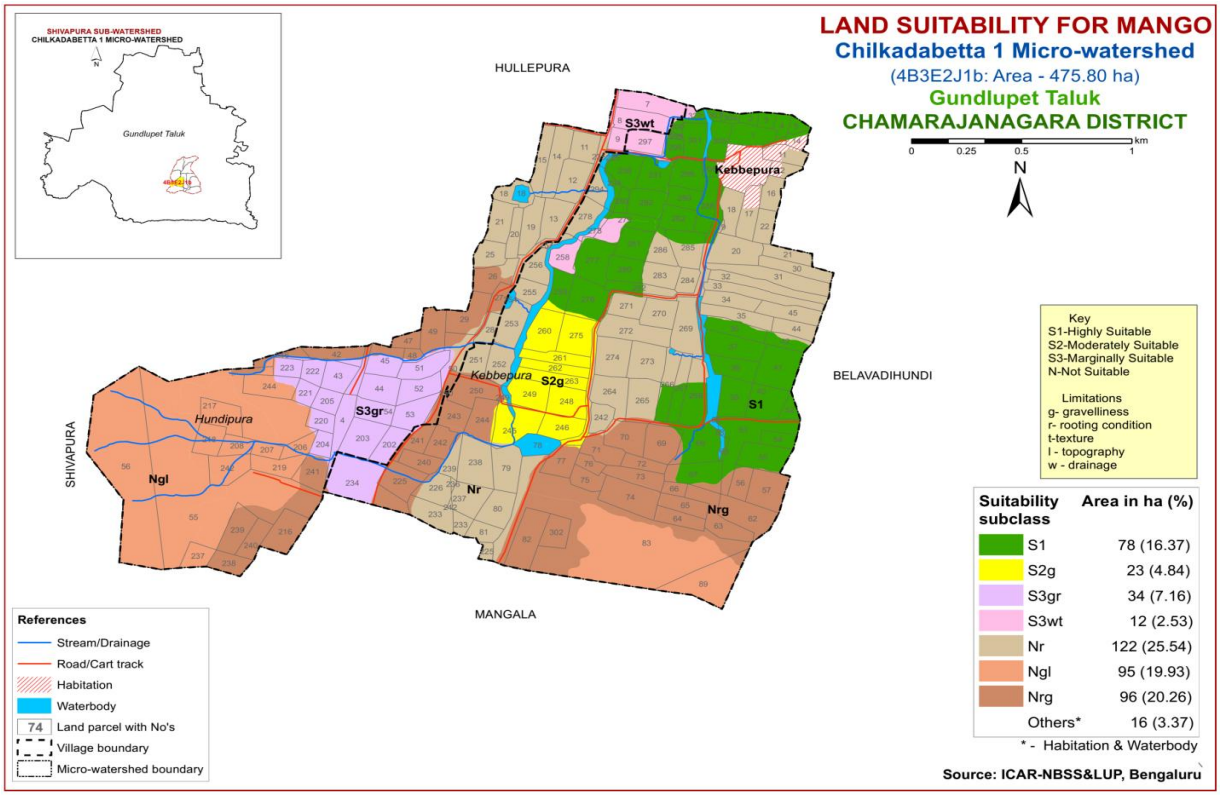


Fig. 7.13 Land Suitability map of Mango

7.14 Land suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in an area of 3.11 lakh ha in almost all the districts of the State. The crop requirements (Table 7.13) for growing sapota were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing sapota was generated. The area extent and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.14.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing sapota. They have minor or no limitations for growing sapota and are distributed in the eastern, central and northern part of the microwatershed. An area of about 57 ha (12%) is moderately suitable (Class S2) for growing sapota and are distributed in the southwestern and central part of the microwatershed. They have minor limitations of gravelliness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 136 ha (29%) and occur in the western, southern, southeastern, central and northern part of the microwatershed. They have moderate limitations of rooting depth, texture, wetness and gravelliness. An area of about 189 ha (40%) is not suitable (Class N) for growing sapota and occur in the southwestern, central, northeastern, northwestern and southern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

Table 7.13 Land 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 availabiliy	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

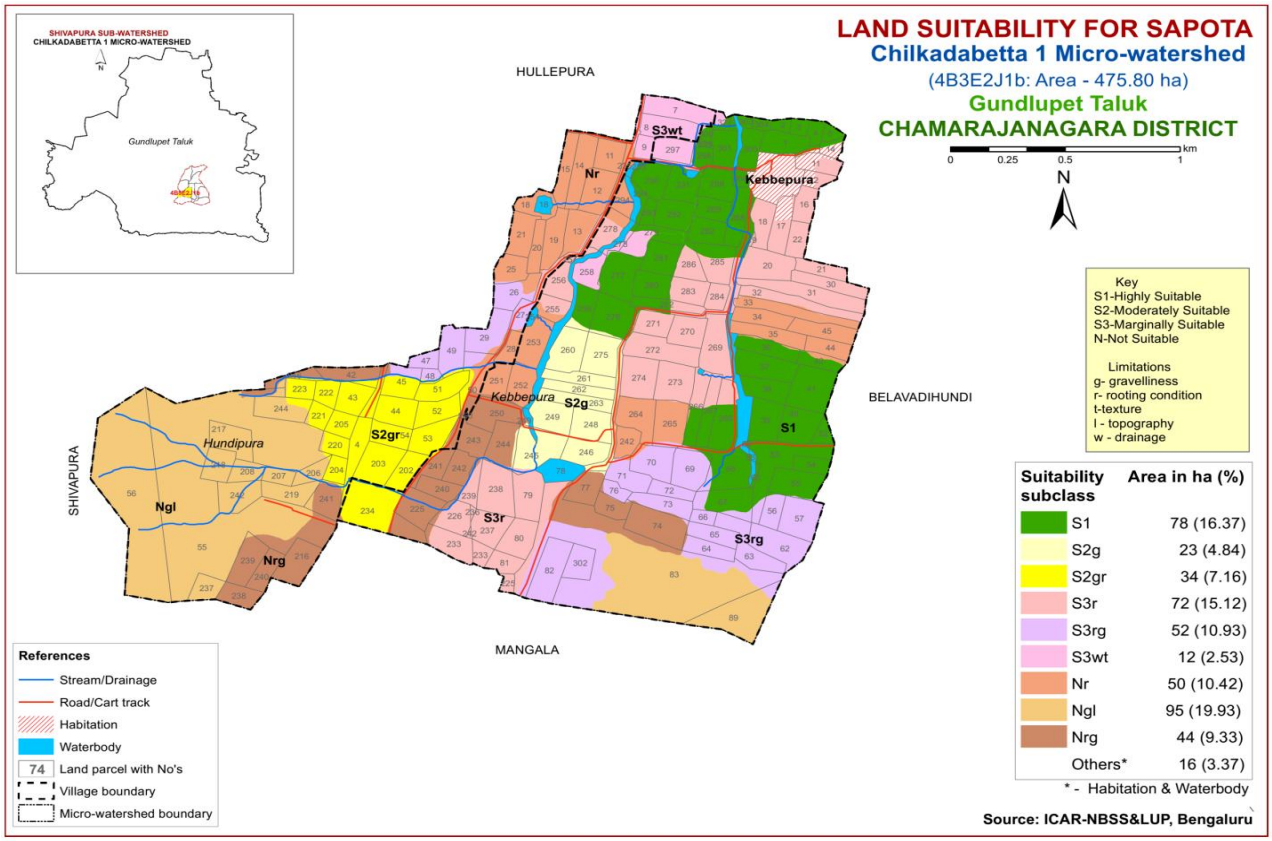


Fig. 7.14 Land Suitability map of Sapota

7.15 Land suitability for Guava (*Psidium guajava*)

Guava is the most important fruit crop grown in an area of 0.64 lakh ha in almost all the districts of the State. The crop requirements (Table 7.14) for growing guava were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing guava was generated. The area and geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.15.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing guava. They have minor or no limitations for growing guava and are distributed in the eastern, central and northern part of the microwatershed. An area of about 57 ha (12%) is moderately suitable (Class S2) for growing guava and are distributed in the southwestern and central part the microwatershed. They have minor limitations of gravelliness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 136 ha (29%) and occur in the western, northeastern, southern, southeastern, central and northern part of the microwatershed. They have moderate limitations of rooting depth, wetness, texture and gravelliness. A major area of about 189 ha (40%) is not suitable (Class N) for growing guava and occur in the southwestern, southeastern, central and northwestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

Table 7.14 Land 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	^{0}C	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 drained	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

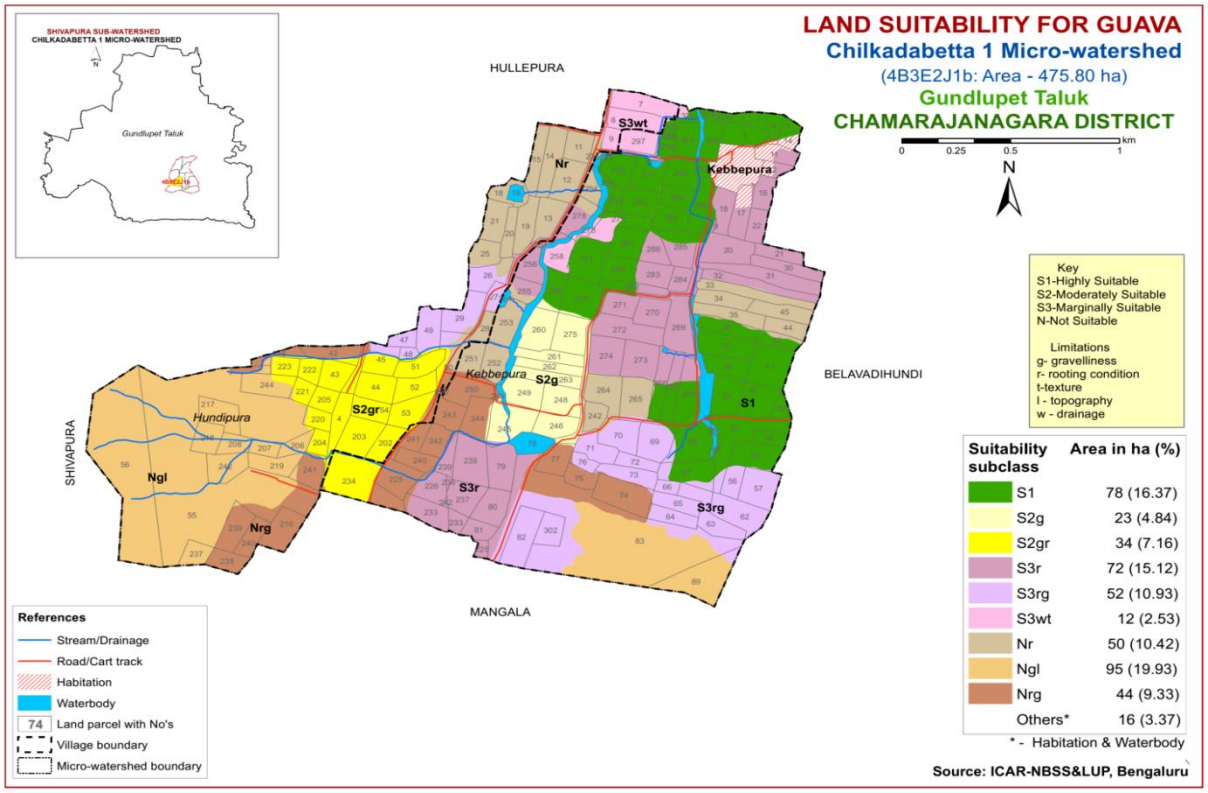


Fig. 7.15 Land Suitability map of Guava

7.16 Land suitability for Banana (*Musa paradisiaca*)

Banana is one of the major fruit crop grown in an area of 1.02 lakh ha in Karnataka State. The crop requirements (Table 7.15) for growing banana were matched with the soil-site (Table 7.1) characteristics of the soils of the microwatershed and land suitability map for growing banana was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.16.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing banana. They have minor or no limitations for growing banana and are distributed in the southern, central and northern part of the microwatershed. An area of about 69 ha (15%) is moderately suitable (Class S2) for growing banana and are distributed in the southwestern, central and northern part of the microwatershed. They have minor limitations of gravelliness, wetness and texture. Marginally suitable (Class S3) lands cover an area of about 121 ha (25%) and occur in the southern, southwestern, southeastern, cental and northeastern part of the microwatershed. They have moderate limitations of gravelliness, rooting depth and topography. Maximum area of about 192 ha (40%) is not suitable (Class N) for growing banana and occur in the southeastern and southwestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

Table 7.15 Land suitability criteria for Banana

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	26-33	34-36 24-25	37-38	>38
Soil aeration	Soil drainage	class	Well drained	Moderately to imperfectly drained	Poorly drained	Very poorly drained
Nutrient availability	Texture	Class	l,cl, scl,sil	Sicl, sc, c(<45%)	C (>45%), sic, sl	ls, s
	pH	1:2.5	6.5-7.0	7.1-8.5; 5.5-6.4	>8.5; <5.5	
Rooting conditions	Soil depth	Cm	>125	76-125	50-75	<50
	Gravelliness	%	<10	10-15	15-35	>35
Soil toxicity	Salinity	ds/m	<1.0	1-2	>2	
	Sodicity	%	<5	5-10	10-15	>15
Erosion	Slope	%	<1	1-3	3-8	>8

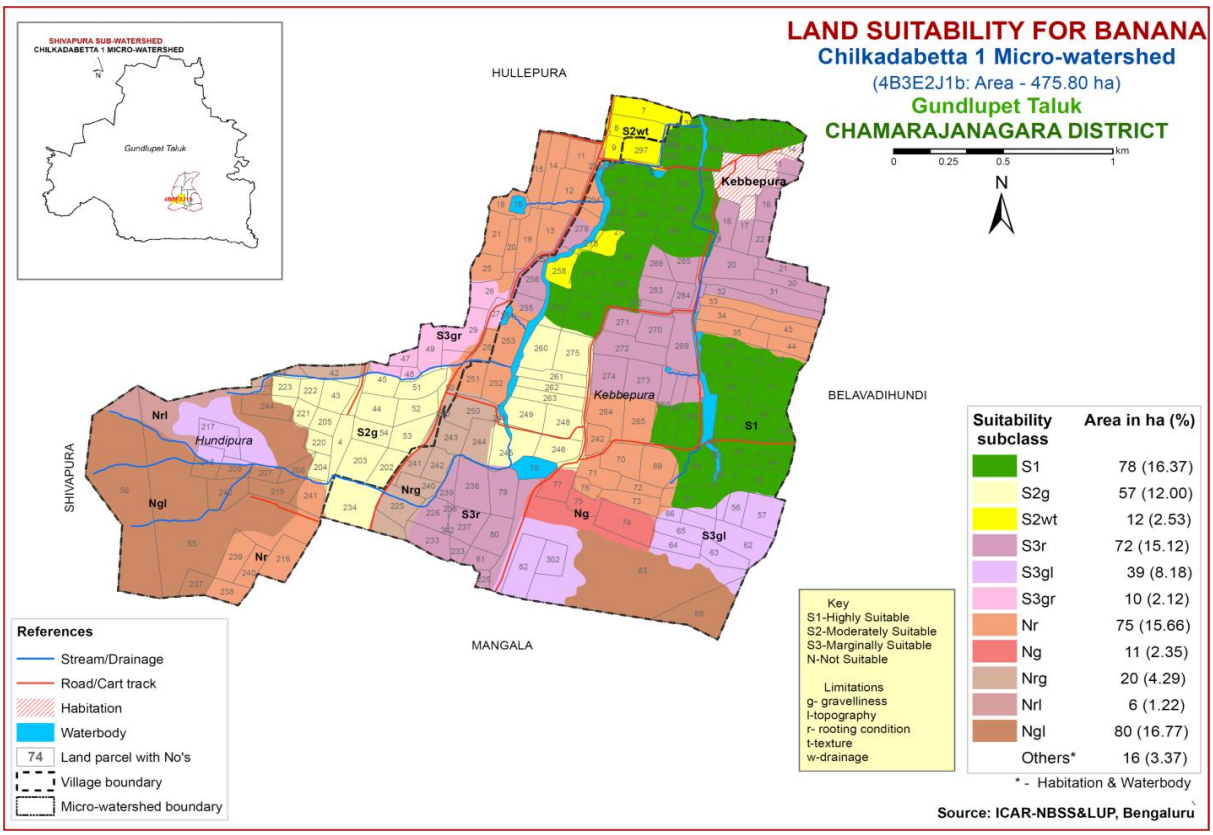


Fig. 7.16 Land Suitability map of Banana

7.17 Land suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in almost 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.17.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing jackfruit. They have minor or no limitations for growing jackfruit and are distributed in the noeastern, central and northern part of the microwatershed. A small area of about 23 ha (5%) is moderately suitable (Class S2) for growing jackfruit and are distributed in the central part of the microwatershed. They have minor limitations of gravelliness. Marginally suitable (Class S3) lands cover an area of about 170 ha (36%) and occur in the southwestern, southern, central, southeastern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, texture, wetness and gravelliness. An area of about 189 ha (40%) is not suitable (Class N) for growing jackfruit and occur in the southwestern, southern, southeastern and northwestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

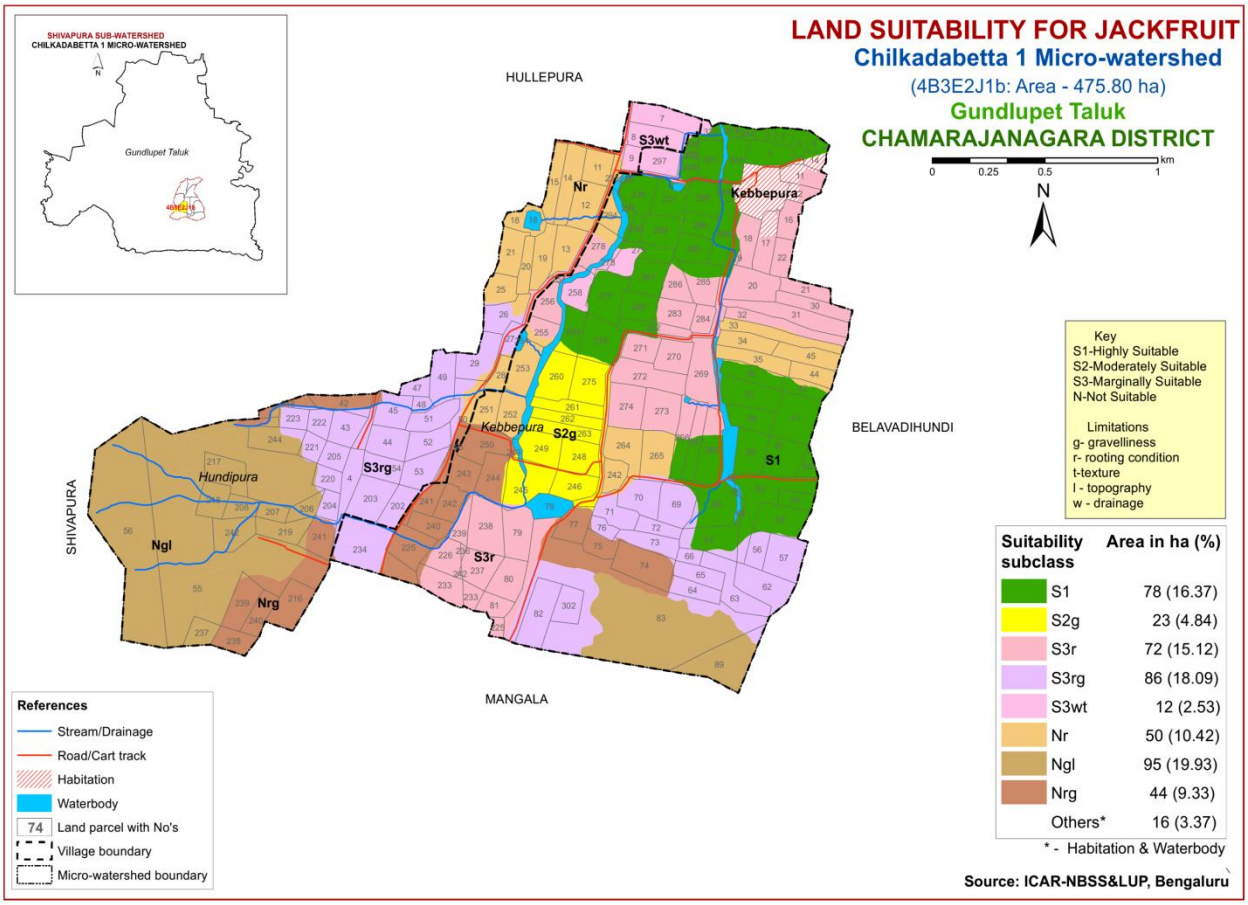


Fig. 7.17 Land Suitability map of Jackfruit

7.18 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.18.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing jamun. They have minor or no limitations for growing jamun and are distributed in the eastern, central and northern part of the microwatershed. An area of about 35 ha (7%) is moderately suitable (Class S2) for growing jamun and are distributed in the central and northern part of the microwatershed. They have minor limitations of gravelliness, texture and wetness. Marginally suitable (Class S3) lands cover an area of about 158 ha (33%) and occur in the western, southern, southeastern, central and northeastern part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 189 ha (40%) is not suitable (Class N) for growing jamun and occur in the southwestern, southeastern, central, northwestern and eastern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

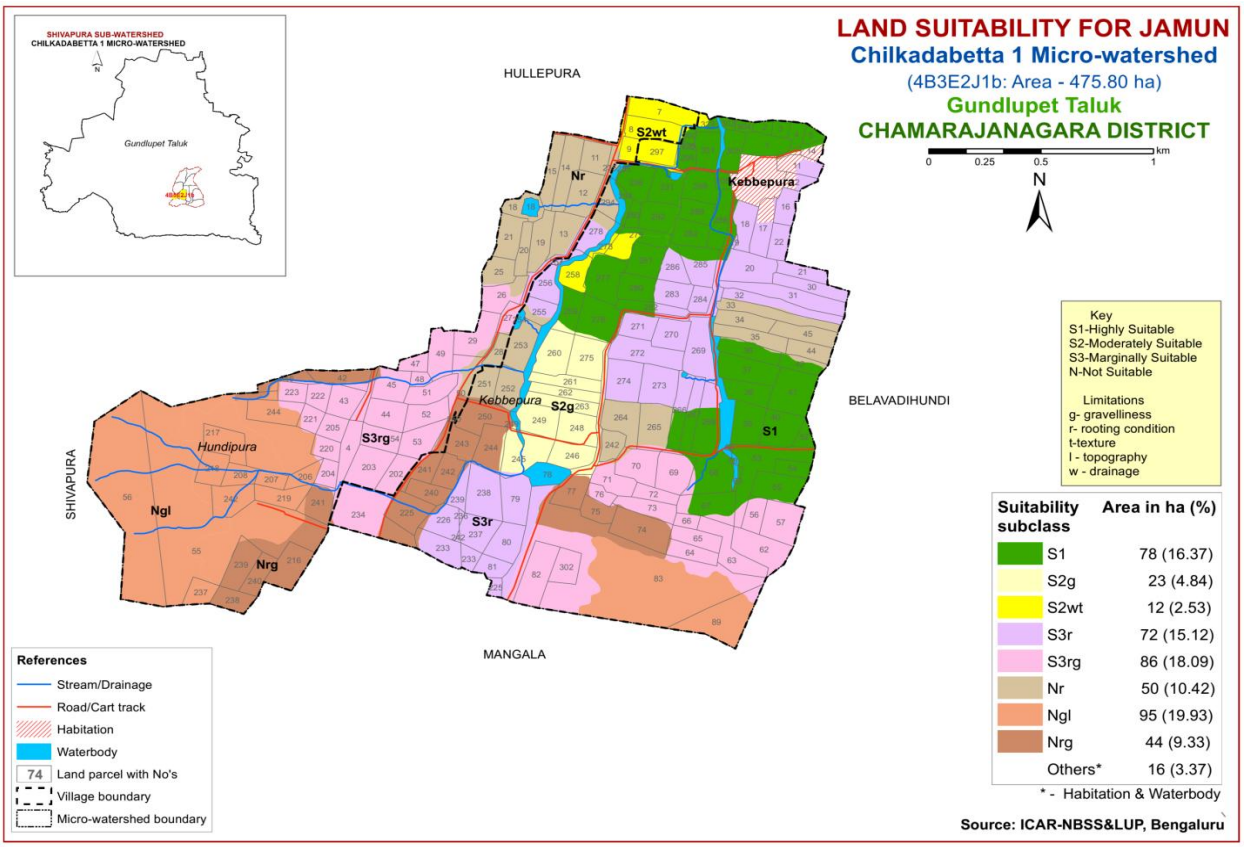


Fig. 7.18 Land Suitability map of Jamun

7.19 Land Suitability for Musambi (*Citrus limetta*)

Musambi is one of the important fruit crop grown 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.19.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing musambi. They have minor or no limitations for growing musambi and are distributed in the eastern, central and northern part of the microwatershed. A small area of about 35 ha (5%) is moderately suitable (Class S2) for growing musambi and are distributed in the central and northern part of the microwatershed. They have minor limitations of gravelliness and wetness. Marginally suitable (Class S3) lands cover an area of about 158 ha (33%) and occur in the southern, southwestern, southeastern and central part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 189 ha (40%) is not suitable (Class N) for growing musambi and occur in the southwestern, southeastern, central and northwestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

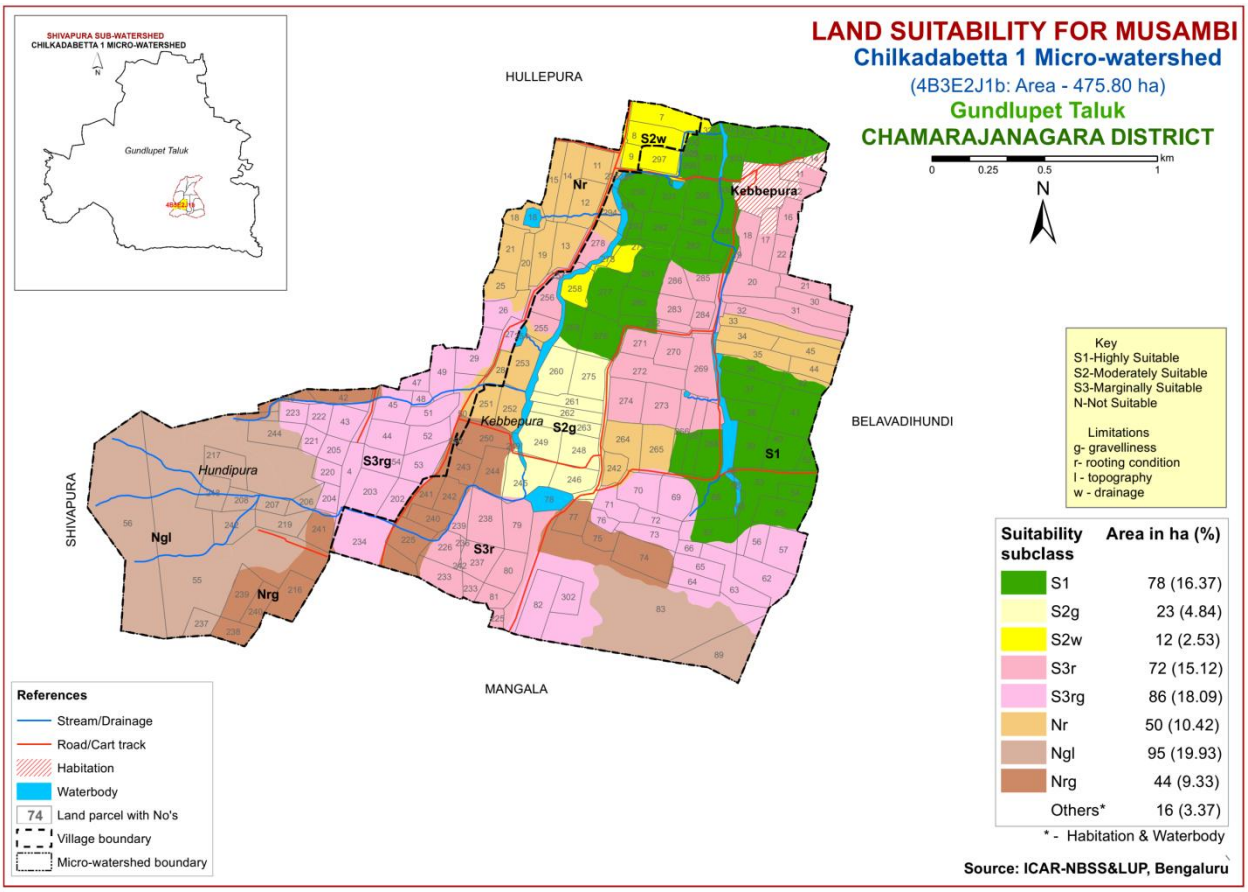


Fig. 7.19 Land Suitability map of Musambi

7.20 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 0.11 lakh ha in almost all the districts of the State. The crop requirements (Table 7.16) for growing lime were matched with the soil-site characteristics and a land suitability map for growing lime was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.20.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing lime. They have minor or no limitations for growing lime and are distributed in the eastern, central and northern part of the microwatershed. A small area of about 35 ha (5%) is moderately suitable (Class S2) for growing lime and are distributed in the central and northern part of the microwatershed. They have minor limitations of gravelliness and wetness. Marginally suitable (Class S3) lands cover an area of about 158 ha (33%) and occur in the southern, southwestern, southeastern and central part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 189 ha (40%) is not suitable (Class N) for growing lime and occur in the southwestern, southeastern, central and northwestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

Table 7.16 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 imperfectly 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	5.5-6.47.6-8.0	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	

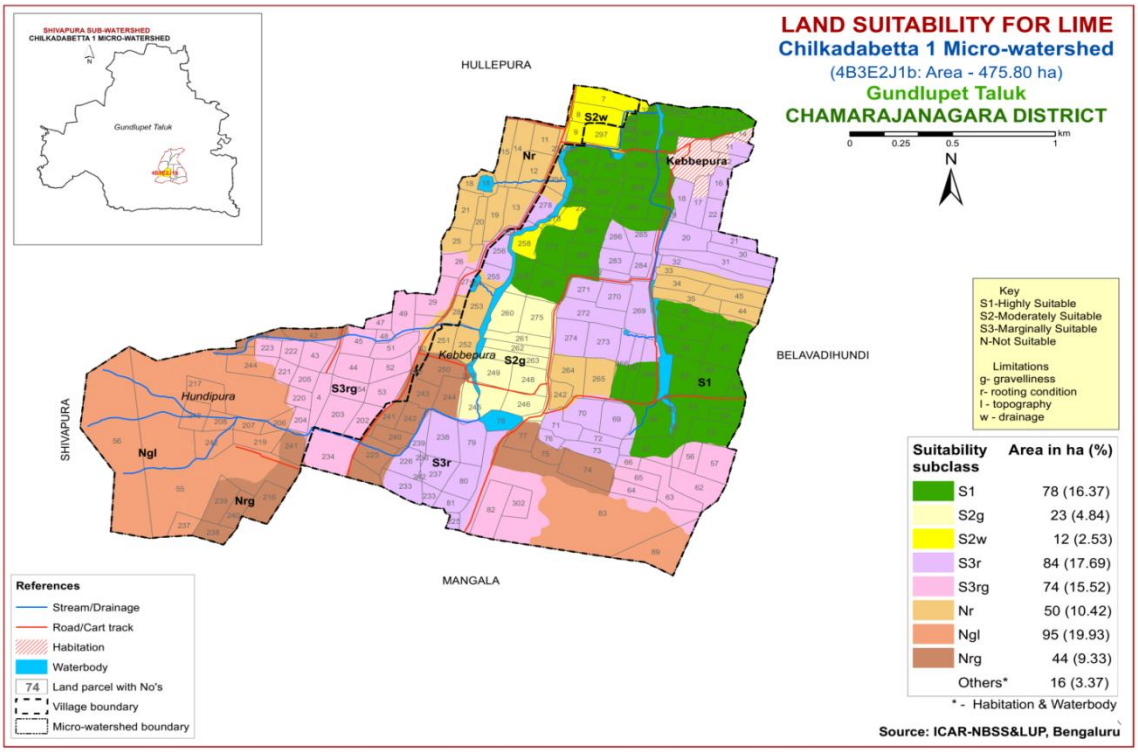


Fig. 7.20 Land Suitability map of Lime

7.21 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important fruit crop grown in an area of 1.24 lakh ha in almost all the districts of the State. The crop requirements for growing cashew were matched with the soil-site characteristics and a land suitability map for growing cashew was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.21.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing cashew. They have minor or no limitations for growing cashew and are distributed in the eastern, central and northern part of the microwatershed. An area of about 57 ha (12%) is moderately suitable (Class S2) for growing cashew and are distributed in the southwestern and central part of the microwatershed. They have minor limitations of gravelliness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 124 ha (26%) and occur in the southern, southeastern, central and northeastern part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 124 ha (26%) is not suitable (Class N) for growing cashew and occur in the southwestern, southeastern, central and northewestern part of the microwatershed. They have severe limitations of gravelliness, rooting depth, wetness, texture and topography.

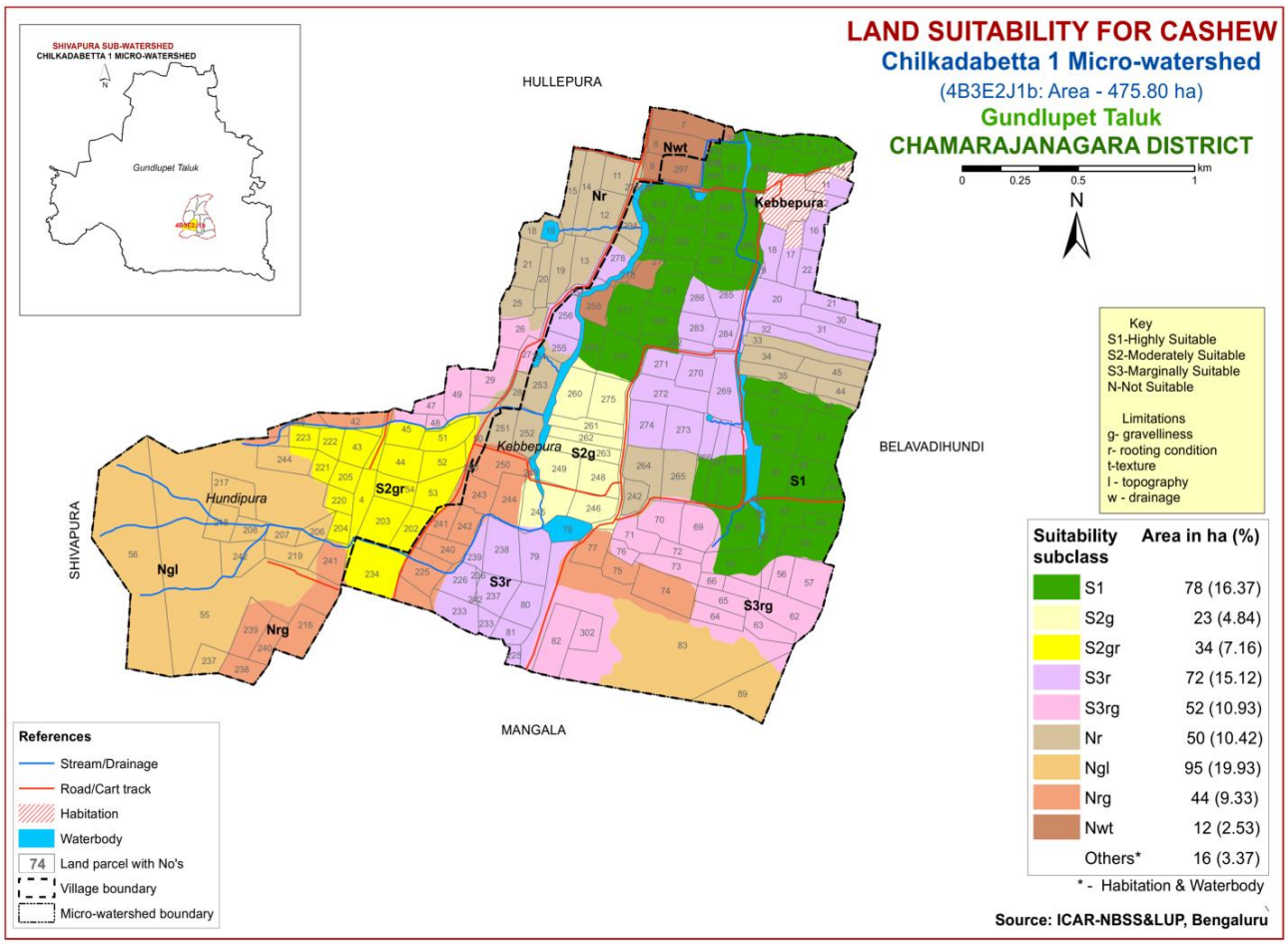


Fig. 7.21 Land Suitability map of Cashew

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

Custard apple is one of the most important fruit crop grown in an area of 1.1 lakh ha in almost all the districts of the State. The crop requirements for growing custard apple were matched with the soil-site characteristics and a land suitability map for growing custard apple was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.22.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing custard apple. They have minor or no limitations for growing custard apple and are distributed in the eastern, central and northern part of the microwatershed. A major area of about 193 ha (40%) is moderately suitable (Class S2) for growing custard apple and are distributed in the southern, southwestern, central, northern and northeastern part the microwatershed. They have minor limitations of gravelliness, wetness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 100 ha (21%) and occur in the southwestern, northwestern, western, central and northeastern part of the microwatershed. They have moderate limitations of rooting depth, topography and gravelliness. An area of about 89 ha (19%) is not suitable (Class N) for growing custard apple and occur in the southwestern and southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

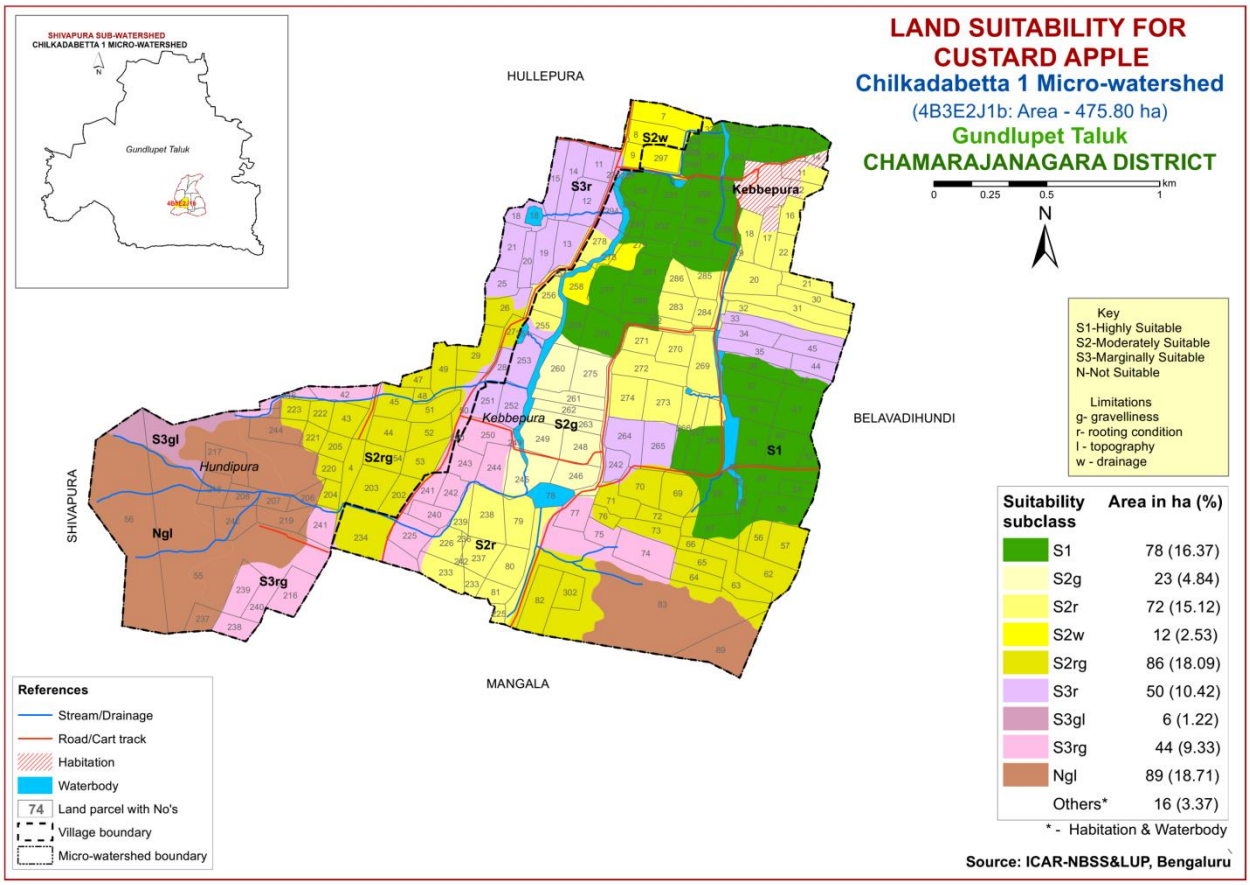


Fig. 7.22 Land Suitability map of Custard apple

7.23 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the fruit crop grown in almost 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.23.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing amla. They have minor or no limitations for growing amla and are distributed in the eastern, central and northern part of the microwatershed. A major area of about 193 ha (40%) is moderately suitable (Class S2) for growing amla and are distributed in the southern, southwestern, central, northern and northeastern part the microwatershed. They have minor limitations of gravelliness, wetness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 100 ha (21%) and occur in the southwestern, northwestern, western, central and northeastern part of the microwatershed. They have moderate limitations of rooting depth, topography and gravelliness. An area of about 89 ha (19%) is not suitable (Class N) for growing amla and occur in the southwestern and southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

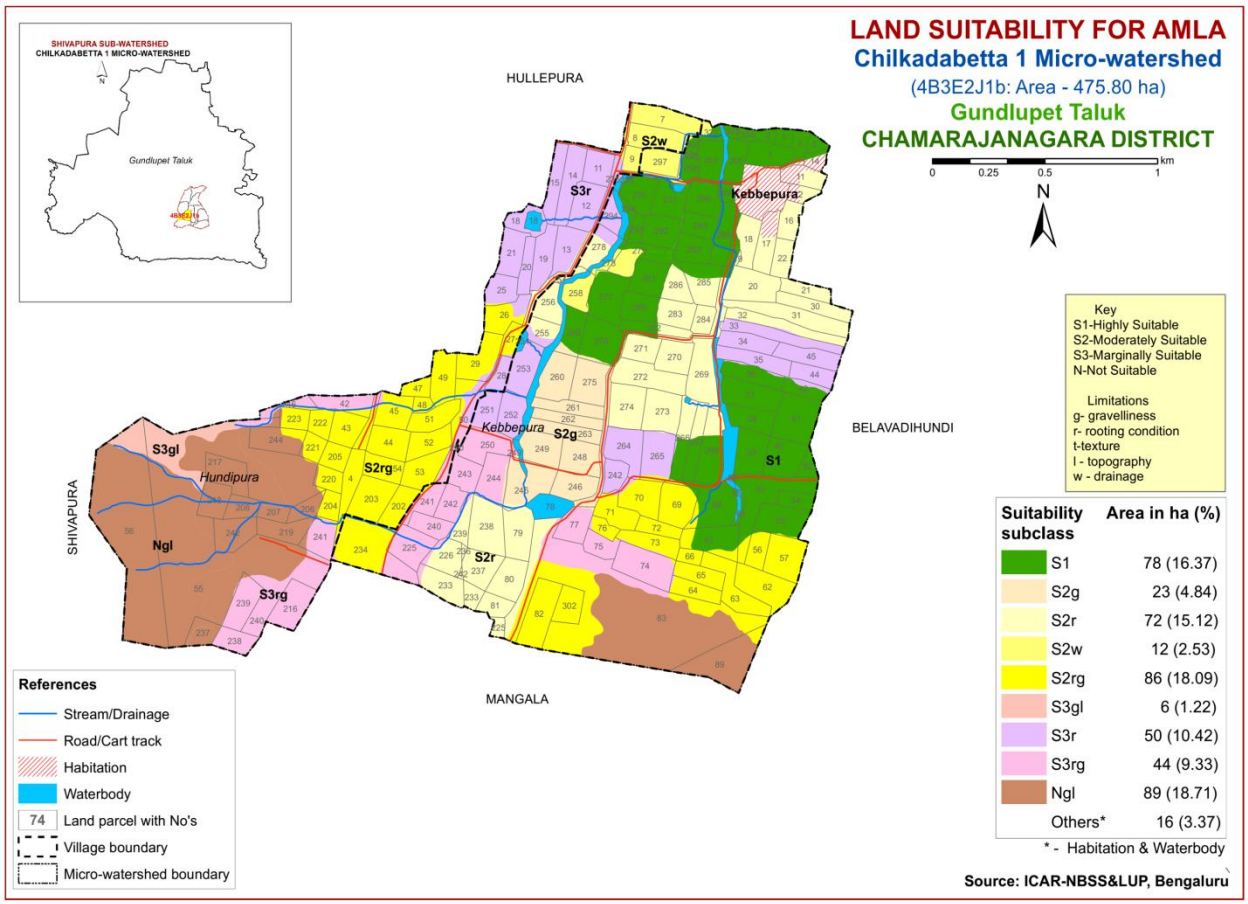


Fig. 7.23 Land Suitability map of Amla

7.24 Land Suitability for Tamarind (*Phyllanthus emblica*)

Tamarind is one of the fruit and spice crop grown in almost 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.24.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing tamarind. They have minor or no limitations for growing tamarind and are

distributed in the eastern, central and northern part of the microwatershed. An area of about 35 ha (5%) is moderately suitable (Class S2) for growing tamarind and are distributed in the northern and central part the microwatershed. They have minor limitations of gravelliness, wetness and texture. Marginally suitable (Class S3) lands cover an area of about 158 ha (33%) and occur in the southern, central, southwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. An area of about 189 ha (43%) is not suitable (Class N) for growing tamarind and occur in the southwestern, southeastern, central and northeastern part of the microwatershed. They have severe limitations of gravelliness, rooting depth and topography.

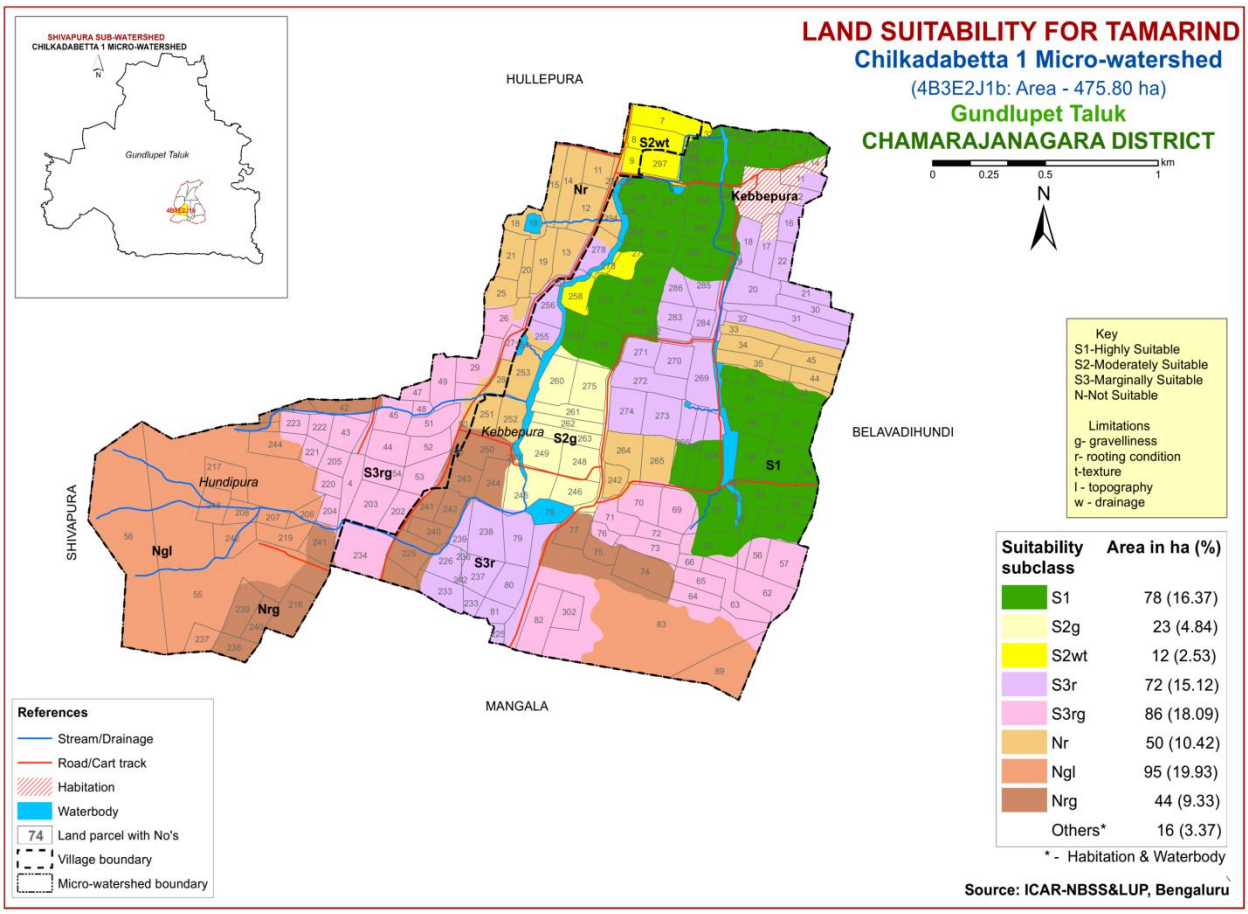


Fig. 7.24 Land Suitability map of Tamarind

7.25 Land suitability for Marigold (*Tagetes sps.)*

Marigold is the most important flower crop grown in an area of 1858 ha in almost all the districts of the State. The crop requirements (Table 7.17) for growing marigold were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing marigold was generated. The area and their geographical distribution of different suitability subclasses in the microwatersheds is given in Figure. 7.25.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing marigold. They have minor or no limitations for growing marigold and are distributed in the eastern, central and northern part of the microwatershed. A major area of about 190 ha (40%) is moderately suitable (Class S2) for growing marigold and are distributed in the southern, southwestern, southeastern, central and northeastern part the microwatershed. They have minor limitations of gravelliness, topography, wetness, texture and rooting depth. Marginally suitable

(Class S3) lands cover an area of about 170 ha (36%) and occur in the southwestern, central, northwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness and topography. A small area of about 22 ha (5%) is not suitable (Class N) for growing marigold and occur in the southwestern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.17 Land suitability criteria for Marigold

Crop requirement			Rating			
Soil –site characteristics		unit	Highly suitable S1	Moderately Suitable S2	Marginally suitable S3	Not suitable N
climate	Temperature in growing season		18-23	17-15 24-35	35-40 10-14	>40 <10
Soil aeration	Soil drainage	class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	l ,sl, scl, cl, sil	sicl, sc, sic, c	C	ls, s
	pH	1:2.5	7.0-7.5	5.5-5.9 7.6-8.5	<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	Slightly	Strongly	-
	Sodicity (ESP)	%	<10	10-15	>15	-
Erosion	Slope	%	1-3	3-5	5-10	-

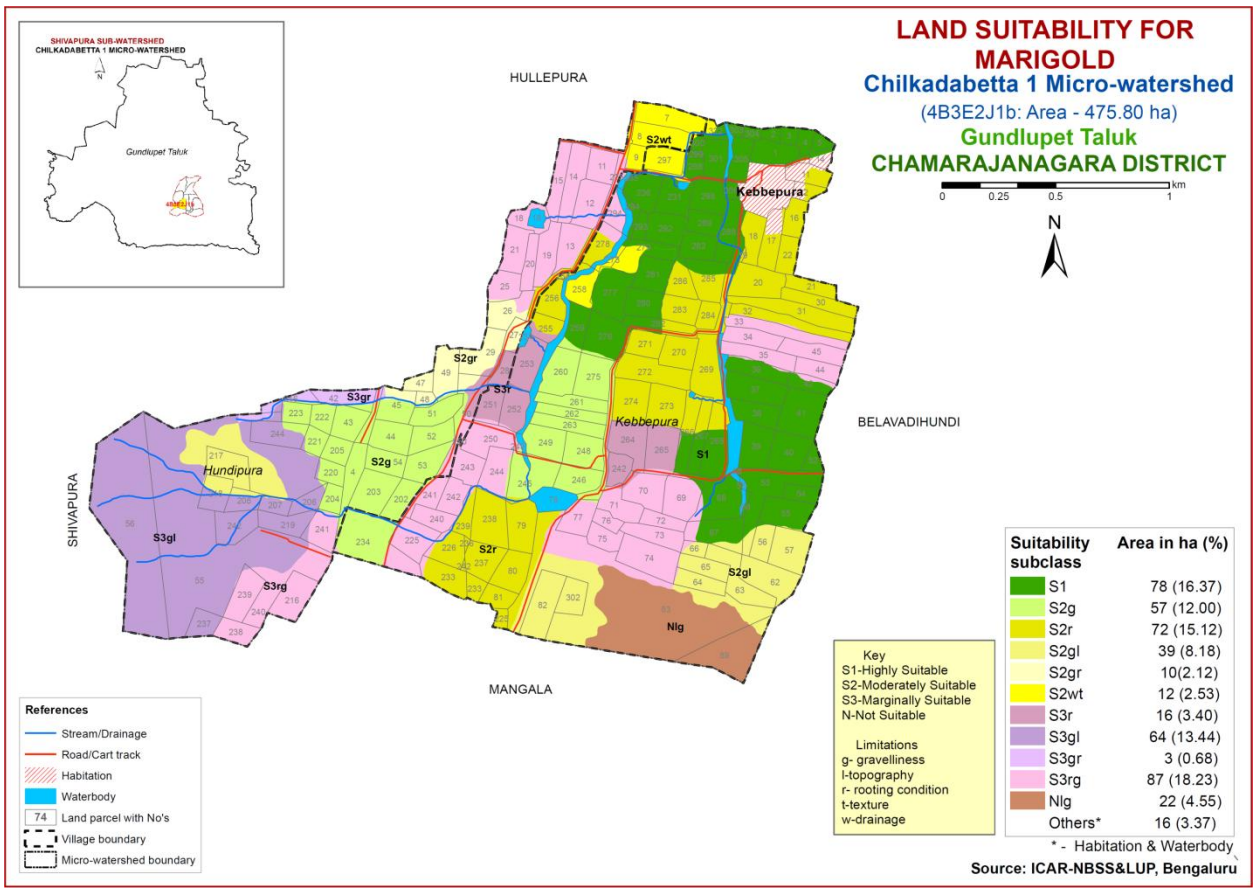


Fig. 7.25 Land Suitability map of Marigold

7.26 Land suitability for Chrysanthemum (*Dendranthema grandiflora*)

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 (Table 7.18) for growing chrysanthemum were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing chrysanthemum was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.26.

An area of about 78 ha (16%) in the microwatershed has soils that are highly suitable (Class S1) for growing chrysanthemum. They have minor or no limitations for growing chrysanthemum and are distributed in the eastern, central and northern part of the microwatershed. A major area of about 190 ha (40%) is moderately suitable (Class S2) for growing chrysanthamum and are distributed in the southern, southwestern, southeastern, central and northeastern part the microwatershed. They have minor limitations of gravelliness, topography, wetness, texture and rooting depth. Marginally suitable (Class S3) lands cover an area of about 170 ha (36%) and occur in the southwestern, central, northwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness and topography. A small area of about 22 ha (5%) is not suitable (Class N) for growing chrysanthamum and occur in the southwestern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.18 Land suitability criteria for Chrysanthemum

Crop requirement			Rating			
Soil –site characteristics		unit	Highly suitable S1	Moderately Suitable S2	Marginally suitable S3	Not suitable N
climate	Temperature in growing season		18-23	17-15 24-35	35-40 10-14	>40 <10
Soil aeration	Soil drainage	class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	l ,sl, scl, cl, sil	sicl, sc, sic, c	C	ls, s
	pH	1:2.5	7.0-7.5	5.5-5.9; 7.6-8.5	<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	slightly	strongly	
	Sodicity (ESP)	%	<10	10-15	>15	-
Erosion	Slope	%	1-3	3-5	5-10	

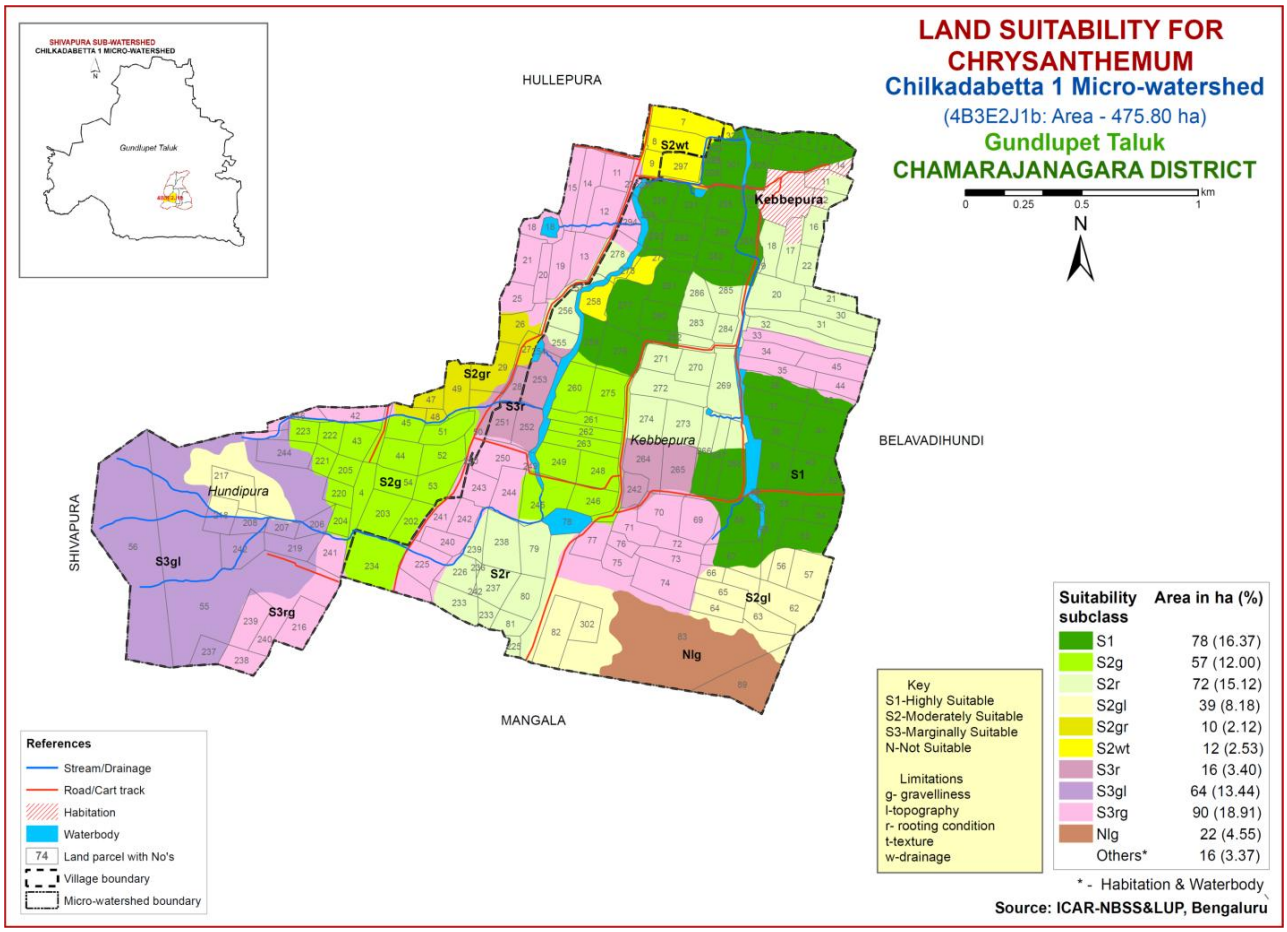


Fig. 7.26 Land Suitability map of Chrysanthemum

7.27 Land Suitability for Turmeric (*Curcuma longa*)

Turmeric is the most important spice crop grown in an area of 1.39 lakh ha in almost all the districts of the State. The crop requirements (Table 7.19) for growing turmeric were matched with the soil-site (Table 7.1) characteristics and a land suitability map for growing turmeric was generated and the area and their geographical distribution of different suitability subclasses in the microwatersheds is given in Figure 7.27.

An area of about 78 ha (16 %) in the microwatershed has soils that are highly suitable (Class S1) for growing turmeric crop. They have minor or no limitations for growing turmeric and are distributed in the southern, central and northern part of the microwatershed. An area of about 178 ha (37%) is moderately suitable (Class S2) for growing turmeric and are distributed in the southern, central, southwestern and northeastern part of the microwatershed. They have minor limitations of gravelliness, topography and rooting depth. Marginally suitable (Class S3) lands cover maximum area of about 182 ha (38%) and occur in the southwestern, central, northwestern and northeastern part of the microwatershed. They have moderate limitations of rooting depth, gravelliness, wetness, texture and topography. An area of about 22 ha (5%) is not suitable (Class N) for growing turmeric and occur in the southeastern part of the microwatershed. They have severe limitations of gravelliness and topography.

Table 7.19 Land suitability criteria for Turmeric

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	20-27 33-37	10-19 38-40	<10 >40
Soil aeration	Soil drainage	class	Well drained	Mod. well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	l, cl, scl, sl	Sc, sic, sicl	C(40-60%), ls	Stony heavy clay>60%
	pH	1:2.5				
	Available nutrient status (NPK)	Fertility rating class	high	medium	low	
Rooting conditions	Soil depth	Cm	>75	50-75	25-50	<25
Erosion	Slope	%	<3	3-8	8-15	>15mm

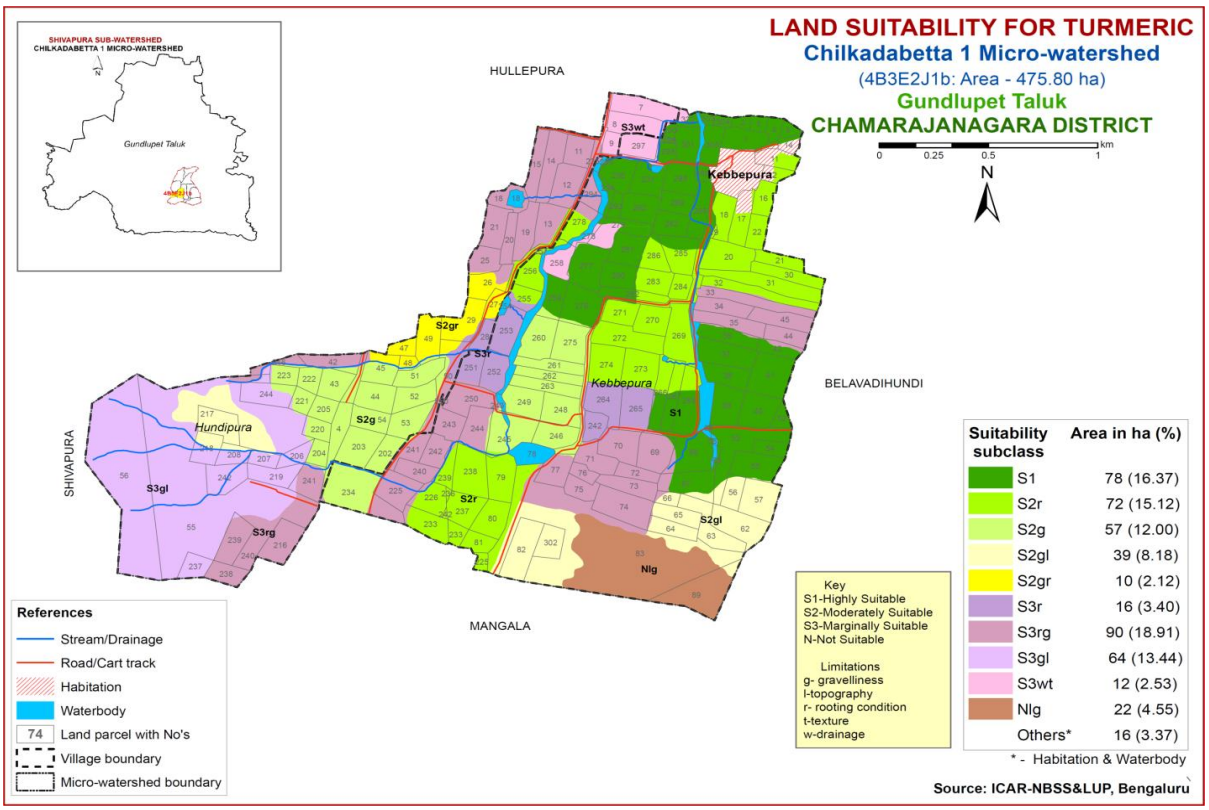


Fig. 7.27 Land Suitability map of Turmeric

7.28 Land Management Units (LMUs)

The 28 soil map units identified in the microwatershed have been regrouped into 8 Land Management Units (LMU's) for the purpose of preparing Proposed Crop Plan (Table 7.20). 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.7.28) has been generatedd. These Land Management Units are expected to behave similarly for a given level of management.

The map units that have been grouped into 8 land management units along with brief description of soil and site characteristics are given below:

LMUs	Soil map units	Soil and site characteristics
1	ARKiB1g1,HGHiB2g2, HGHmB1,KDHiA1g1, KDHiB1	Very deep, red sandy clay to clay soils with slopes of 0-3%, slight to moderate erosion, gravelly to very gravelly (15-60%)
2	BMBiB1g1	Very deep, black sandy clay soils with slopes of 1-3%, slight erosion, and gravelly (15-35%)
3	KNGcB2g2	Moderately deep, red sandy loam soils with slopes of 1-3%, moderate erosion, very gravelly (35-60%)
4	DRHbC2g2,DRHcB2g2 DRHhB1g1,HPRbB2g2 HPRcB1g1,HPRhB1g1 HPRiB1g1	Moderately shallow, red sandy clay to sandy clay loam soils with slopes of 1-5%, slight to moderate erosion, gravelly to very garvelly (15-60%)
5	MGHcC2g2	Moderately shallow, red sandy loam soils with slopes of 3-5%, moderate erosion, very gravelly (35-60%)

6	HDRbB2g2,HDRcB1g1, HDRcB1g2, HDRhB1g1 HDRiB1,HDRiB2g2	Shallow, red sandy clay to sandy clay loam and loamy sand soils with slopes of 1-3%, slight to moderate erosion and gravelly to very gravelly (15-60%)
7	HDRcC2g2, SPRbB2g2	Shallow, red sandy loam to loamy sand soils with slopes of 1-5%, moderate erosion, very gravelly (35-60%)
8	HDRcD3g2,KNGbE3g2 MGHhD3g2,SPRcD2g2 SPRcD3g2	Shallow to Moderately deep, red sandy clay loam to sandy loam soils and loamy sand soils with slopes of 5-15%, moderate to severe erosion, very gravelly (35-60%)

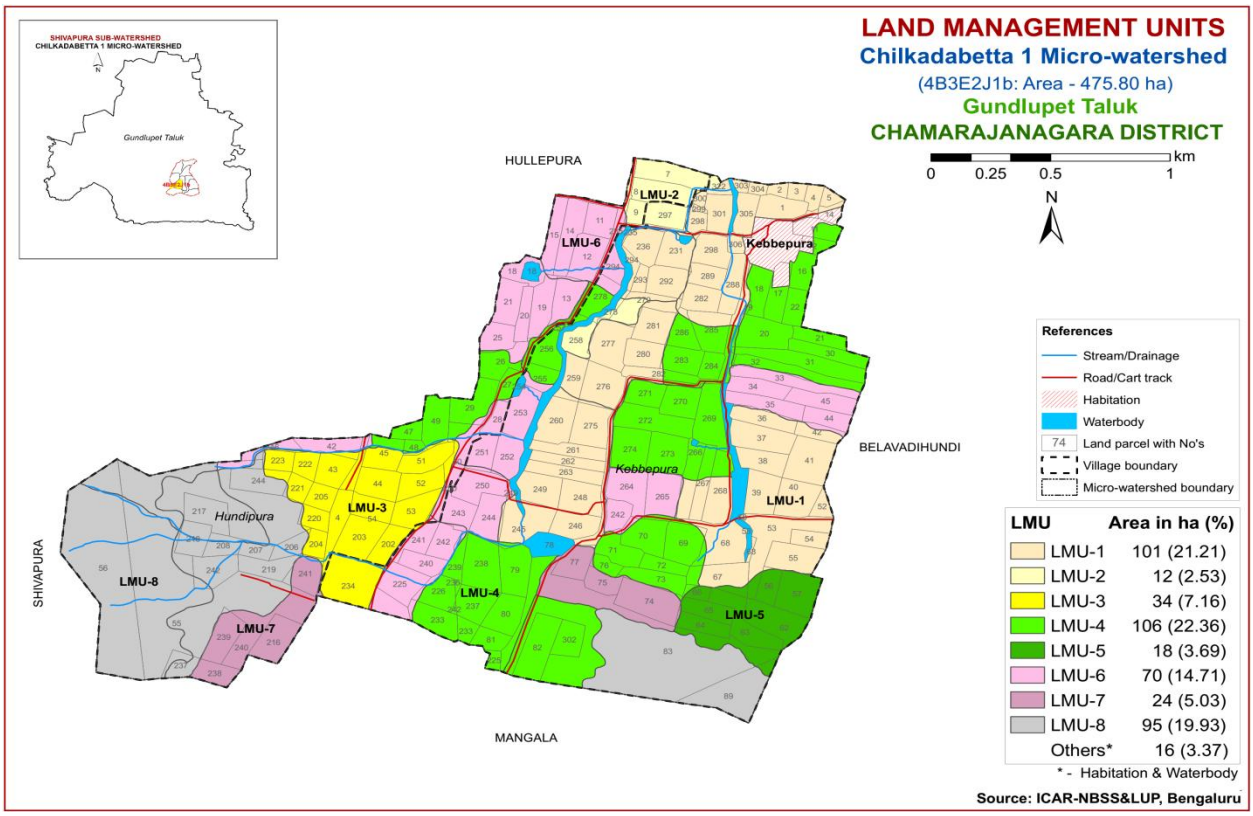


Fig. 7.28 Land Management Units Map- Chilkadabetta-1 Microwatershed

7.29 Proposed Crop Plan for Chilkadabetta-1 Microwatershed

After assessing the land suitability for the 27 crops, the proposed crop plan has been prepared for the 8 identified LMUs by considering only the highly (Class S1) and moderately (Class S2) suitable lands for each of the 27 crops. The resultant proposed crop plan is presented below in Table 7.14

Table 7.20 Proposed Crop Plan for Chilkadabetta-1 Microwatershed

LMU No	Mapping Units	Survey Number	Field Crops/Forestry	Suitable Horticulture Crops under Irrigation	Horticulture Crops with suitable Interventions	Suitable Interventions
LMU1	1,14, 15, 20, 21 (101 ha) (>150 cm) (Very deep, red clayey soils)	Kebbepura: 1,2,3,4,5,36,37,38,39,40,41, 42,52,53,54,55,67,68,231,235, 236,245,246,248,249,259,260, 261,262,263,267,268,275,276, 277,280,281,282,288,289,292, 293,298,299,300,301,303,304, 305,306,322	Maize, Sorghum, Cotton, Sunflower, Redgram, Sugarcane **Multiple crop rotation:** Redgram+Maize Redgram+Groundnut Pulses+Ragi Pulses+Sorghum	Turmeric, Banana, Lime, Tomato, Beans, Bhendi	**Perennial components:** Mango, Sapota, Lime **Flower crops:** Marigold, Chrysanthemum **Annual vegetables:** Chillies, Bhendi	Drip irrigation, Mulching, crop suitable conservation practices
LMU 2	2 (12 ha) (>150 cm) (Very deep, lowland clay soils)	Hundipura: 7,8,9 Kebbepura: 258,279,297	Cotton, Sorghum, Sunflower, Redgram, Sugarcane **Multiple crop rotation:** Reg gram+Fodder Sorghum Pulses+ Sorghum	Beetroot, Banana, Lime, Tomato, Beans, Bhendi	**Flower crops:** Marigold, Chrysanthemum **Perennial components:** Custard apple, Amla, Lime **Annual vegetables:** Chillies, Bhendi	Drip Irrigation, Mulching, crop suitable conservation practices

LMU 3	23 (34 ha) (75-100 cm) Moderately deep, gravelly red clay soils	Hundipura: 4,43,44,45,51,52,53,54,202, 203,204,205,220,221,222, 223 Kebbepura: 234	Maize, Sorghum, Cotton, Ragi, Sunflower Pulses+Sorghum	Fieldbean, Tomato, Beetroot, Onion, Banana, Turmeric	**Perennial components:** Sapota, Guava **Flower crops:** Marigold, Chrysanthemum **Annual vegetables:** Chillies, Bhendi	Drip irrigation, Mulching, Crop suitable conservation practices
LMU 4	3, 4, 5, 16, 17, 18, 19 (106 ha) (50-75 cm) Moderately shallow, red clay soils	Hundipura: 26,27,29,47,48,49 Kebbepura: 12,16,17,18,19,20,21,22,30, 31,32,69,70,71,72,73,76,79, 80,81,82,226,233,237,238, 239,255,256,257,266,269, 270,271,272,273,274,278, 283,284,285,286,302	Ragi, Groundnut, Maize, Sorghum, Cotton, Horsegram Pulses+Sorghum	Fieldbean, Tomato, Beetroot, Onion, Banana	Custard apple, Ber, Aonla **Vegetables:** Clusterbean, Bhendi, Beans **Flower crops:** Marigold, Chrysanthemum, Gillardia	Drip irrigation, Mulching, Crop suitable conservation practices
LMU 5	24 (18 ha) (50-75 cm) Moderately shallow, gravelly red loam soils	Kebbepura: 56,57,62,63,64,65,66	Groundnut, Ragi, Horsegram	Custard apple, Amla	Custard apple, Amla, Drumstick, Fig	Drip irrigation, Mulching, Crop suitable conservation practices
LMU 6	6, 7, 8, 11, 12, 13 (70 ha) (25-50 cm) Shallow, red clay soils	Hundipura: 11,12,13,14,15,18,19,20,21, 25,28,42,50,246 Kebbepura: 33,34,35,44,45,225,240,241, 242,243,244,250,251,252, 253,264,265,294	Groundnut, Ragi, Horsegram	Custard apple, Amla	Custard apple, Amla,	Drip irrigation, Mulching, Crop suitable conservation practices

LMU 7	9, 26 (24 ha) (25-50 cm) Shallow, gravelly red clay soils (Marginal lands)	Hundipura: 216,238,239,240, 241 Kebbepura: 74,75,77	Horsegram, Simaruba, Agave, Glyricidia	Custard apple, Amla	Custard apple, Ber	Drip irrigation, Mulching, Crop suitable conservation practices
LMU 8	10, 22, 25, 27, 28 (95 ha) (25-100 cm) Shallow to moderately deep, gravelly red clay soils of mounds slopes	Hundipura: 55,56,206,207,208,217,218, 219,237, 242,244 Kebbepura: 83,89	**Silviculture:** Acacia auriculiformis, Glyricidia, Agave, simaruba, Cassia sp. **Grasses:** Styloxanthus hamata, Styloxanthus Scabra, Khus grass.	Custard apple, Amla	Custard apple, Amla	Drip irrigation, Mulching, Crop suitable conservation practices

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 characteristics 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 unfavourable conditions occur

Characteristics of Chilkadabetta-1 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of HDR (89 ha), HPR (79 ha), SPR (69 ha), KNG (56 ha), ARK (35 ha), KDH (35 ha), HGH (31 ha), DRH (27 ha), MGH (27 ha) and BMB (12 ha).
- As per land capability classification, nearly 77 per cent area falls under arable land category (Class II, III and IV). The major limitations identified in the arable lands were soil wetness and erosion.
- On the basis of soil reaction, maximum area of about 128 ha (27%) is moderately alkaline (pH 7.8-8.4), about 86 ha (18%) is slightly alkaline (pH 7.3-7.8) and about 66 ha (14%) is strongly alkaline (pH 8.4-9.0). An area of about 112 ha (24%) is neutral (pH 6.5-7.3) and a minor area of about 24 ha (5%) under slightly acid (pH 6-6.5) followed by moderately acid (pH 5.5-6.0) reaction covering an area of about 43 ha (9%).

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 (Azospirullum, 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 – 5kg/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, (Azospirullum, 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.

Soil Degradation

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 476 ha area in the microwatershed, a major area of 239 ha is suffering from moderate and severe erosion. These areas need immediate soil and water conservation and, other land development and land husbandry practices for restoring soil health. Major area of 221 ha is relatively a stable terrain with slight erosion.

Dissemination of 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 and Interventions needed

Net planning in IWMP is focusing on preparation of Soil and Water Conservation Plans for each plot or farm.

1. Productivity enhancement measures/ interventions for existing crops/livestock/other farm enterprises.
2. Diversification of farming mainly with perennial horticultural crops and livestock.
3. 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 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, raddish, 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, wetness and soil are the major constraints in the microwatershed.
- **Organic Carbon:** The OC content is medium (0.5-0.75%) in about 124 ha (26%) area, low (<0.5%) in about 330 ha (69%) and high (>0.75%) in 6 ha (1%) area. 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 65 ha area where OC is low to medium. 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 292 ha (61%) the available phosphorus is low (<23 kg/ha) and 167 ha (35%) area medium (23-57 kg/ha) in available phosphorus. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is medium in 187 ha (39%) area of the microwatershed and high in 273 ha (57%). Hence, in all these plots where available potassium is medium, an additional 25 % potassium may be applied for all crops.

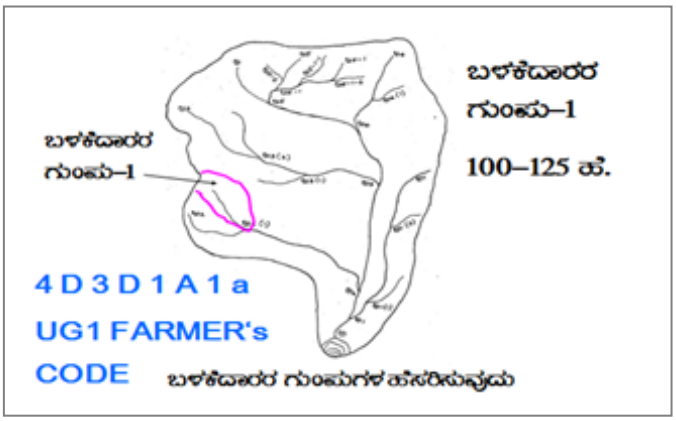
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. It is low in major area of about 457 ha (96%) of the microwatershed and medium in very small area of about 3 ha (<1%). These areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.
- **Available iron:** It is deficient in an area of 194 ha (41%) 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 266 ha (56 %) area in the microwatershed.
- **Available Zinc:** It is deficient in the entire area of the microwatershed. Application of zinc sulphate @25kg/ha is to be applied in those area where available zinc is deficient,
- **Soil alkalinity:** The microwatershed has 214 ha area where the soils are slightly to moderatly 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.

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Chilkadabetta-1 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
- Soil gravelliness
- Available water capacity
- Soil slope
- Soil erosion
- Land capability
- Present land use and land cover
- Crop suitability maps
- Rainfall map
- 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.

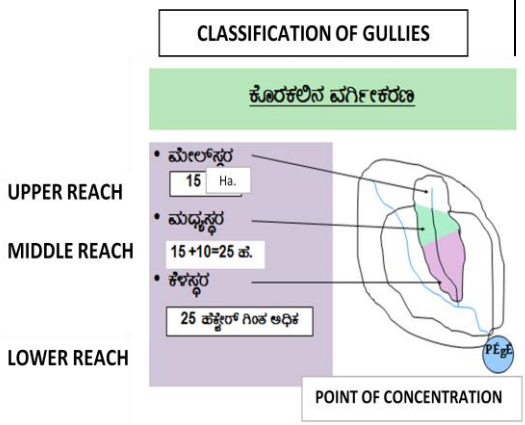
- Naming of user groups and farmers
- Identification of arable and non arable lands
- Identification of drainage lines and gullies
- Identification of non treatable areas
- Identification of priority areas in the arable lands
- Treatment plan for arable lands
- Location of water harvesting and recharge 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		USER GROUP-1
• 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)	

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 Hydrometer.

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

Slope per centage	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, b=loamy sand, g_0 = <15% gravel). The recommended Sections for different soils are given below.

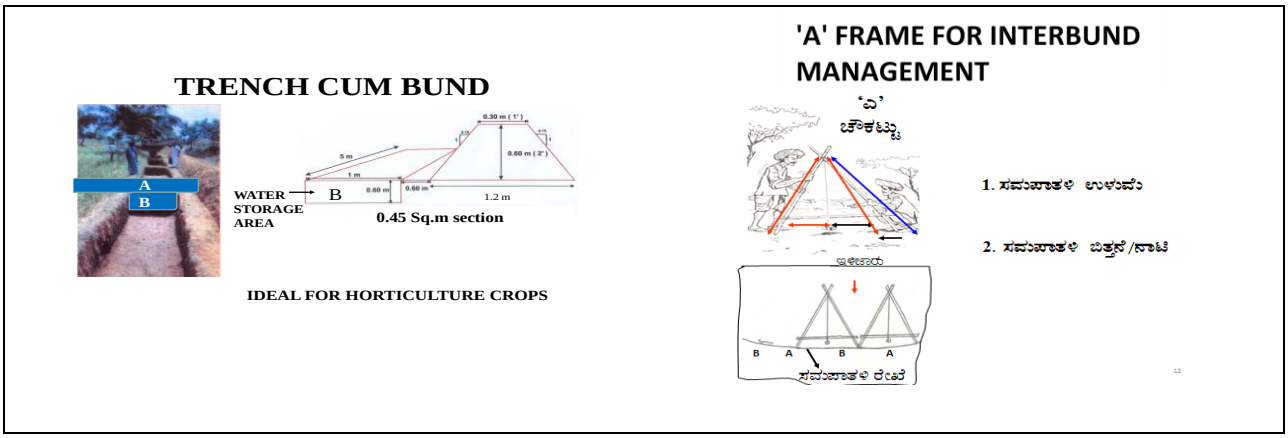
Recommended bund section

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 soil	
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. Water ways

a) Existing water ways are marked on the cadastral map (1:10000 scale). Their dimensions have to be recorded.
b) Considering the Contour plan of the MWS, additional water ways/ modernization of the existing ones can be thought of.
c) The design details are given in the Manual.

C. Farm ponds

Water ways and catchment will give an indication on the size of the 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 into 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/ concerned authorities, Contour Trench, Staggered Trench, Crescent Bund, Boulder Bund or Pebble Bunds 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 drainge 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 Levelling Survey using Dumpy Level / Total Station has to be carried out to arrive at 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 earthen checks in the natural water course. Location and design details are 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 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 / Strngthening
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. An area of about 351 ha (74%) requires trench cum bunding and an area of about 95 ha (20%) requires terracing.

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.

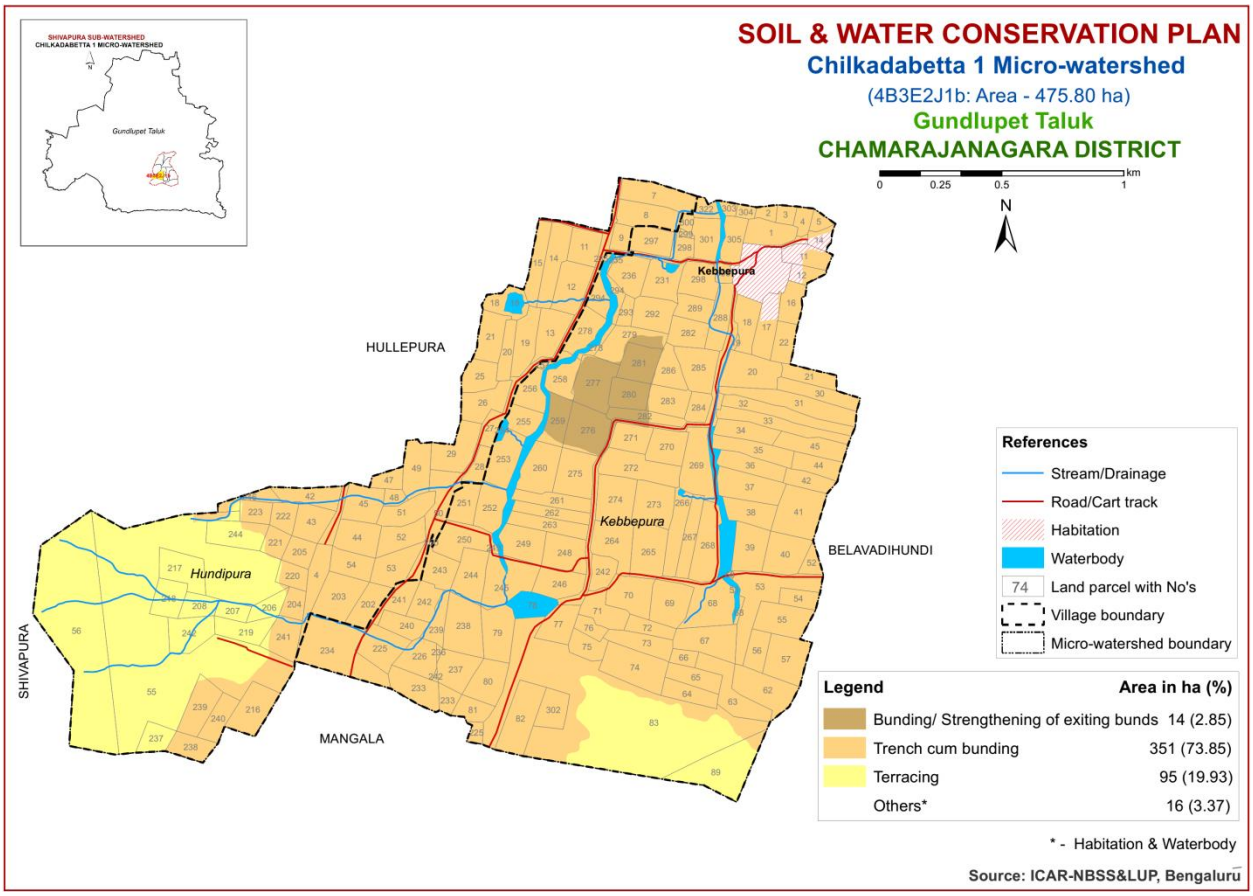


Fig. 9.1 Soil and Water Conservation Plan map of Chilkadabetta-1 Microwatershed

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 methods of planting these trees are 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 be 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 and temperature are listed below; water logged areas are recommended to be planted with species like Neral (*Sizyziumcumini*) and Bamboos. 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			Temp (°C)	Rainfall (mm)
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	*Santalum 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

Chilkadabetta 1 Microwatershed

Soil Phase Information

Village	Survey Number	Total Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	LCC	Conservation Plan
Hundipura	4	2.06	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIIes	TCB
Hundipura	7	2.68	BMBiB1g1	LMU-2	Very deep (>150 cm)	Sandy clay	Gravelly (15-35%)	Very High (>200 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum+Red gram (Sg+Rg)	Not Available	IIw	TCB
Hundipura	9	0.82	BMBiB1g1	LMU-2	Very deep (>150 cm)	Sandy clay	Gravelly (15-35%)	Very High (>200 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIw	TCB
Hundipura	11	1.73	HDRiB1	LMU-6	Shallow (25-50 cm)	Sandy clay	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Hundipura	12	2.58	HDRiB1	LMU-6	Shallow (25-50 cm)	Sandy clay	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cotton (Ct)	Not Available	IIIs	TCB
Hundipura	13	2.19	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Tomato (Tm)	Not Available	IIIs	TCB
Hundipura	14	2.57	HDRiB1	LMU-6	Shallow (25-50 cm)	Sandy clay	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Hundipura	15	1.97	HDRiB1	LMU-6	Shallow (25-50 cm)	Sandy clay	Non gravelly (<15%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cotton (Ct)	Not Available	IIIs	TCB
Hundipura	18	1.24	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cotton (Ct)	Not Available	IIIs	TCB
Hundipura	18	0.54	Waterbody	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Hundipura	19	2.17	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Red gram (Rg)	Not Available	IIIs	TCB
Hundipura	20	1.29	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cultiveted Land (Cl)	Not Available	IIIs	TCB
Hundipura	21	2.1	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Coconut (CN)	Not Available	IIIs	TCB
Hundipura	25	1.71	HDRhB1g1	LMU-6	Shallow (25-50 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cotton (Ct)	Not Available	IIIs	TCB
Hundipura	26	2.21	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	Not Available	IIes	TCB
Hundipura	27	1.04	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	1 Bore Well not working	IIes	TCB
Hundipura	28	1.01	HDRcB1g1	LMU-6	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Cultiveted Land (Cl)	Not Available	IIIs	TCB
Hundipura	29	2.71	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIes	TCB
Hundipura	42	1.89	HDRbB2g2	LMU-6	Shallow (25-50 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB

Village	Survey Number	Total Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	LCC	Conservation Plan
Hundipura	43	1.93	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Field Beans (Fb)	Not Available	IIIes	TCB
Hundipura	44	2.3	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut (Gn)	Not Available	IIIes	TCB
Hundipura	45	2.24	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Hundipura	47	0.92	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	Not Available	IIes	TCB
Hundipura	48	0.58	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIes	TCB
Hundipura	49	2.4	DRHcB2g2	LMU-4	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	Not Available	IIes	TCB
Hundipura	50	3.18	HDRcB1g1	LMU-6	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	1 For. pond,1 B-Well not wor.	IIIs	TCB
Hundipura	51	2	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	1 Bore Well not working	IIIes	TCB
Hundipura	52	1.98	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Field Beans (Fb)	1 Bore Well	IIIes	TCB
Hundipura	53	2.27	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIIes	TCB
Hundipura	54	1.75	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Hundipura	55	40.79	SPRcD3g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Severe	Cotton (Ct)	1 Chek Dam	VIes	Terracing
Hundipura	56	19.59	SPRcD3g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Severe	Forest	Not Available	VIes	Terracing
Hundipura	202	1.78	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Hundipura	203	2.97	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Red gram (Rg)	Not Available	IIIes	TCB
Hundipura	204	1.03	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIIes	TCB
Hundipura	205	1.26	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut (Gn)	Not Available	IIIes	TCB
Hundipura	206	1.15	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Cotton (Ct)	Not Available	VIes	Terracing
Hundipura	207	0.95	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Horsegram (Hg)	Not Available	VIes	Terracing

Village	Survey Number	Total Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	LCC	Conservation Plan
Hundipura	208	1.31	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Horsegram (Hg)	Not Available	VIes	Terracing
Hundipura	216	2.69	HDRcC2g2	LMU-7	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Groundnut+Fallow land (Gn+Fl)	Not Available	IVes	TCB
Hundipura	217	2.46	MGHhD3g2	LMU-8	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Severe	Horsegram (Hg)	Not Available	VIes	Terracing
Hundipura	218	1.82	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Fallow Land (Fl)	1 Chek Dam	VIes	Terracing
Hundipura	219	1.94	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Fallow Land (Fl)	Not Available	VIes	Terracing
Hundipura	220	1.16	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut (Gn)	Not Available	IIIes	TCB
Hundipura	221	1.08	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Field Beans (Fb)	Not Available	IIIes	TCB
Hundipura	222	1.18	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Field Beans (Fb)	Not Available	IIIes	TCB
Hundipura	223	1.16	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Hundipura	237	1.36	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Horsegram (Hg)	Not Available	VIes	Terracing
Hundipura	238	1.57	HDRcC2g2	LMU-7	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Horsegram (Hg)	Not Available	IVes	TCB
Hundipura	239	2.38	HDRcC2g2	LMU-7	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Horsegram (Hg)	Not Available	IVes	TCB
Hundipura	240	1.6	HDRcC2g2	LMU-7	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Groundnut (Gn)	Not Available	IVes	TCB
Hundipura	241	2.06	HDRcC2g2	LMU-7	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Gently sloping (3-5%)	Moderate	Groundnut (Gn)	Not Available	IVes	TCB
Hundipura	242	2.36	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Cotton (Ct)	Not Available	VIes	Terracing
Hundipura	244	2.5	SPRcD2g2	LMU-8	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Moderately sloping (5-10%)	Moderate	Cultiveted Land (Cl)	Not Available	VIes	Terracing
Hundipura	246	1.05	HDRbB2g2	LMU-6	Shallow (25-50 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Kebbepura	225	2.6	HDRcB1g2	LMU-6	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut (Gn)	Not Available	IIIs	TCB
Kebbepura	226	2.02	HPRiB1g1	LMU-4	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut (Gn)	Not Available	IIs	TCB

Village	Survey Number	Total Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	LCC	Conservation Plan
Kebbepura	233	2.32	HPRiB1g1	LMU-4	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut (Gn)	Not Available	IIs	TCB
Kebbepura	234	5.95	KNGcB2g2	LMU-3	Moderately deep (75-100 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram (Hg)	Not Available	IIIes	TCB
Kebbepura	240	1.49	HDRcB1g2	LMU-6	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Kebbepura	241	1.59	HDRcB1g2	LMU-6	Shallow (25-50 cm)	Sandy loam	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Slight	Sorghum (Sg)	Not Available	IIIs	TCB
Kebbepura	242	0.08	HPRiB1g1	LMU-4	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut (Gn)	Not Available	IIs	TCB
Kebbepura	250	0.04	HDRiB2g2	LMU-6	Shallow (25-50 cm)	Sandy clay	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum (Sg)	Not Available	IIIes	TCB

Appendix II

Chilkadabetta 1 Microwatershed

Soil fertility Information

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Hundipura	4	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)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	7	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	9	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	11	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	12	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)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	13	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	14	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	15	Strongly alkaline (pH 8.4 - 9.0)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	18	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Medium (0.5 - 0.75 %)	Low (<23 kg/ha)	High (> 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)
Hundipura	18	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Hundipura	19	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	20	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	21	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	25	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	26	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	27	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	28	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	29	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	42	Neutral (pH 6.5 - 7.3)	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)
Hundipura	43	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)
Hundipura	44	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	45	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)

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Hundipura	47	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)
Hundipura	48	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	49	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	50	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	51	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	52	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	53	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	54	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	55	Moderately acid (pH 5.5 - 6.0)	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)
Hundipura	56	Moderately acid (pH 5.5 - 6.0)	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)
Hundipura	202	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	203	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Hundipura	204	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)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	205	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)
Hundipura	206	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)
Hundipura	207	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)
Hundipura	208	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)
Hundipura	216	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)
Hundipura	217	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)
Hundipura	218	Moderately acid (pH 5.5 - 6.0)	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)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	219	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)
Hundipura	220	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)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	221	Neutral (pH 6.5 - 7.3)	Non saline (<2 dsm)	Low (< 0.5 %)	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)

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Hundipura	222	Neutral (pH 6.5 - 7.3)	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)
Hundipura	223	Neutral (pH 6.5 - 7.3)	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)
Hundipura	237	Moderately acid (pH 5.5 - 6.0)	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)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (<0.6 ppm)
Hundipura	238	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)
Hundipura	239	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)
Hundipura	240	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)
Hundipura	241	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)
Hundipura	242	Slightly acid (pH 6.0 - 6.5)	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)
Hundipura	244	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)
Hundipura	246	Neutral (pH 6.5 - 7.3)	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)
Kebbepura	225	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	226	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	233	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	234	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	240	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	241	Slightly alkaline (pH 7.3 - 7.8)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)
Kebbepura	242	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)	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)
Kebbepura	250	Moderately alkaline (pH 7.8 - 8.4)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 - 57 kg/ha)	High (> 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)

Appendix III

Chilkadabetta 1 Microwatershed

Soil Suitability Information

Village	Survey No.	Sorgham	Maize	Red gram	Groundnut	Sunflower	Cotton	Onion	Turmeric	Beetroot	Potato	Beans	Horsegram	Field-bean	Guava	Mango	Sapota	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Banana	Marigold	Chrysanthemum
Hundipura	4	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	7	S1	S3wt	S2w	S3wt	S2w	S1	S2wt	S3wt	S3wt	S3wt	S2wt	S2w	S2w	S3wt	S3wt	S3wt	S3wt	S2wt	S2w	S2w	Nwt	S2w	S2w	S2wt	S2wt	S2wt	S2wt
Hundipura	9	S1	S3wt	S2w	S3wt	S2w	S1	S2wt	S3wt	S3wt	S3wt	S2wt	S2w	S2w	S3wt	S3wt	S3wt	S3wt	S2wt	S2w	S2w	Nwt	S2w	S2w	S2wt	S2wt	S2wt	S2wt
Hundipura	11	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	12	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	13	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	14	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	15	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	18	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	18	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	Others	Others
Hundipura	19	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	20	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	21	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	25	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3rg	S3rg
Hundipura	26	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	27	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	28	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3r	S3r
Hundipura	29	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	42	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3gr	S3rg
Hundipura	43	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	44	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	45	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g

Village	Survey No.	Sorgham	Maize	Red gram	Ground nut	Sunflower	Cotton	Onion	Turmeric	Beet root	Potato	Beans	Horsegram	Field-bean	Guava	Mango	Sapota	Jack fruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Banana	Marigold	Chrysanthemum
Hundipura	47	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	48	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	49	S2gr	S2gr	S3gr	S2gr	S3gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S2gr	S3rg	Nrg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S2rg	S2rg	S3rg	S3gr	S2gr	S2gr
Hundipura	50	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	S3r	S3r	Nr	Nr	S3r	S3r
Hundipura	51	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	52	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	53	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	54	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	55	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	56	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	202	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	203	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	204	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	205	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	206	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	207	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	208	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	216	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nr	S3rg	S3rg
Hundipura	217	S2gl	S2gl	S2gl	S2gl	S3gl	S2gl	S2gl	S2gl	S2gl	S2gl	S2gl	S2gl	S2gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S2gl	S2gl
Hundipura	218	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	219	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	220	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	221	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	222	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g

Village	Survey No.	Sorgham	Maize	Red gram	Groundnut	Sunflower	Cotton	Onion	Turmeric	Beetroot	Potato	Beans	Horsegram	Field-bean	Guava	Mango	Sapota	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Banana	Marigold	Chrysanthemum
Hundipura	223	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Hundipura	237	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	238	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nr	S3rg	S3rg
Hundipura	239	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nr	S3rg	S3rg
Hundipura	240	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nr	S3rg	S3rg
Hundipura	241	S3r	S3r	Nr	S3r	Nr	S3r	S3r	S3rg	S3r	S3rg	S3r	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nr	S3rg	S3rg
Hundipura	242	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	244	S3gl	S3gl	Ngl	S3gl	Ngl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	S3gl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	Ngl	S3gl	S3gl
Hundipura	246	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3gr	S3rg
Kebbepura	225	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3rg	S3rg
Kebbepura	226	S2r	S2r	S3r	S2rt	S3r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S3r	Nr	S3r	S3r	S3r	S3r	S3r	S3r	S2r	S2r	S3r	S3r	S2r	S2r
Kebbepura	233	S2r	S2r	S3r	S2rt	S3r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S3r	Nr	S3r	S3r	S3r	S3r	S3r	S3r	S2r	S2r	S3r	S3r	S2r	S2r
Kebbepura	234	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2g	S2gr	S3gr	S2gr	S3rg	S3rg	S3rg	S3rg	S2gr	S2rg	S2rg	S3rg	S2g	S2g	S2g
Kebbepura	240	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3rg	S3rg
Kebbepura	241	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3rg	S3rg
Kebbepura	242	S2r	S2r	S3r	S2rt	S3r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S2r	S3r	Nr	S3r	S3r	S3r	S3r	S3r	S3r	S2r	S2r	S3r	S3r	S2r	S2r
Kebbepura	250	S3gr	S3gr	Nrg	S3r	Nrg	S3gr	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	S3rg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	Nrg	S3rg	S3rg	Nrg	Nrg	S3rg	S3rg

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**: Chilakadabetta-1 Microwatershed (Shivapura sub-watershed, Gundlupet taluk, Chamarajanagar district) is located in between $11^0 41'$ – $11^0 42'$ North latitudes and $76^0 40'$ – $76^0 42'$ East longitudes, covering an area of about 476 ha, bounded by Hullipura, Belavadihundi, Mangala and Shivapura villages with length of growing period (LGP) 120-150 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 Chilakadabetta-1 micro-watershed (Shivapura sub-watershed, Gundlupet taluk and Chamarajanagar district) are presented here.*

Social Indicators

- *Male and female ratio is 61.2 to 38.8 per cent to the total sample population.*
- *Younger age 18 to 50 years group of population is around 55.1 per cent to the total population.*
- *Literacy population is around 71.4 per cent.*
- *Social groups belong to scheduled caste (SC) is around 30 per cent.*
- *Liquefied petroleum gas (LPG) is the source of energy for a cooking among 90 per cent.*
- *About 60.0 per cent of households have a yashaswini health card.*
- *Around 30.0 percent of farm households are having MGNREGA card for rural employment.*
- *Dependence on ration cards for food grains through public distribution system is around 70 per cent.*
- *Swach bharath program providing closed toilet facilities around 80 per cent.*
- *Institutional participation is only 8.2 per cent.*
- *Rural migration to urban centre for employment is prevalent among 10 per cent of sample households.*
- *Women participation in decisions making are around 30 per cent of sample households.*

Economic Indicators

- *The average land holding is 0.8 ha indicates that majority of farm households are belong to marginal farmers. The dry land account for 72.1 % and irrigated land is 27.9 % of total cultivated land of the sample farmers.*
- *Agriculture is the main occupation among 79.6 per cent and agriculture is the main agriculture labour is the subsidiary occupation around 10.2 per cent of sample households.*
- *The average value of domestic assets is around Rs 93314 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets is around Rs 74219 per household, about 50.0 per cent of sample farmers are having sprayer.*
- *The average value of livestock is around Rs 25750 per household; about 58.3 per cent of household are having livestock.*
- *The average per capita food consumption is around 588.3 grams (1253.5 kilo calories) against national institute of nutrition (NIN) recommendation at 827 gram. Around 80.0 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs. 36529 per household. All sample farm households are below poverty line.*
- *The per capita average monthly expenditure is around Rs.1401.*

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. 900 per ha/year. The total cost of annual soil nutrients is around Rs. 505064 per year for the total area of 475.8 ha.*
- *The average value of ecosystem service for food grain production is around Rs. 16231/ ha/year. Per hectare food grain production services is maximum in tomato (Rs. 43260) followed by beans (Rs. 18914), maize (Rs. 16914), sorghum (Rs. 16401), horse gram (Rs. 7824), sunflower (Rs. 5818) and groundnut (Rs. 4485).*
- *The average value of ecosystem service for fodder production is around Rs. 449/ ha/year. Per hectare fodder production services is maximum in groundnut (Rs. 675) followed by horse gram (Rs. 472), sunflower (Rs. 329) and sorghum (Rs. 318).*
- *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 beans (Rs. 538092) followed by tomato (Rs. 49965), sorghum (Rs. 48561), maize (Rs. 36220), sunflower (Rs. 30947), horse gram (Rs. 20349) and groundnut (Rs. 20287).*

Economic Land Evaluation

- *The major cropping pattern is horse gram (29.9 %) followed by sorghum (19.4 %) groundnut (18.1 %), sunflower (16.7 %), maize (8.7 %) and beans (3.6 %).*
- *Chilakadabetta-1 Micro watershed, major soils are soil Hindupur (HDR) series is having shallow soil depth cover around 6.5 % of area. On this soil farmers are presently growing sunflower (50.0 %) and sorghum (50.0%). Hullipura (HPR) are also having moderately shallow soil depth cover around 16.6 % of area, the crops are beans (5.5 %), horse gram(44.5%), sorghum(44.5%) and tomato was 5.5 % each. Shivapura (SPR) soil series having shallow soil depth cover around 14.6 % of areas, crops are groundnut (50.0 %) and horse gram (50.0 %). Kannigala (KNG) soil series are having moderately deep soil depth cover around 11.7 % per cent of area. The major crops grown are groundnut (31.7%) and horse gram (68.3%). Annurkeri (ARK) soil series are having very deep soil depth covers around 7.4 % of area, the major crop grown is beans (13.1%), groundnut (36.9%), sorghum (36.9%) and tomato (13.1%). Kalligaudanahalli (KDH) and Beemanabeedu (BMB) soil series having very deep soil depth cover 7.3 % and 2.5 % of areas respectively; crops are maize, sunflower and horse gram.*
- *The total cost of cultivation and benefit cost ratio (BCR) in study area for groundnut ranges between Rs.18746/ha in SPR soil (with BCR of 1.0) and Rs.30525/ha in KNG soil (with BCR of 1.04).*
- *In horse gram the cost of cultivation range between Rs 6371/ha in SPR soil (with of 2.62) and Rs. 28728/ha in BMB soil (with BCR of 1.57).*
- *In sorghum the cost of cultivation range between Rs. 11171/ha in ARK soil (with BCR of 2.53) and Rs. 18249/ha in HDR soil (with BCR of 1.71).*
- *In tomato the cost of cultivation range between is Rs.118609 /ha in ARK soil (with BCR of 1.25) and Rs331873 in HPR soil (with BCR of 1.28).*
- *In sunflower the cost of cultivation range between is Rs 17602/ha in HDR soil (with BCR of 1.94) and Rs. 33353/ha in BMB soil (with BCR of 1.03).*
- *In beans the cost of cultivation range between is Rs 112311/ha in ARK soil (with BCR of 1.23) and Rs. 126088/ha in HPR soil (with BCR of 1.02).*
- *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 on deeper soils 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 groundnut (56.6 to 58.7 %), horse gram (24.1 to 45.8 %), sorghum (38.2 to 53.1 %), sunflower (31.7 to 39.3 %) and tomato (44.9 to 64 %).*

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 3

METHODOLOGY

Study area

Chilakadabetta-1 Microwatershed is located in southern dry zone of Karnataka (Figure 1). It's has a total geographical area of 1.56 M ha with 0.74 M ha under cultivation of which 0.22 M ha is irrigated. The mean elevation ranges from 450 to 900 m MSL; most part of the zone is situated at 800-900m. The major soils are red loams with pockets of black soils in Kollegal, Yalandur and T.N. Pura taluks of Mysore district. The average annual rainfall ranges from 670 to 890 mm, of which about 55 to 75 per cent is received during the kharif season. The major crops grown are rice, ragi, sugarcane, pulses and minor millets. It represents Agro Ecological Sub Region (AESR) 8.2 having LGP 120-150 days.

Chilakadabetta-1 Microwatershed (Shivapura sub-watershed, Gundlupet taluk, Chamarajanagar district) is located in between $11^0$41' – $11^0$42' North latitudes and $76^0$40' – $76^0$42' East longitudes, covering an area of about 476 ha, bounded by Hullipura, Belavadihundi, Mangala and Shivapura 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).

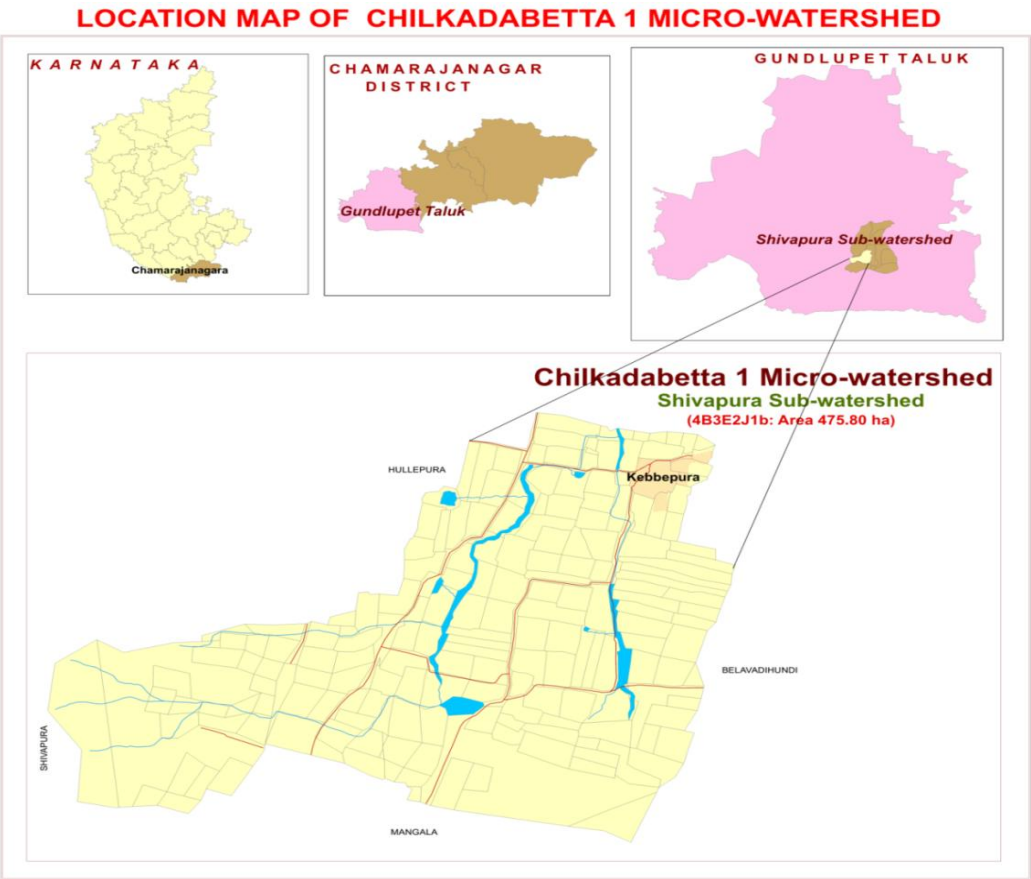

Figure 1: Location of study area

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 .

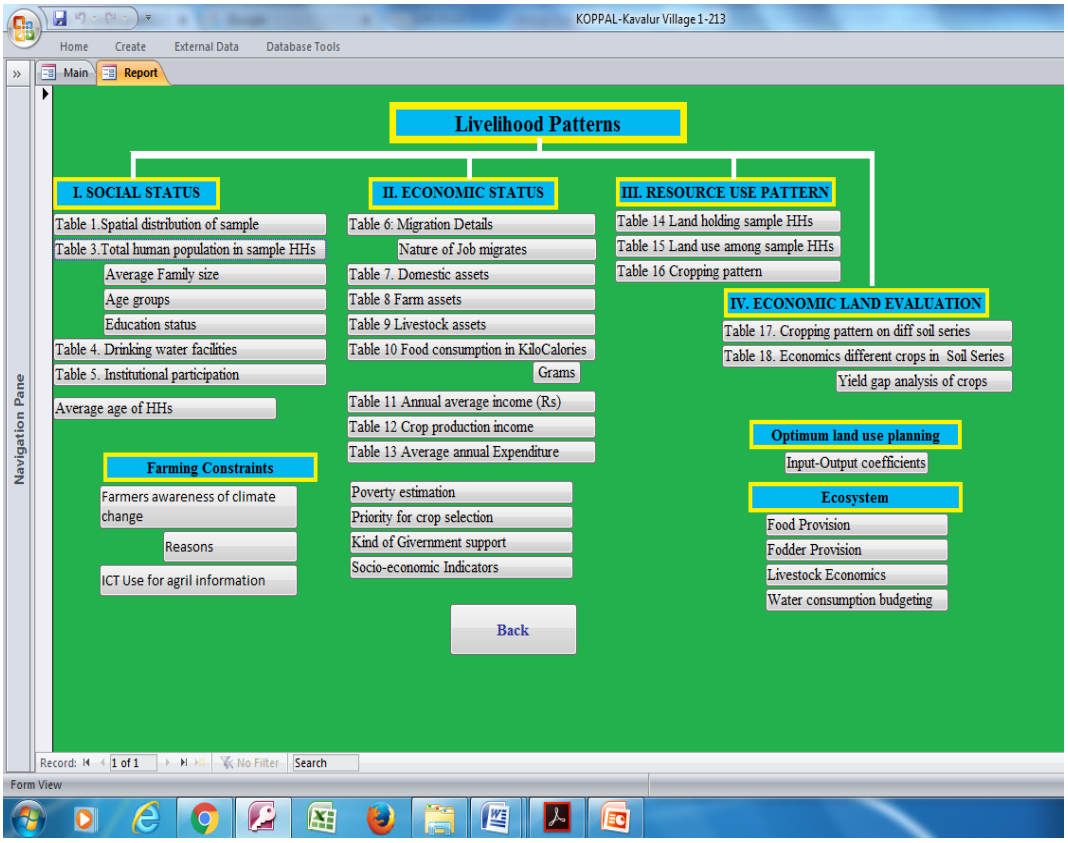

Figure 2: ALPES FRAMEWORK

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 49, out of which 61.2, per cent were males and 38.8, per cent females. Average family size of the households is 4.9. 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 30 to 50 years (34.7 %) followed by more than 50 years (26.5 %), 18 to 30 years (20.4 %) and 0 to18 years (18.3 %). 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 28.5 per cent of respondents were illiterate and 71.4 per cent literate (Table 1).

Table 1: Human population among sample households in Chilkadabetta 1 Microwatershed

Particulars	**Units**	**Value**
Total human population in sample HHs	Number	49
Male	% to total Population	61.2
Female	% to total Population	38.8
Average family size	Number	4.9
Age group		
0 to 18 years	% to total Population	18.3
18 to 30 years	% to total Population	20.4
30 to 50 years	% to total Population	34.7
>50 years	% to total Population	26.5
Average age	Age in years	37.5
Education Status		
Illiterates	% to total Population	28.5
Literates	% to total Population	71.4
Primary School (<5 class)	% to total Population	20.5
Middle School (6- 8 class)	% to total Population	8.1
High School (9- 10 class)	% to total Population	6.1
Others	% to total Population	36.7

The ethnic groups among the sample farm households found to be 60.0 per cent belonging to general castes followed by 30.0 percent belonging to schedule casts (SC) and only 10.0 per cent of belonging to other backward castes (OBC) (Table 2 and Figure

3). About 90.0 per cent of sample households are using liquefied petroleum gas as source of fuel for cooking and only 10 percent of fire wood source. All the sample farmers are having electricity connection. About 60 per cent are sample households having health cards. About 30.0% are having MNREGA job cards for employment generation. About 70 per cent of farm households are having ration cards for taking food grains from public distribution system. About 80 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Chilkadabetta 1 Microwatershed

Particulars	**Units**	**Value**
Social groups		
SC	% of Households	30.0
OBC	% of Households	10.0
General	% of Households	60.0
Types of fuel use for cooking		
Fire wood	% of Households	10.0
Gas	% of Households	90.0
Energy supply for home		
Electricity	% of Households	100
Number of households having Health card		
Yes	% of Households	60.0
No	% of Households	40.0
MGNREGA Card		
Yes	% of Households	30.0
No	% of Households	70.0
Ration Card		
Yes	% of Households	70.0
No	% of Households	30.0
Households with toilet		
Yes	% of Households	80.0
No	% of Households	20.0
Drinking water facilities		
Tube well	% of Households	100.0

The data collected on the source of drinking water in the study area is presented in Table 2. All the sample respondents are having tube well source for water supply for domestic purpose.

Only 8.2 per cent of the farmers are participating in community based organizations (Table 3). Among them majority were participating in self help groups (SHG's) (2.2%) like Sri Dharmasthala Swasahaya Sangha, Stri Shakhti Sangha followed by credit co-operative societies (2.0 %), dairy co-operatives societies (2.0 %) and user group (2.0 %).

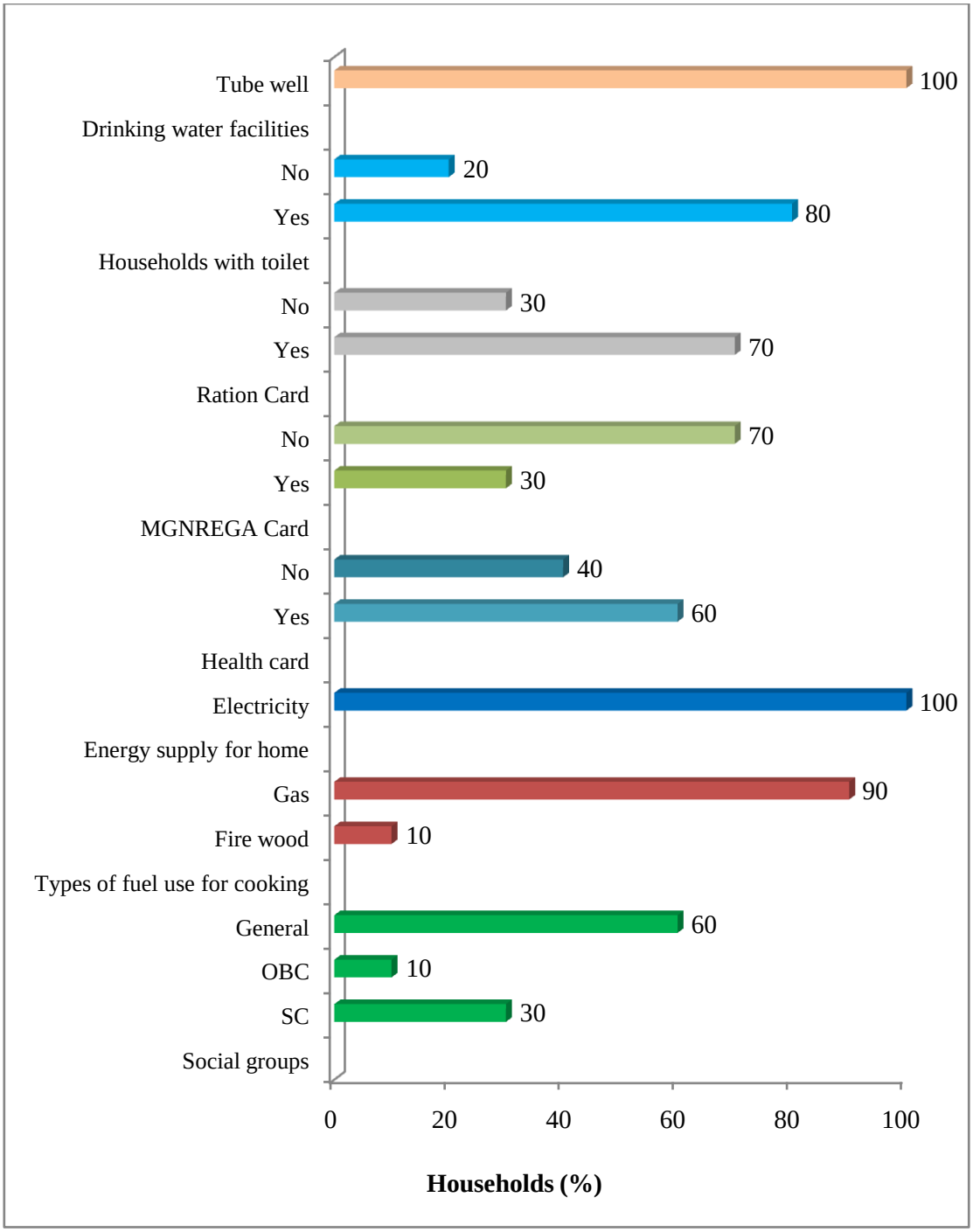

Figure 3: Basic needs of sample households in Chilkadabetta 1 Microwatershed

Table 3: Institutional participation among the sample population in Chilkadabetta 1 Microwatershed

Particulars	Units	Value
No. Of people participating	% to total	8.2
Co-operative Societies- Dairy	% to total	2.0
Co-operative Societies - credit	% to total	2.0
User groups	% to total	2.0
Self help groups (SHG's)	% to total	2.2
No. Of people not participating	% to total	91.8

The data on migration in Chilkadabetta 1 Microwatershed is given in Table 4. It indicated that around 10.0 per cent of samples households were migrated. The average distance travelled for seeking employment is 40 km.

Table 4: Migration details among the sample households in Chilkadabetta 1 micro-watershed

Particulars	**Value**
% of households showing migration	10.0
% of persons migrating	2.0
No. of months migrated in a year	12.0
Average Distance of migration(Km)	40.0
Nature of job (%)	
Education of the children	100.0

The occupational pattern (Table 5) among sample households shows that agriculture is the main occupation around 79.6 per cent of farmers followed by subsidiary occupations like agricultural labour (10.2 %), non agriculture labour (2.0 %) and non agriculture as main occupation households and as subsidiary occupations like government service and private service were 4.1 per cent each.

Table 5: Occupational pattern in sample population in Chilkadabetta 1 Microwatershed

Occupation		**% to total**
Main	**Subsidiary**	
Agriculture	Agriculture	79.6
	Agriculture Labour	10.2
	Non Agriculture Labour	2.0
Non Agriculture	Government service	4.1
	Private service	4.1
Family labour availability		**Man days/month**
Male		36.1
Female		22.2
Total		58.3

The important assets especially with reference to domestic assets were analyzed and are given in table 6 and figure 4. The important domestic assets possessed by all categories of farmers are mobile phones (100 %) followed by television (90 %), mixer/grinder (80 %), motorcycle (60 %), bicycle (50 %) and four wheeler (20 %). The average value of domestic assets is around Rs 93314 per households.

Table 6: Domestic assets among the sample households in Chilkadabetta 1 Microwatershed

Particulars	% of households	Average value in Rs
Bicycle	50.0	3600
Computer/laptop	30.0	32667
Dvd/Cvd	20.0	3500
Four Wheeler	20.0	650000
Mixer/grinder	80.0	2325
Mobile Phone	100.0	9130
Motor cycle	60.0	35333
Television	90.0	9956
Average value	93314	

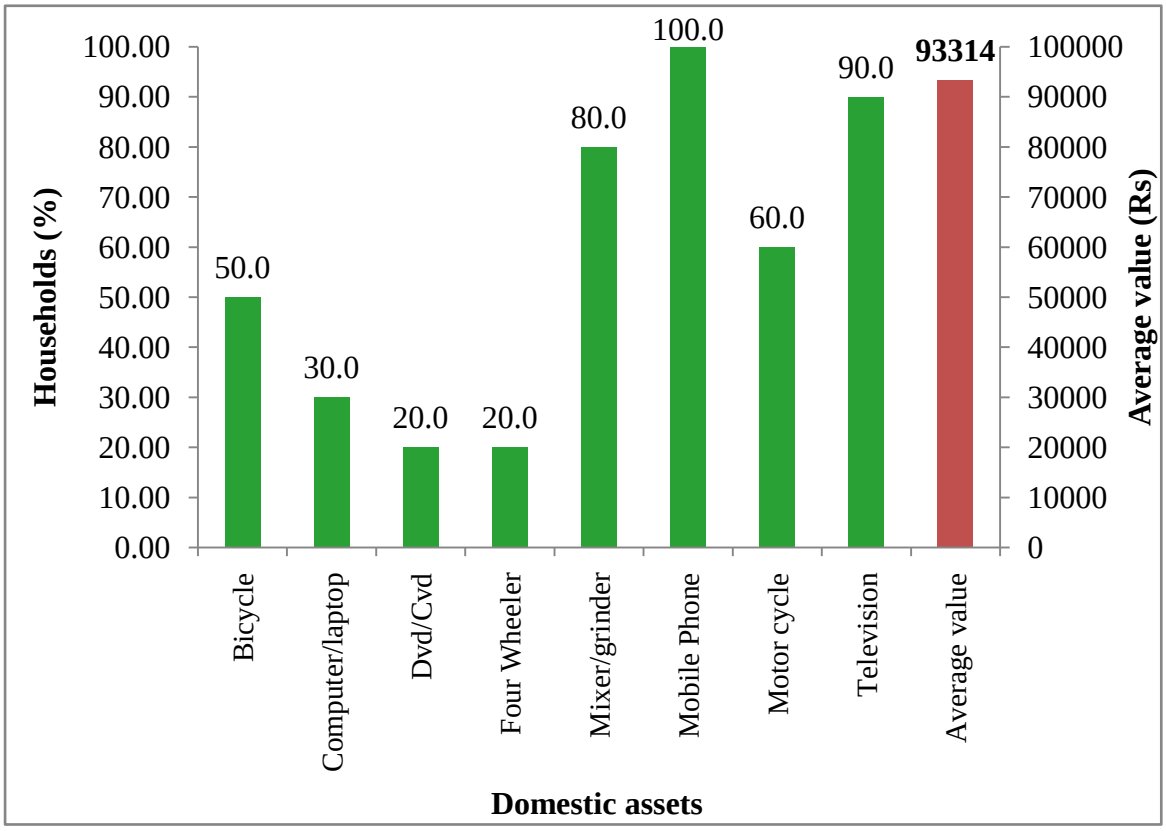

Figure 4: Domestic assets among the sample households in Chilkadabetta 1 Microwatershed

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 (50 %), weeder (20 %), plough (20 %), bullock cart (10 %), tractor (10 %) and earth remover (10 %) was found highest among the sample farmers. The average value of farm assets is around Rs 74219 per households (Table 7 and Figure 5).

Table 7: Farm assets among samples households in Chilkadabetta 1 Microwatershed

Particulars	% of households	Average value in Rs
Bullock cart	10.0	20000
Drip/sprinkler	30.0	5000
Earth Remover	10.0	14000
Plough	20.0	2100
Sprayer	50.0	3375
Tractor	10.0	475000
Weeder	20.0	60
Average Value	74219	

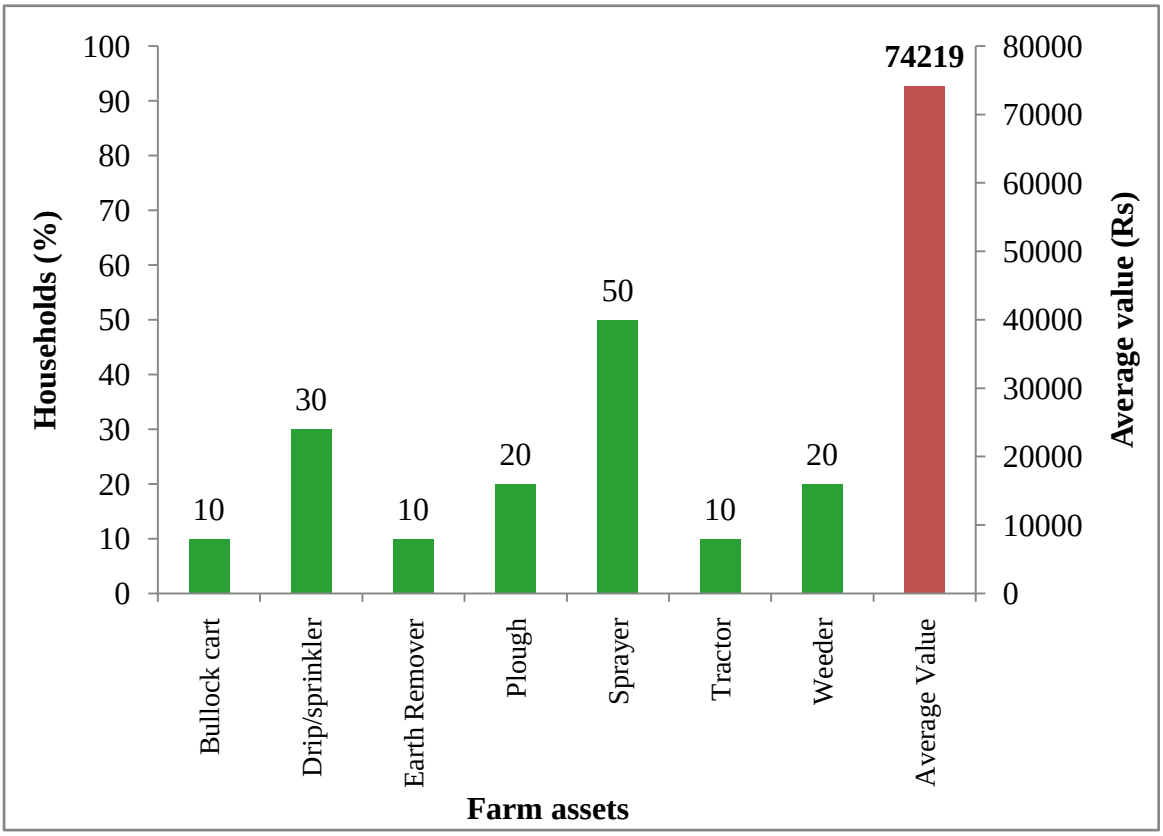

Figure 5: Farm assets among samples households in Chilkadabetta1Microwatershed

Table 8: Livestock assets among sample households in Chilkadabetta 1 micro-watershed

Particulars	% of livestock population	Average value in Rs
Crossbred Dry Cow	14.3	50000
Crossbred Milching Cow	28.6	40000
Goats	28.6	6000
Sheeps	28.5	7000
Average value	25750	

Livestock is an integral component of the conventional farming systems (Table 8 and Figure 6). The highest livestock population is crossbred milching cow were around 28.6 per cent followed by crossbred milching cow (28.6 %), crossbred dry cow (14.3 %), sheep's (28.5 %) and goats (28.6%). The average value of livestock was Rs. 25750 per household.

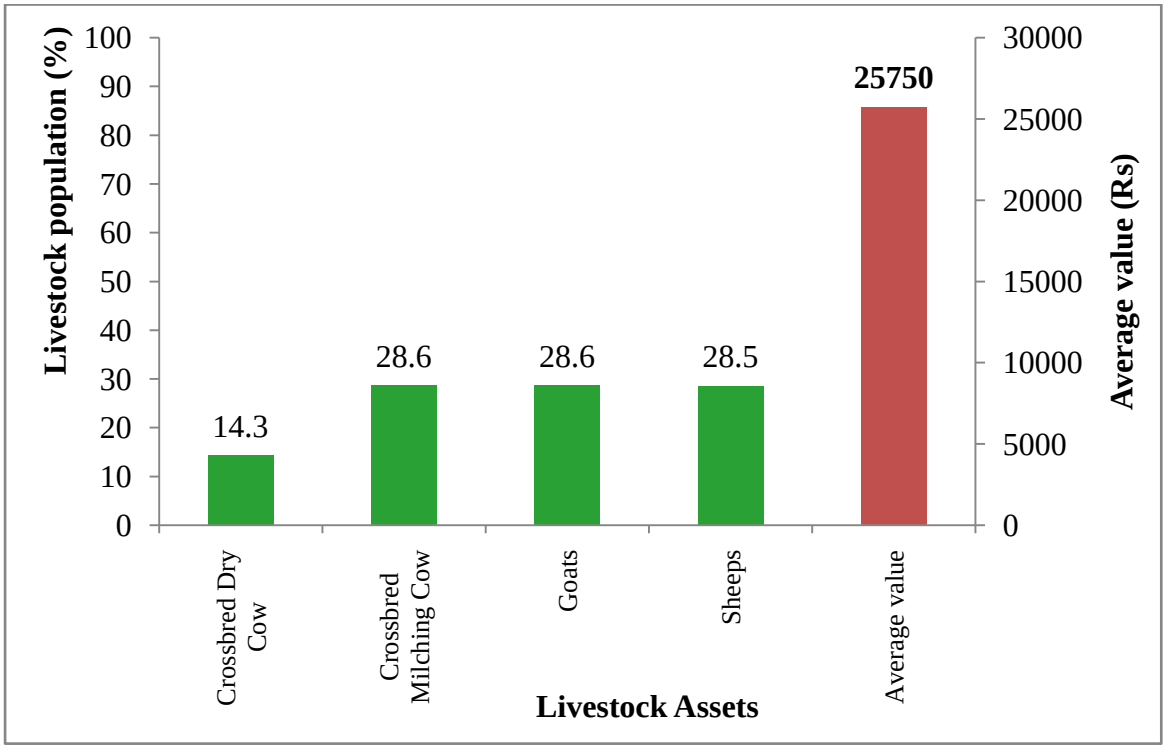

Figure 6: Livestock assets among sample households in Chilkadabetta 1 micro-watershed

Table 9: Milk produced and fodder availability of sample householdsinChilkadabetta 1 Microwatershed

Particulars	
Name of the Livestock	**Ltr./Lactation/animal**
Crossbred Milching Cow	1050
Fodder produces	**Fodder yield (kg/ha.)**
Horsegram	929
Groundnut	908
Maize	764
Sorghum	1631
Average fodder availability	1058
Livestock having households (%)	58.3
Livestock population (Numbers)	14

Average milk produced in sample households is 1050 litters/ annum. Among the farm households, sorghum, horse gram maize and groundnut are the main crops for domestic food and fodder for animals. About 1058.7 kg /ha of average fodder is available per season for the livestock feeding (Table 9).

A woman participation in decision making is in this micro-watershed is presented in Table 10. About 10 per cent of women participation in local organisation activates and 30 per cent of women taking decision in her family and agriculture related activities.

Table 10: Women empowerment of sample households in Chilkadabetta 1 Microwatershed **% of grand total**

Particulars	**Yes**	**No**
Women participation in local organization activities	10.0	90.0
Women elected as panchayat member	0.0	100.0
Women earning for her family requirement	0.0	100.0
Women taking decision in her family and agriculture related activities	30.0	70.0

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 11 and Figure 7. More quantity of cereals is consumed by sample farmers which accounted for 1253.5 kcal per person. The other important food items consumed was pulses 87.6 kcal followed by cooking oil 197.2 kcal, milk 893.7 kcal, vegetables 22.6 kcal, egg 85 kcal and meat 19.1 kcal. In the sampled households, farmers were consuming less (1253.5 kcal) than NIN- recommended food requirement (2250 kcal).

Table 11: Per capita daily consumption of food among the sample households in Chilkadabetta 1 Microwatershed

Particulars	**NIN recommendation (gram/ per day/ person)**	**Present level of consumption (gram/ per day/ person)**	**Kilo Calories /day/person**
Cereals	396.0	220.0	748.0
Pulses	43.0	25.5	87.6
Milk	200.0	144.1	93.7
Vegetables	143.0	94.5	22.6
Cooking Oil	31.0	34.6	197.2
Egg	0.5	56.6	85
Meat	14.2	12.7	19.1
Total	**827.7**	**588.3**	**1253.5**
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		80.0	100.0
% Above NIN		20.0	0.0

Note: * day/person

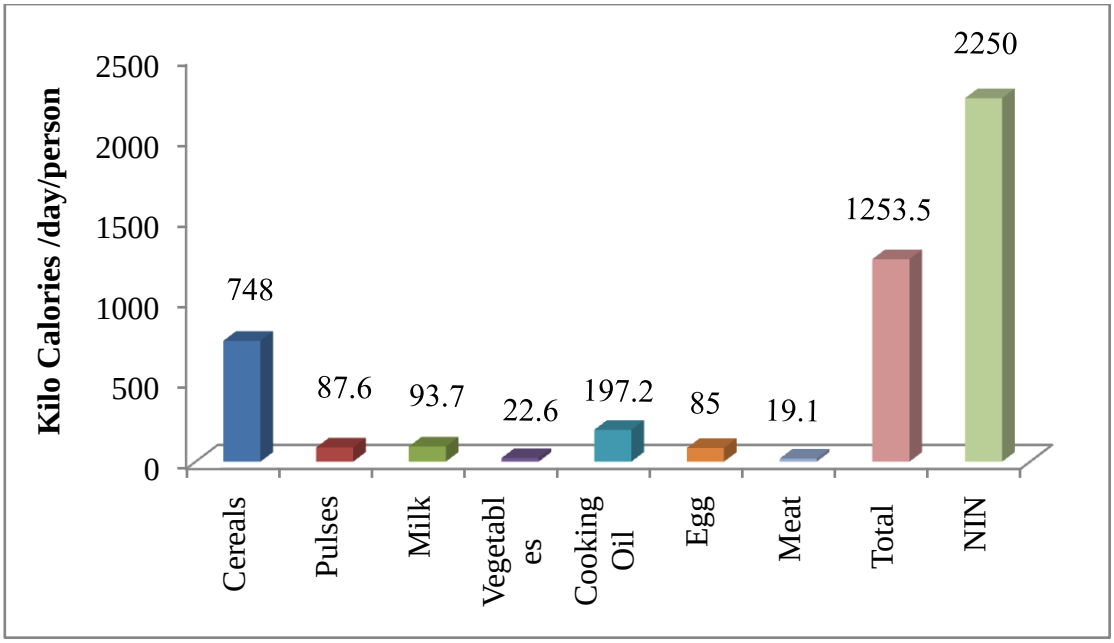

Figure 7: Per capita daily consumption of food among the sample households in Chilkadabetta 1 Microwatershed

Annual income of the sample HHs: The average annual household income is around Rs 36529. Major source of income to the farmers in the study area is from crop production (Rs 16927) followed by livestock (Rs. 16770). The income from Non farm income was very low at Rs 2832. The monthly per capita income is Rs.621, which is less than the threshold monthly income of Rs 975 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 12).

Table 12: Annual average income of HHs from various sources in Chilkadabetta 1 Microwatershed

Particulars	Income *
Nonfarm income (Rs)	2832 (10)
Livestock income (Rs)	16770 (20)
Crop Production (Rs)	16927 (100)
Total Annual Income (Rs)	***36529***
Average monthly per capita income (Rs)	621
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	100
% of households above poverty line	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. 32384) 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 1401 and all farm households are below poverty line (Table 13 and Figure 8).

Table 13: Average annual expenditure of sample HHs in Chilkadabetta 1 Microwatershed

Particulars	Value in Rupees	Per cent
Food	32384	39.3
Education	17200	20.9
Clothing	7400	9.0
Social functions	11500	14.0
Health	13900	16.9
Total Expenditure (Rs/year)	82384	100.0
Monthly per capita expenditure (Rs)	1401	

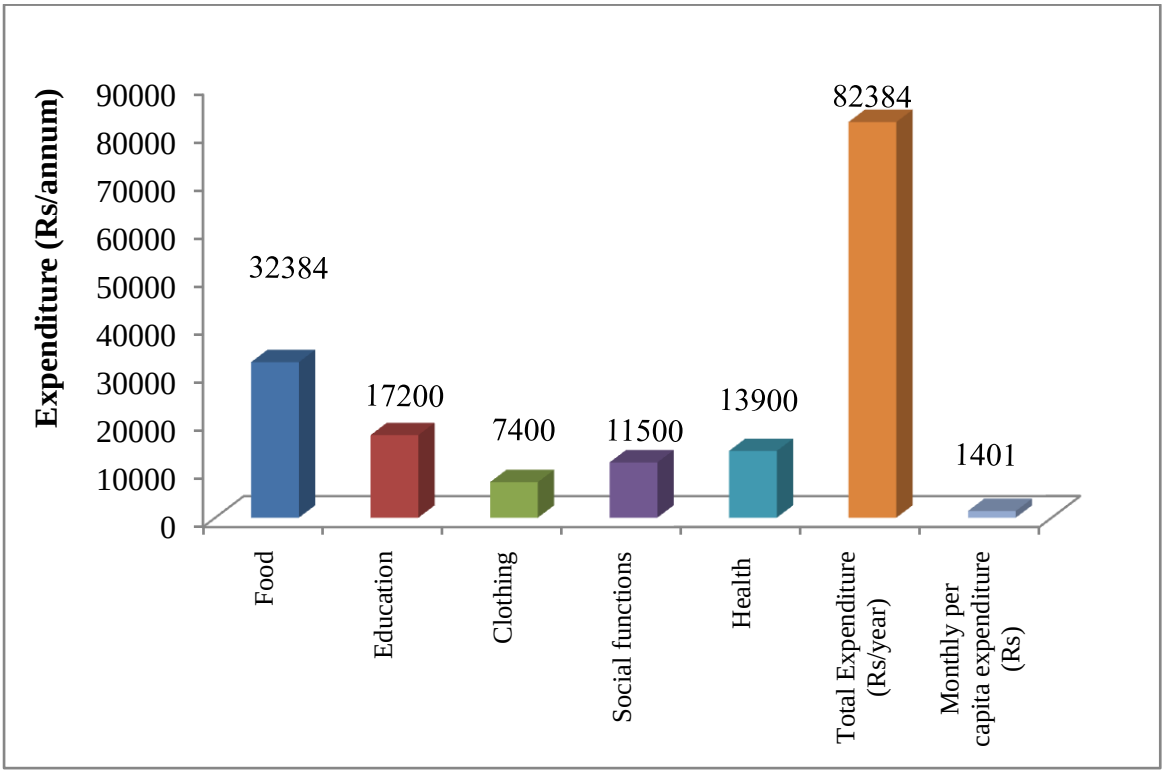

Figure 8: Average annual expenditure of sample HHs in Chilkadabetta 1 Microwatershed

Land use: The total land holding in the Chilkadabetta 1 Microwatershed is 8.5 ha (Table 14). Of which 72.1 per cent is rain fed land and 27.9 per cent is irrigated land. The average land holding per household is worked out to be 0.8 ha.

Table 14: Land use among samples households in Chilkadabetta 1 Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	27.9	2.3
Rainfed Land	72.1	6.1
Fallow Land	0.0	0.0
Total land holding	100.0	8.5
Average land holding	0.8	

In the micro-watershed, the prevalent present land uses under perennial plants are neem trees (32.8 %) followed by pongamia (16.4%), coconut (9.8 %), saputo (6.6%) jack fruit (6.5%), guava (4.9%), lime (3.2%), mango (3.2%), teak (3.2%),tamarind (1.6 %), jalli (1.6 %) and honge (1.6%) (Table15).

Table 15: Number of trees/plants covered in sample farmhouseholds in Chilkadabetta 1 Microwatershed

Particulars	Number of Plants/trees	Per cent
Coconut	6	9.8
Jalli	6	9.8
Lime	2	3.2
Mango	2	3.2
Neem trees	20	32.8
Pongamia	10	16.4
Tamarind	1	1.6
Guava	3	4.9
Honge	1	1.6
Jack fruit	4	6.5
Saputo	4	6.6
Teak	2	3.2
Grand Total	61	100

Table 16: Present cropping pattern and cropping intensity in Chilkadabetta 1Microwatershed

%toGrand Total

Crops	Kharif	Rabi	Grand Total
Beans	0.0	3.6	3.6
Groundnut	18.1	0.0	18.1
Horsegram	3.0	26.8	29.9
Maize	0.0	8.7	8.7
Sorghum	11.4	8.0	19.4
Sunflower	16.7	0.0	16.7
Tomato	3.6	0.0	3.6
Grand Total	52.8	47.1	100
Cropping intensity (%)	189.1		

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 groundnut (18.1 %) followed by sunflower (16.7%), sorghum (11.4 %), tomato (3.6 %), horse gram (3.0 %) which are taken during Kharif and horse gram (26.8 %), maize (8.7 %) sorghum (8.0 %) and beans (3.6 %) during rabi season respectively. The cropping intensity was 189.1 per cent (Table 16 and Figure 9).

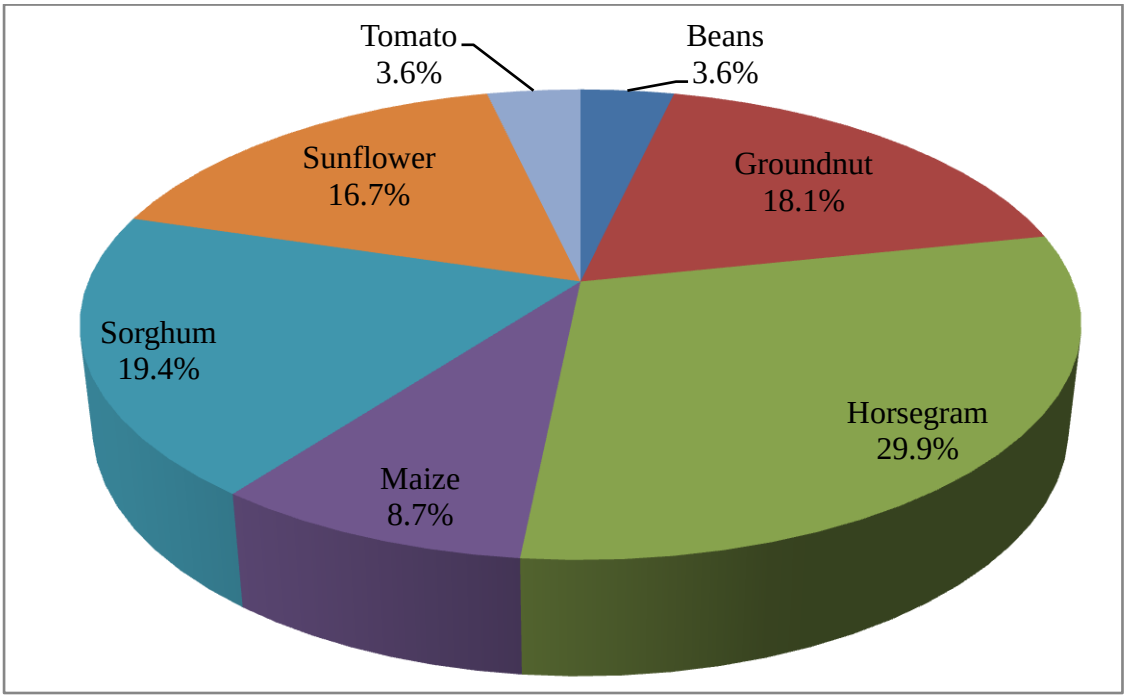

Figure 9: Present cropping pattern in Chilkadabetta 1 Microwatershed

Economic land evaluation

The main purpose to characterise the socio-economic systems 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 Chilkadabetta 1 Microwatershed, 10 soil series are identified and mapped (Table 17). The distribution of major soil series are Hindupur covering an area around 88.6ha (18.6 %) followed by Hullipura 78.9 ha (16.6 %), Shivapura 69.3 ha (14.6 %), Kannigala 55.7 ha (11.7 %), Annurkeri 35.2 ha (7.4 %), Kalligaudanahalli 34.6 ha (7.3%), Honnegaudanahalli 31.1 ha (6.5 %), Devarahalli 27.5 ha (5.8 %), Magoonahalli 26.8 ha (5.6 %) and Beemanabeedu 12 ha (2.5 %).

Table 17: Distribution of soil series in Chilkadabetta 1 Microwatershed

Soil No	Soil Series	Mapping Unit Description	Area in ha (%)
1	ARK	Annurkeri soils are very deep (>150 cm), well drained, have dark reddish brown to very dusky red sandy clay to clay soils occurring on very gently sloping uplands under cultivation.	35.2 (7.4)
2	BMB	Beemanabeedu soils are very deep (>150 cm), moderately well drained, have very dark greyish brown to dark grey and very dark brown clayey soils occurring on nearly level to very gently sloping lowlands under cultivation	12.0 (2.5)
3	DRH	Devarahalli soils are moderately shallow (50-75 cm), well drained, have dark red to reddish brown and dusky red gravelly sandy clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation	27.5 (5.8)
4	HDR	Hindupur soils are shallow (25-50 cm), well drained, have dark reddish brown to dusky red sandy clay loam to sandy clay soils occurring on very gently sloping uplands and moderately sloping mounds and ridges	88.6 (18.6)
5	HGH	Honnegaudanahalli soils are very deep (>150 cm), well drained, have very dark brown to brown and dark reddish brown sandy clay loam soils occurring on very gently sloping uplands under cultivation	31.1 (6.5)
6	HPR	Hullipura soils are moderately shallow (50-75 cm), well drained, have dark brown to very dark brown gravelly sandy clay loam to sandy clay soils occurring on very gently to gently sloping uplands under cultivation	78.9 (16.6)
7	KDH	Kalligaudanahalli soils are very deep (>150 cm), well drained, have dark red to dark reddish brown and dark brown sandy clay to clay soils occurring on very gently sloping uplands under cultivation	34.6 (7.3)
8	KNG	Kannigala soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red gravelly sandy clay loam to sandy clay soils occurring on very gently sloping uplands and strongly sloping mounds and ridges.	55.7 (11.7)
9	MGH	Magoonahalli soils are moderately shallow (50-75 cm), well drained, have very dark brown to dark brown gravelly sandy clay loam soils occurring on very gently sloping uplands and moderatly sloping mounds and ridges	26.8 (5.6)
10	SPR	Shivapura soils are shallow (25-50 cm), well drained, have dark reddish brown gravelly sandy clay loam to sandy clay soils occurring on very gently sloping uplands and very strongly sloping hills, mounds and ridges.	69.3 (14.6)
11	Others		16.0(3.4)

Present cropping pattern on different soil series are given in Table 18. Crops grown on Hindupur soils are sorghum sunflower. Groundnut and horsegram on Shivapura soils is grown. Horsegram, sorghum and beans tomato are grown on Hullipura soils. Groundnuts, horsegram on Kannigala soils are grow. Beans, groundnut sorghum and

tomato on Annurkeri soils are grow. Maize and sunflower on Kalligaudanahalli soils is grow. Horsegram, sunflower on Beemanabeedu soils is growing.

Table 18: Cropping pattern on major soil series in Chilkadabetta 1 Microwatershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Irrigated		Grand Total
			Kharif	Rabi	Kharif	Rabi	
Hindupur (HDR)	Shallow (25-50 cm)	Sorghum	50.0	0.0	0.0	0.0	50.0
		Sunflower	50.0	0.0	0.0	0.0	50.0
Shivapura (SPR)	Shallow (25-50 cm)	Groundnut	50.0	0.0	0.0	0.0	50.0
		Horse gram	0.0	50.0	0.0	0.0	50.0
Hullipura (HPR)	Moderately shallow (50-75 cm)	Beans	0.0	0.0	0.0	5.5	5.5
		Horse gram	0.0	44.5	0.0	0.0	44.5
		Sorghum	44.5	0.0	0.0	0.0	44.5
		Tomato	0.0	0.0	5.5	0.0	5.5
Kannigala (KNG)	Moderately deep (75-100 cm)	Groundnut	31.7	0.0	0.0	0.0	31.7
		Horse gram	0.0	68.3	0.0	0.0	68.3
Annurkeri (ARK)	Very deep (>150 cm)	Beans	0.0	0.0	0.0	13.1	13.1
		Groundnut	36.9	0.0	0.0	0.0	36.9
		Sorghum	0.0	36.9	0.0	0.0	36.9
		Tomato	0.0	0.0	13.1	0.0	13.1
Kalligaudanahalli (KDH)	Very deep (>150 cm)	Maize	0.0	0.0	0.0	50.0	50.0
		Sunflower	0.0	0.0	50.0	0.0	50.0
Beemanabeedu (BMB)	Very deep (>150 cm)	Horse gram	0.0	50.0	0.0	0.0	50.0
		Sunflower	50.0	0.0	0.0	0.0	50.0

Land is used for agricultural use for growing cereals, pulse, oilseeds and commercial 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 19).

Table 19: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Chilkadabetta 1 Microwatershed.

Soil Series	Small Farmer
HDR	Sorghum (1.46) & Sunflower (1.77)
SPR	Groundnut (0.96) & Horsegram (2.66)
HPR	Beans (1.10), Horsegram (1.94), Sorghum (2.19) & Tomato (1.19)
KNG	Groundnut (0.93) & Horsegram (1.22)
ARK	Beans (1.50), Groundnut (1.79), Sorghum (2.52) & Tomato (1.23)
BMB	Horsegram (1.60) & Sunflower (1.22)
KDH	Maize (1.63) &Sunflower (2.70)

The productivity of different crops grown in Chilkadabetta 1 Microwatershed under potential yield of the crops is given in Tables 20 and 20a.

Table 20: Economic land evaluation and bridging yield gap for different crops in Chilkadabetta 1 Microwatershed

Particulars	HDR (25-50 cm)		SPR (25-50 cm)		HPR (50-75 cm)			
	Sorghum	**Sunflower**	**Groundnut**	**Horsegram**	**Beans**	**Horsegram**	**Sorghum**	**Tomato**
Total cost (Rs/ha)	18249	17602	18746	6371	126088	11824	16970	331873
Gross Return (Rs/ha)	31122	34086	18701	16673	128646	22858	37213	423429
Net returns (Rs/ha)	12873	16484	-44	10301	2557	11035	20242	91556
BCR	1.71	1.94	1.00	2.62	1.02	1.93	2.19	1.28
Farmers Practices (FP)								
FYM (t/ha)	2.5	1.3	1.8	0.0	5.2	0.0	0.0	8.9
Nitrogen (kg/ha)	19.4	19.4	28.6	28.6	412.4	24.7	24.7	412.4
Phosphorus (kg/ha)	8.1	8.1	20.5	20.5	419.5	63.0	63.0	419.5
Potash (kg/ha)	56.3	56.3	26.8	26.8	98.0	32.9	32.9	98.0
Grain (Qtl/ha)	17.5	11.3	7.1	5.4	130.2	6.6	17.5	285.7
Price of Yield (Rs/Qtl)	1800	3000	2500	3000	1000	3400	2100	1500
Soil test based fertilizer Recommendation (STBR)								
FYM (t/ha)	7.4	6.6	8.6	0.0	12.4	0.0	7.4	24.7
Nitrogen (kg/ha)	101.9	69.0	30.9	30.9	46.9	30.9	101.9	191.4
Phosphorus (kg/ha)	71.0	74.1	77.2	46.3	74.1	46.3	71.0	185.3
Potash (kg/ha)	39.5	37.1	30.9	24.7	37.1	24.7	39.5	103.7
Grain (Qtl/ha)	28.4	16.5	17.3	9.9	9.9	9.9	28.4	518.7
% of Adoption/yield gap (STBR-FP) / (STBR)								
FYM (%)	66.3	81.0	79.3	0.0	57.8	0.0	100.0	63.9
Nitrogen (%)	81.0	71.9	7.5	7.5	-778.7	20.1	75.8	-115.4
Phosphorus (%)	88.6	89.0	73.4	55.7	-466.1	-36.1	11.2	-126.4
Potash (%)	-42.3	-51.8	13.2	-8.4	-164.6	-33.2	16.8	5.5
Grain (%)	38.4	31.7	58.7	45.8	-1217.9	33.4	38.2	44.9
Value of yield and Fertilizer (Rs)								
Additional Cost (Rs/ha)	8333	8451	9461	1120	-13659	-826	8820	2929
Additional Benefits (Rs/ha)	19629	15650	25368	13569	-120328	11224	22808	349479
Net change Income (Rs/ha)	11296	7199	15906	12448	-106669	12049	13989	346550

To be continued...

Table 20a: Economic land evaluation and bridging yield gap for different crops in Chilkadabetta 1 Microwatershed

Particulars	KNG (75-100 cm)		ARK (>150 cm)				BMB (>150 cm)		KDH (>150 cm)	
	Groundnut	Horsegram	Beans	Groundnut	Sorghum	Tomato	Horsegram	Sunflower	Maize	Sunflower
Total cost (Rs/ha)	30525	18793	112311	18950	11171	118609	28728	33353	29028	23531
Gross Return (Rs/ha)	31616	22117	138505	33839	28282	147738	45201	34333	45942	23712
Net returns (Rs/ha)	1091	3324	26194	14889	17111	29129	16473	980	16914	181
BCR	1.04	1.20	1.23	1.79	2.53	1.25	1.57	1.03	1.58	1.01
Farmers Practices (FP)										
FYM (t/ha)	2.5	0.0	18.7	0.0	0.0	2.3	0.0	5.0	0.0	1.7
Nitrogen (kg/ha)	70.6	70.3	87.6	45.0	45.0	87.6	78.1	78.1	72.9	72.9
Phosphorus (kg/ha)	71.9	64.6	137.9	62.9	62.9	137.9	125.6	125.6	54.6	54.6
Potash (kg/ha)	10.6	7.1	0.0	25.0	25.0	0.0	35.6	35.6	50.0	50.0
Grain (Qtl/ha)	7.5	7.2	93.5	7.5	13.3	186.9	7.5	10.0	30.0	6.7
Price of Yield (Rs/Qtl)	4200	3067	1500	4500	2100	800	6100	3400	1550	3600
Soil test based fertilizer Recommendation (STBR)										
FYM (t/ha)	8.6	0.0	12.4	8.6	7.4	24.7	0.0	6.6	8.6	6.6
Nitrogen (kg/ha)	30.9	30.9	46.9	30.9	101.9	191.4	30.9	69.0	154.4	69.0
Phosphorus (kg/ha)	61.8	37.1	59.3	61.8	56.8	148.2	46.3	74.1	77.2	74.1
Potash (kg/ha)	23.2	20.6	37.1	23.2	29.6	103.7	18.5	27.8	24.1	27.8
Grain (Qtl/ha)	17.3	9.9	9.9	17.3	28.4	518.7	9.9	16.5	84.0	16.5
% of Adoption/yield gap (STBR-FP) / (STBR)										
FYM (%)	71.1	0.0	-51.3	100.0	100.0	90.5	0.0	24.1	100.0	74.7
Nitrogen (%)	-128.7	-127.6	-86.7	-45.7	55.8	54.2	-153.0	-13.3	52.8	-5.7
Phosphorus (%)	-16.4	-74.3	-132.5	-1.9	-10.7	7.0	-171.3	-69.5	29.3	26.3
Potash (%)	0.0	65.6	100.0	-8.0	0.0	100.0	-92.3	-28.2	-107.6	-79.9
Grain (%)	56.6	27.4	-845.9	56.6	53.1	64.0	24.1	39.3	64.3	59.5
Value of yield and Fertilizer (Rs)										
Additional Cost (Rs/ha)	5473	-1414	-9546	8387	7917	26139	-4399	-947	10099	5287
Additional Benefits (Rs/ha)	41118	8299	-125367	44055	31651	265427	14518	21987	83669	35280
Net change Income (Rs/ha)	35645	9713	-115821	35668	23734	239288	18917	22934	73570	29993

The data on cost of cultivation and benefit cost ratio (BCR) of different crops is given in Tables 20 and 20a. The total cost of cultivation in study area for groundnut ranges between Rs.18746/ha in SPR soil (with BCR of 1.0) and Rs.30525/ha in KNG soil (with BCR of 1.04), horse gram range between Rs 6371/ha in SPR soil (with of 2.62) and Rs.28728/ha in BMB soil (with BCR of 1.57), sorghum range between Rs. 11171/ha in ARK soil (with BCR of 2.53) and Rs. 18249/ha in HDR soil (with BCR of 1.71), tomato cost of cultivation range between is Rs.118609 /ha in ARK soil (with BCR of 1.25) and Rs331873 in HPR soil (with BCR of 1.28), sunflower range between is Rs 17602/ha in HDR soil (with BCR of 1.94) and Rs. 33353/ha in BMB soil (with BCR of 1.03) and beans cultivation in Rs 112311/ha in ARK soil (with BCR of 1.23) and Rs. 126088/ha in HPR soil (with BCR of 1.02).

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Tables 20 and 20a. 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 239288 in tomato and a minimum of Rs 7199 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 21 and Figure 10. The average value of soil nutrient loss is around Rs 900.3 per ha/year. The total cost of annual soil nutrients is around Rs 50064 per year for the total area of 475.8 ha.

Table 21: Estimation of onsite cost of soil erosion in Chilkadabetta 1 Microwatershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total
Organic matter	119.88	67252	755.23	423686
Phosphorus	0.07	40	3.13	1757
Potash	2.03	1136	40.51	22727
Iron	0.07	38	3.23	1813
Manganese	0.12	66	32.38	18167
Cupper	0.01	7	6.52	3658
Zinc	0.00	2	0.13	75
Sulphur	1.47	826	58.91	33046
Boron	0.01	3	0.24	136
Total	123.65	69370	900.3	505064

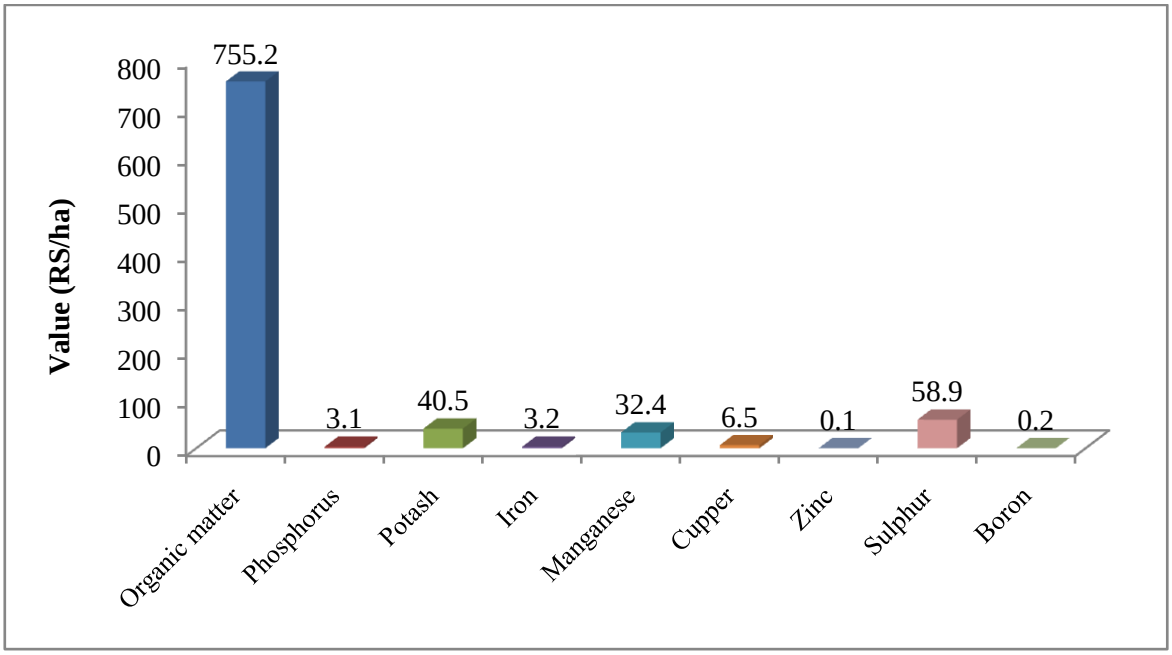

Figure 10: Estimation of onsite cost of soil erosion in Chilkadabetta 1 micro-watershed

The average value of ecosystem service for food grain production is around Rs.16231/ ha/year (Table 22 and Figure 11). Per hectare food grain production services is maximum in tomato (Rs.43260) followed by beans (Rs.18914), maize (Rs.16914), sorghum (Rs.16401), horse gram (Rs.7824), sunflower (Rs.5818) and groundnut (Rs.4485).

Table 22: Ecosystem services of food grain production in Chilkadabetta 1 Microwatershed

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	1.2	29.6	1550	45942	29028	16914
	Sorghum	3.0	15.9	2000	31864	15463	16401
Pulses	Horse gram	3.3	6.6	3740	24726	16902	7824
Oil seeds	Groundnut	2.8	7.3	3733	27225	22740	4485
	Sunflower	2.4	9.2	3333	30646	24829	5818
Vegetables	Beans	0.6	110.5	1250	138114	119200	18914
	Tomato	0.6	233.5	1150	268501	225241	43260
Average value		13.85	58.9	2394	81003	64772	16231

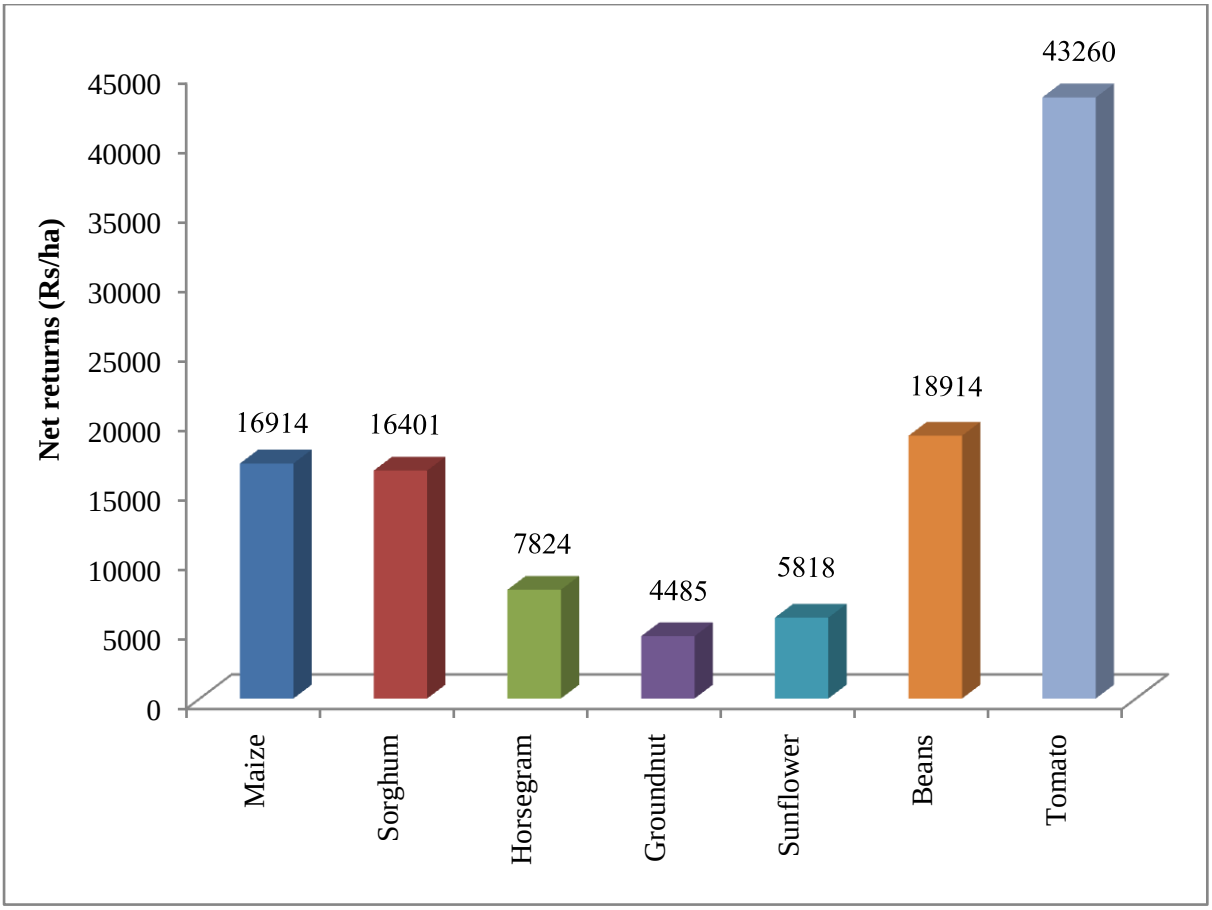

Figure 11: Ecosystem services of food grain production in Chilkadabetta 1 Microwatershed

Table 23: Ecosystem services of fodder production in Chilkadabetta 1 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Net Returns (Rs/ha)
Cereals	Sorghum	2.9	1	333	318
Pulses	Horsegram	3.3	0.9	500	472
Oil seeds	Groundnut	2.8	1.2	567	675
Average value		9.0	1.0	467	488

The average value of ecosystem service for fodder production is around Rs.488/ ha/year (Table 23). Per hectare fodder production services is maximum in groundnut (Rs.675) followed by horse gram (Rs.472) and sorghum (Rs.318).

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. The per hectare value of water used and value of water was maximum (Table 24 and Figure 12) in beans (Rs.538092) followed by tomato (Rs 49965), sorghum (Rs. 48561), maize (Rs.36220), sunflower (Rs.30947), horse gram (Rs.20349) and groundnut (Rs. 20287).

Table 24: Ecosystem services of water supply in Chilkadabetta 1 Microwatershed

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water(Rs/ha)	Water consumption (Cubic meters/Qtl)
Beans	110.5	53809	538092	487
Groundnut	7.3	2029	20287	278
Horsegram	6.6	2035	20349	308
Maize	29.6	3622	36220	122
Sorghum	15.9	4856	48561	305
Sunflower	9.2	3095	30947	337
Tomato	233.5	4996	49965	21
Average value	58.9	10635	106346	265

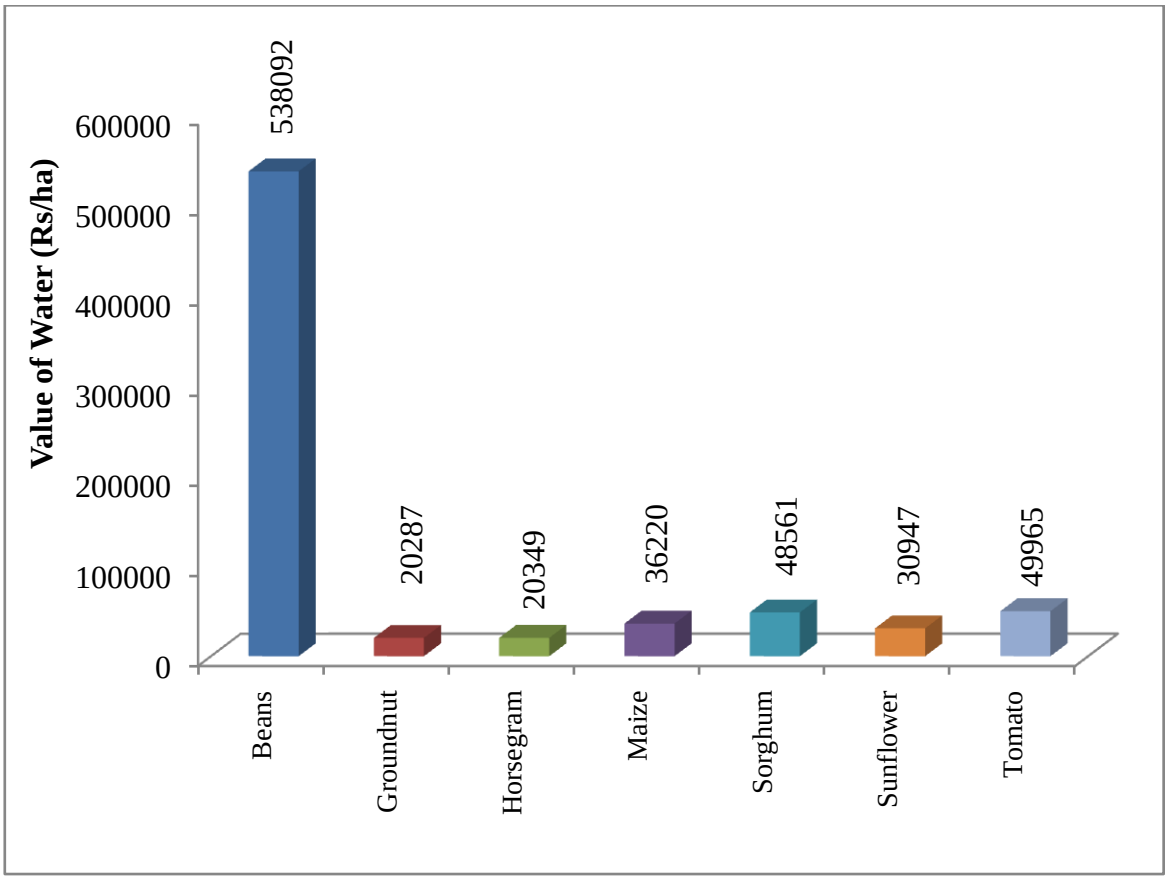

Figure 12: Ecosystem services of water supply in Chilkadabetta 1 Microwatershed

The main farming constraints in Chilkadabetta 1 Microwatershed to be found are less rainfall, lack of good quality seeds, lack of transportation and damage of crops by wild animals. 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 25).

Table 25: Farming constraints related land resources of sample households in Chilkadabetta 1 Microwatershed

Sl.No.	Particulars	Per cent
1	Less Rainfall	90
2	Lack of good quality seeds	10
3	Non availability Fertilizers	10
4	High Crop Pests & Diseases	10
5	Damage of crops by Wild Animals	100
6	**Source of loan**	
	Money Leander	100
7	**Market for selling**	
	Regulated	10
	Village market	90
8	**Sources of Agri-Technology information**	
	Newspaper	70
	Television	30

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.