ICAR-NBSS&LUP Sujala MWS Publ.251

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

CHANDRAGERI-1 (4D3A9F2a) MICRO WATERSHED

Irakallagada Hobli, Koppal Taluk and 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.

Citation: Rajendra Hegde, Ramesh Kumar, S.C., K.V. Niranjana, S. Srinivas, M.Lalitha, B.A. Dhanorkar, R.S. Reddy and S.K. Singh (2019). "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of Chanadrageri-1 (4D3A9Fab) Microwatershed, Irakallagada Hobli, Koppal Taluk and District, Karnataka", ICAR-NBSS&LUP Sujala MWS Publ. 251, ICAR – NBSS & LUP, RC, Bangalore. p.121 & 38.

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PREFACE

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

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

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

The natural resources (land, water and vegetation) of the state need adequate and constant care and management, backed by site-specific technological interventions and investments particularly by the government. Detailed database pertaining to the nature of

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of for Chandrageri-1 microwatershed in Koppal Taluk, Koppal 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 micro-watershed. 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**

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The land resource inventory of Chandrageri-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 these physiographic delineations were used as base for mapping soils. The soils were studied in several transects and a soil map was prepared with phases of soil series as mapping units. Random checks were made all over the area outside the transects to confirm and validate the soil map unit boundaries. The soil map shows the geographic distribution and extent, characteristics, classification, behavior and use potentials of the soils in the Microwatershed.

The present study covers an area of 507 ha in Koppal taluk and district, Karnataka. The climate is semiarid and categorized as drought - prone with an average annual rainfall of 662 mm, of which about 424 mm is received during south –west monsoon, 161 mm during north-east and the remaining 77 mm during the rest of the year. An area of about 24 per cent is covered by soil, 76 per cent by rock out crops and less than one per cent by water bodies. The salient findings from the land resource inventory are summarized briefly below

- *The soils belong to 5 soil series and 9 soil phases (management units) and 5 land management units.*
- *The length of crop growing period is <90 days and starts from 2nd week of August to 2nd 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 320 m grid interval.*
- *Land suitability for growing 28 major agricultural and horticultural crops were assessed and maps showing the degree of suitability along with constraints were generated.*
- *Entire area is suitable for agriculture.*
- *About 5 per cent is very shallow (<25 cm), 11 per cent is shallow (25-50 cm), 4 per cent moderately shallow (50-75 cm) and 4 per cent is moderately deep (75- 100 cm).*
- *About 2 per cent is sandy (loamy sand) at the surface and 22 per cent is loamy (sandy loam and sandy clay loam)at the surface.*
- *Entire area in the microwatershed has gravelly (15-35 % gravel) soils.*
- *With respect to available water capacity 19 per cent of the area has very low (<50mm/m) and 5 per cent of the area has low (51-100 mm/m).*
- *Entire area in the microwatershed has very gently sloping (1-3%) lands.*
- *An area of about <1 per cent is slightly eroded (e1) and 23 per cent is moderately eroded (e2) lands.*

- *An area of about 1 per cent is slightly acid (pH 6.0 to 6.5), 4 per cent has neutral (pH 6.5 to 7.3) soils, 6 per cent slightly alkaline (pH 7.3 to 7.8), 9 per cent moderately alkaline (pH 7.8 to 8.4) and 4 per cent strongly alkaline (pH 8.4 to 9.0).*
- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm^{-1} indicating that soils are non saline.*
- *Organic carbon is medium (0.5-0.75%) in 6 per cent and high (>0.75%) in 18 per cent area of the soils.*
- *Available phosphorus is low (<23 kg/ha) in 6 per cent and medium (23-57 kg/ha) in 18 per cent per cent of the soils.*
- *Available potassium is low (<145 kg/ha) in 6 per cent, medium (145-337 kg/ha) in 17 per cent and high (>337 kg/ha) in 1 per cent of the soils.*
- *Available sulphur is low (<10 ppm) in 17 per cent and medium (10-20 ppm) in 7 per cent area of the soils.*
- *Available boron is low (<0.5 ppm) in 16 per cent and medium (0.5-1.0 ppm) in 8 percent area of the microwatershed.*
- *Available iron is deficient in the entire area of (>4.5 ppm) the microwatershed.*
- *Available zinc is deficient (<0.6 ppm) in the entire the area of the microwatershed.*
- *Available manganese and copper are sufficient in the entire area.*
- *The land suitability for 28 major agricultural and horticultural crops grown in the microwatershed was 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, market price, and finally the demand and supply position.*

Land suitability for various crops in the microwatershed

Crop	Suitability Area in ha (%)			Crop	Suitability Area in ha (%)	
	Highly suitable (S1)	Moderately suitable (S2)			Highly suitable (S1)	Moderately suitable (S2)
Sorghum	-	*26(5)*		*Pomegranate*	-	*20(4)*
Maize	-	*26(5)*		*Guava*	-	*20(4)*
Bajra	*4(<1)*	*37(7)*		*Jackfruit*	-	*20(4)*
Redgram	-	*5 (1)*		*Jamun*	-	*20(4)*
Bengal gram	-	*26 (5)*		*Musambi*	-	*20(4)*
Groundnut	-	*41(8)*		*Lime*	-	*20(4)*
Sunflower	-	*5 (1)*		*Cashew*	-	*20(4)*
Cotton	-	*26(5)*		*Custard apple*	*5 (1)*	*36(7)*
Chilli	*4(<1)*	*22(4)*		*Amla*	*4(<1)*	*37 (7)*
Tomato	*4(<1)*	*22(4)*		*Tamarind*	-	-
Drumstick	-	*5(1)*		*Marigold*	-	*26(5)*
Mulberry	-	*15(3)*		*Chrysanthemum*	-	*26(5)*
Mango	-	-		*Jasmine*	-	*26(5)*
Sapota	-	*20(4)*		*Crossandra*	-	*26(5)*

Apart from the individual crop suitability, a proposed crop plan has been prepared for the 5 identified LMUs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fodder, fibre and other horticulture crops.

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

Chapter 1

INTRODUCTION

Land is a scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use the land in a rational and judicious manner. But what is happening in many areas of the state is a cause for concern to everyone involved in the management of land resources at the grassroots level. The area available for agriculture is about 51 per cent of the total area and more than 60 per cent of the people are still dependant on agriculture for their livelihood. The limited land area is under severe stress and strain due to increasing population pressure and competing demands of various land uses. Due to this, every year there is significant diversion of farm lands and water resources for non-agricultural purposes. Apart from this, due to lack of interest in farmers for farming, large tracts of cultivable lands are turning into fallows in many areas and this trend is continuing at an alarming rate.

Further, land degradation has emerged as a serious problem which has already affected about 38 lakh ha of cultivated area in the state. Soil erosion alone has degraded about 35 lakh ha. Almost all the uncultivated areas are facing various degrees of degradation, particularly soil erosion. Salinity and alkalinity has emerged as a major problem in more than 3.5 lakh ha in the irrigated areas of the state. Nutrient depletion and declining factor productivity is common in both rainfed and irrigated areas. The degradation is continuing at an alarming rate and there appears to be no systematic effort among the stakeholders to contain this process. In recent times, an aberration of weather due to climate change phenomenon has added another dimension leading to unpredictable situations to be tackled by the farmers.

In this critical juncture, the challenge before us is not only to increase the productivity per unit area which is steadily declining and showing a fatigue syndrome, but also to prevent or at least reduce the severity of degradation. If the situation is not reversed at the earliest, then the sustainability of the already fragile crop production system and the overall ecosystem will be badly affected in the state. The continued neglect and unscientific use of the resources for a long time has led to the situation observed at present in the state. It is a known fact and established beyond doubt by many studies in the past that the cause for all kinds of degradation is the neglect and irrational use of the land resources. Hence, there is urgent need to generate a 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 not only the surface but also consider the other parameters which are critical for productivity *viz.*, soils, climate, water, minerals and rocks, topography, geology, hydrology, vegetation, crops, land use pattern, animal population, socio-

economic conditions, infrastructure, marketing facilities and various schemes and developmental works of the government etc. From the data collected at farm level, the specific problems and potentials of the area can be identified and highlighted, conservation measures required for the area can be planned on a scientific footing, suitability of the area for various uses can be worked out and finally viable and sustainable land use options suitable for each and every land holding can be prescribed.

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

The land resource inventory aims to provide site specific database for Chandrageri-1 microwatershed in Koppal Taluk, Koppal 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 Chandrageri-1 micro-watershed is located in the central part of Karnataka in Koppal taluk and district (Fig2.1). It lies between $15^0$22' and $15^0$23' North latitudes and $76^0$20'and $76^0$23' East longitudes and covers an area of about 507 ha. It comprises parts of Kumara Ramanakunta, Chandragiri, Achalapura, Nageshanahalli and Shivapura villages. It is about 86 km from Koppal town and is bounded by Kumara Ramnakunta on the east, Nageshanahalli and Achalapura on the west and Shivapura on the southern side of the microwatershed.

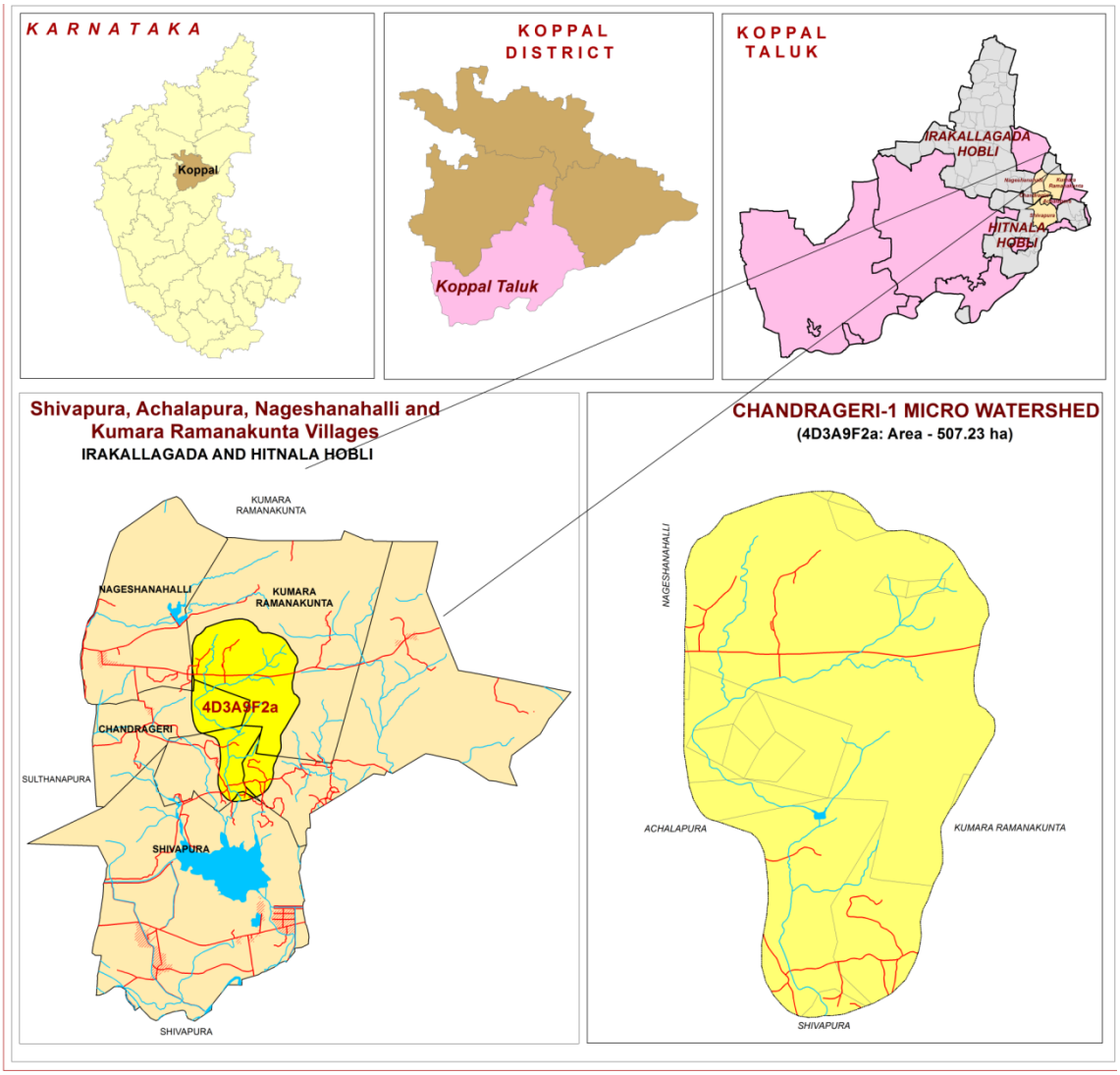


Fig.2.1 Location map of Chandrageri-1 Microwatershed

2.2 Geology

Major rock formations observed in the microwatershed are granite gneiss (Fig.2.2). Granite gneisses are essentially pink to gray and are coarse to medium grained. They

consist primarily of quartz, feldspar, biotite and hornblende. The gray granite gneisses are highly weathered, 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 Chandrageri-1 village.

Fig.2.2 Granite and granite gneiss rocks

2.3 Physiography

Physiographically, the area has been identified as Granite gneiss landscape based on geology. The microwatershed area has been further divided into mounds/ridges, summits, side slopes and very gently sloping uplands and nearly level plains based on slope and its relief features. The elevation ranges from 530 553 m in the gently sloping uplands. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

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

2.5 Climate

The district falls under semiarid tract of the state and is categorized as drought - prone with total annual rainfall of 662 mm (Table 2.1). Of this, a maximum of 424 mm

precipitation is received during south–west monsoon period from June to September, north-east monsoon contributes about 161 mm and prevails from October to early December and the remaining 77 mm is received during the rest of the year. The winter season is from December to February. During April and May, the temperatures reach up to 45°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 145 mm and varies from a low of 101 mm in December to 193 mm in the month of May. The PET is always higher than precipitation in all the months except in the month of September. Generally, the Length of crop Growing Period (LGP) is <90 days and starts from 2nd week of August to 2nd week of November.

Table 2.1 Mean Monthly Rainfall, PET, 1/2 PET at Koppal Taluk and District

Sl.No.	Months	Rainfall	PET	1/2 PET
1	January	1.60	116.70	58.35
2	February	1.50	129.20	64.60
3	March	14.10	169.80	84.90
4	April	18.10	180.60	90.30
5	May	41.60	193.50	96.75
6	June	85.80	167.90	83.95
7	July	72.10	156.20	78.10
8	August	110.50	152.50	76.25
9	September	155.60	138.50	69.25
10	October	116.30	122.30	61.15
11	November	36.00	106.40	53.20
12	December	9.10	101.00	50.50
TOTAL		**662.30**	**144.55**	

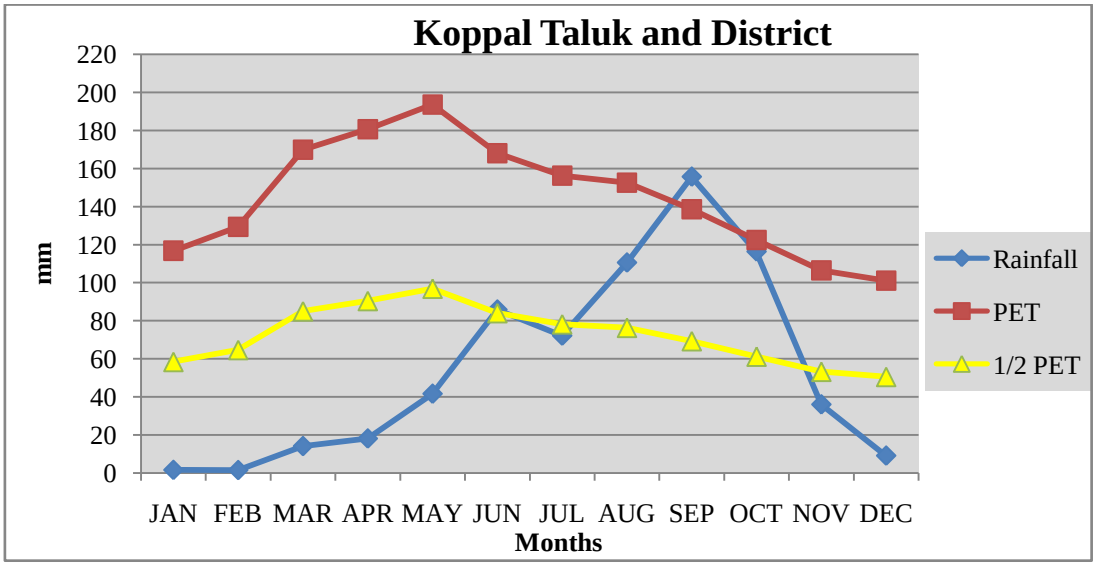


Fig. 2.3 Rainfall distribution in Koppal Taluk and District

2.6 Natural Vegetation

The natural vegetation is sparse comprising few tree species, shrubs and herbs. The mounds, ridges and boulders occupy 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 (Fig 2.4).

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 left in the area. The uncontrolled grazing has left no time for the regeneration of the vegetative cover. This leads to the accelerated rate of erosion on the hill slopes, resulting in the formation of deep gullies in the foot slopes and eventually resulting in the heavy siltation of few tanks and reservoirs in the microwatershed.

Fig 2.4 Natural vegetation of Chandrageri-1 microwatershed

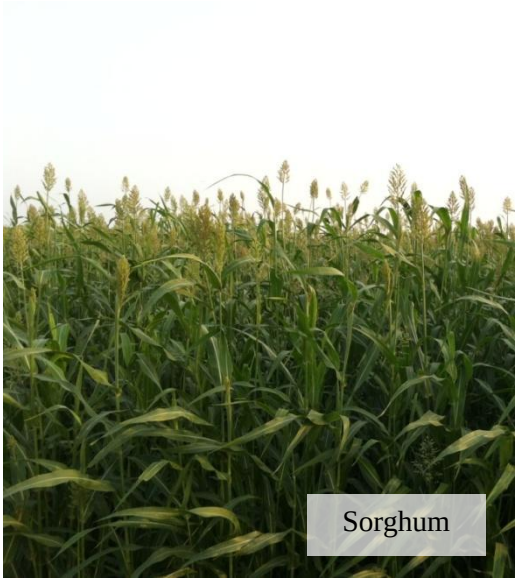
2.7 Land Utilization

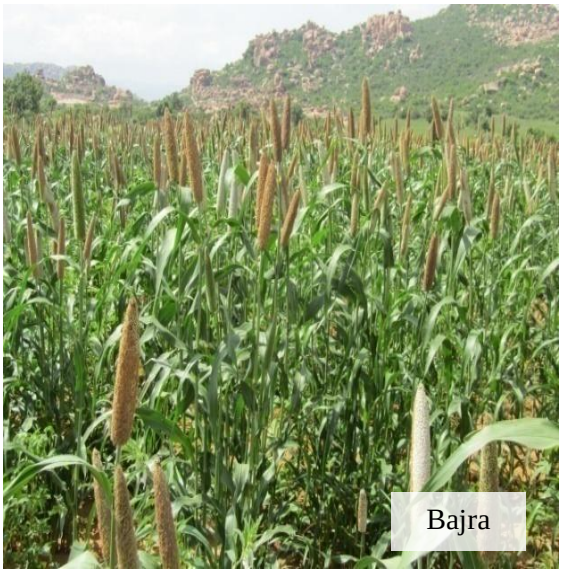
About 91 per cent area (Table 2.2) in Koppal district is cultivated at present and about 17 per cent of the area is sown more than once. An area of about 3 per cent is currently barren. Forests occupy a small area of about 5 per cent and the tree cover is in a very poor state. Most of the mounds, ridges and boulder areas have very poor vegetative cover. Major crops grown in the area are sorghum, maize, bajra, cotton, safflower, sunflower, red gram, horse gram, onion, mulberry, pomegranate, sugarcane, bengalgram and groundnut (Fig 2.5). 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 Chandrageri-1 microwatershed is presented in Fig.2.6. Simultaneously, enumeration of existing wells (bore wells) and conservation structures is made and their location in different survey numbers is marked on the cadastral map. Map showing the location of wells and conservation structures in Chandrageri-1 microwatershed is given in Fig 2.7.

Table 2.2 Land Utilization in Koppal District

Sl.No.	Agricultural land use	Area (ha)	Per cent
1	Total geographical area	552495	
2	Total cultivated area	500542	90.6
3	Area sown more than once	92696	16.8
4	Trees and groves	210	0.04
5	Cropping intensity	-	118
6	Forest	29451	5.33
7	Cultivable wasteland	2568	0.46
8	Permanent Pasture land	14675	2.66
9	Barren land	16627	3.01
10	Non agricultural land	40591	7.35
11	Current fallow	19660	3.56

Maize


Sorghum


Bajra

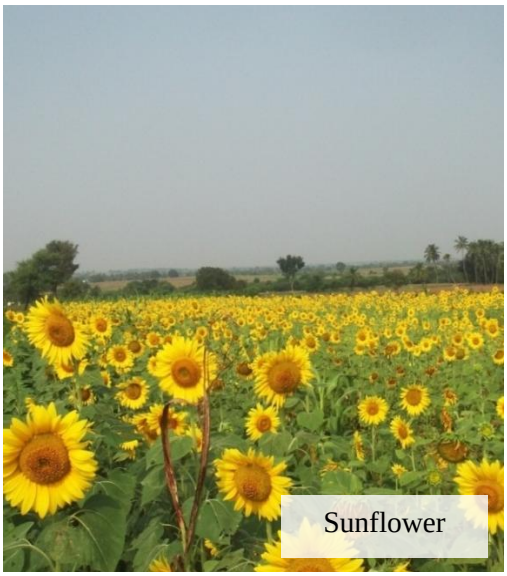

Sunflower

Fig.2.5 Different crops and cropping systems in Chandrageri-1 Microwatershed

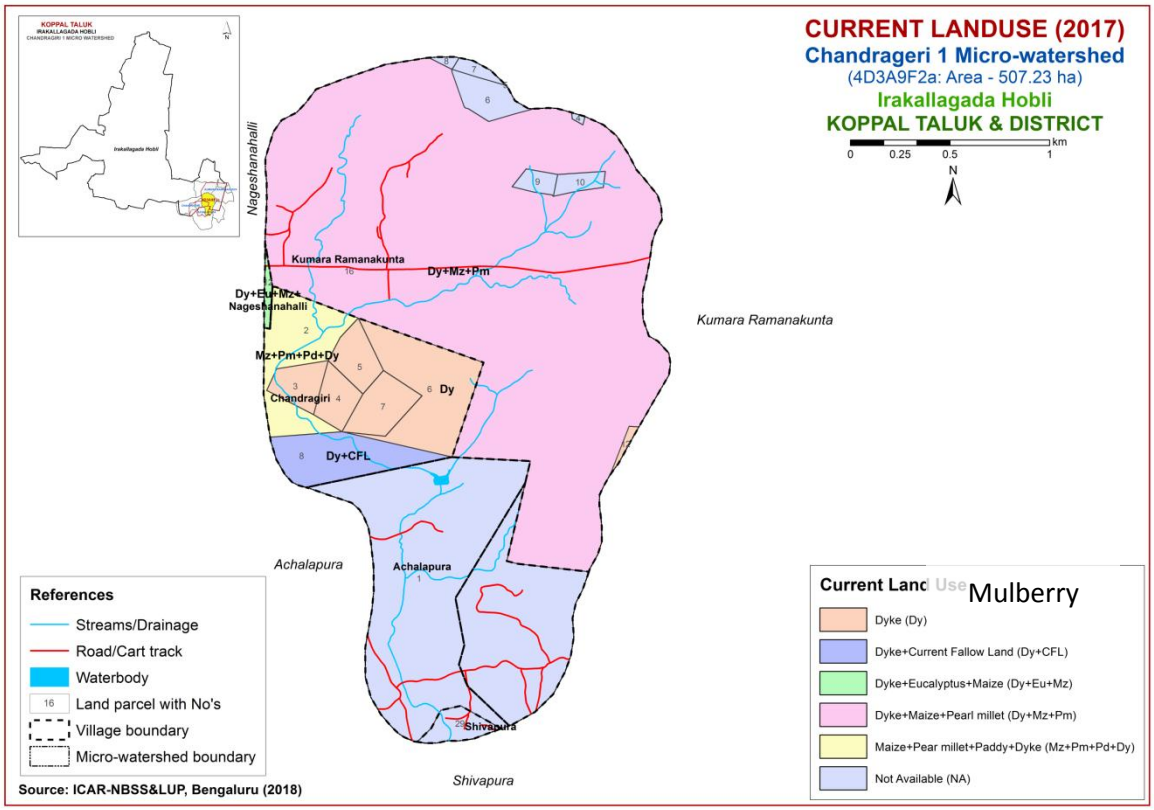


Fig.2.6 Current Land Use – Chandrageri-1 Microwatershed

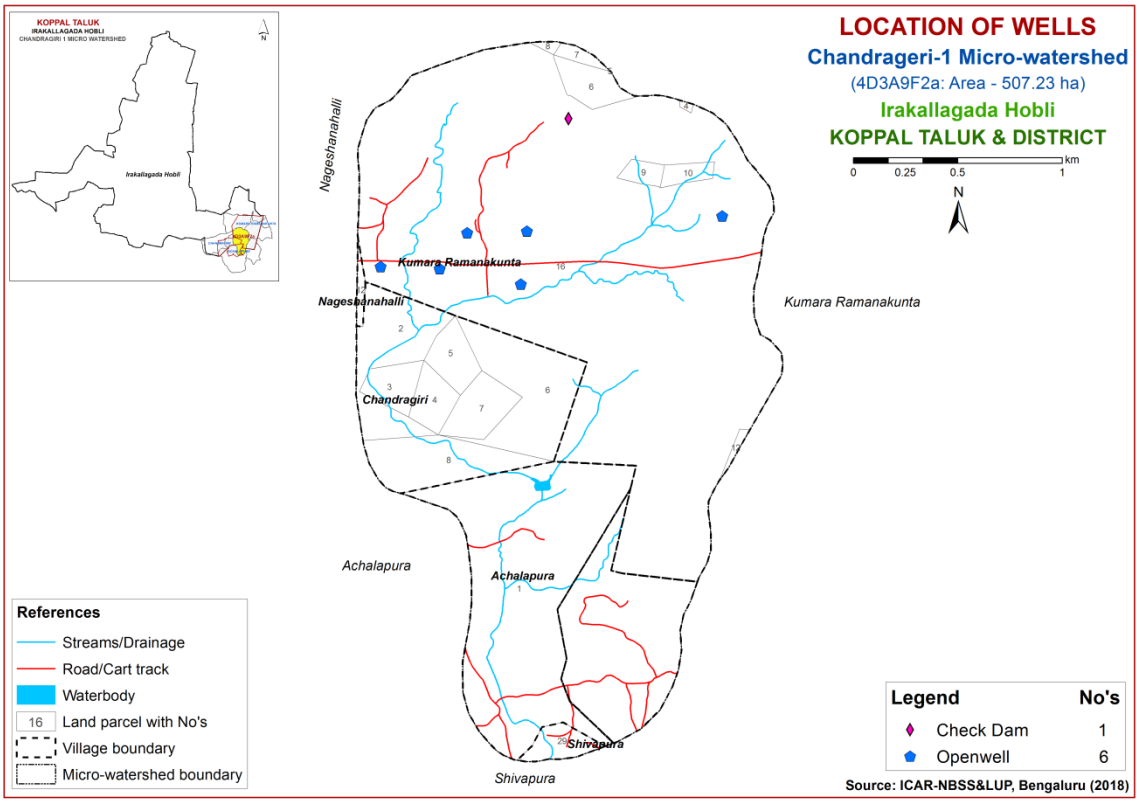


Fig.2.7 Location of wells and conservation structures– Chandrageri-1 Microwatershed

Chapter 3

SURVEY METHODOLOGY

The purpose of land resource inventory is to delineate similar areas (soil series and phases), which respond or expected to respond similarly for a given level of management. This was achieved in Chandrageri-1 microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.) and site (slope, erosion, drainage, occurrence of rock fragments etc.) followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units and showing their extent and geographic distribution on the microwatershed cadastral map. The detailed soil survey at 1:7920 scale was carried out in 507 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 and IRS satellite imagery as base supplied by KSRSAC. The cadastral map shows field boundaries with their survey numbers, location of tanks, streams and other permanent features of the area (Fig. 3.1). Apart from the cadastral map, remote sensing data products from Cartosat-1 and LISS IV merged at the scale of 1:7920 were used in conjunction with the cadastral map to identify the geology, landscapes, landforms and other surface features. The imagery helped in the identification and delineation of boundaries between hills, uplands and lowlands, water bodies, forest and vegetated areas, roads, habitations and other cultural features of the area (Fig.3.2).The cadastral map was overlaid on the satellite imagery (Fig.3.3) that helps to identify the parcel boundaries and other permanent features. Apart from cadastral maps and images, toposheets of the area (1:50,000 scale) were used for initial traversing, identification of geology, landscapes 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 (FCC) of Cartosat-I and LISS-IV merged satellite data covering the microwatershed area was visually interpreted using image interpretation elements and all the available collateral data with local knowledge. The delineated physiographic boundaries were transferred on to a cadastral map overlaid on satellite imagery. Physiographically, the area has been identified as granite gneiss landscape and is divided into landforms such as ridges, mounds and uplands based on slope. They were further subdivided into physiographic/ image interpretation units based on image characteristics. The image interpretation legend for physiography is given below.

Image Interpretation Legend for Physiography

G- Granite gneiss landscape

G1 Hills/ Ridges/ Mounds

G11 Summits

G12 Side slopes

G121 Side slopes with dark grey tones

G2 Uplands

G21 Summits

G22 Gently sloping uplands

G221 Gently sloping uplands, yellowish green (eroded)

G222 Gently sloping uplands, yellowish white (severely eroded)

G23 Very gently sloping uplands

G231 Very gently sloping uplands, yellowish green

G232 Very gently sloping uplands, medium green and pink

G233 Very gently sloping uplands, pink and green (scrub land)

G234 Very gently sloping uplands, medium greenish grey

G235 Very gently sloping uplands, yellowish white (eroded)

G236 Very gently sloping uplands, dark green

G237 Very gently sloping uplands, medium pink (coconut garden)

G238 Very gently sloping uplands, pink and bluish white (eroded)

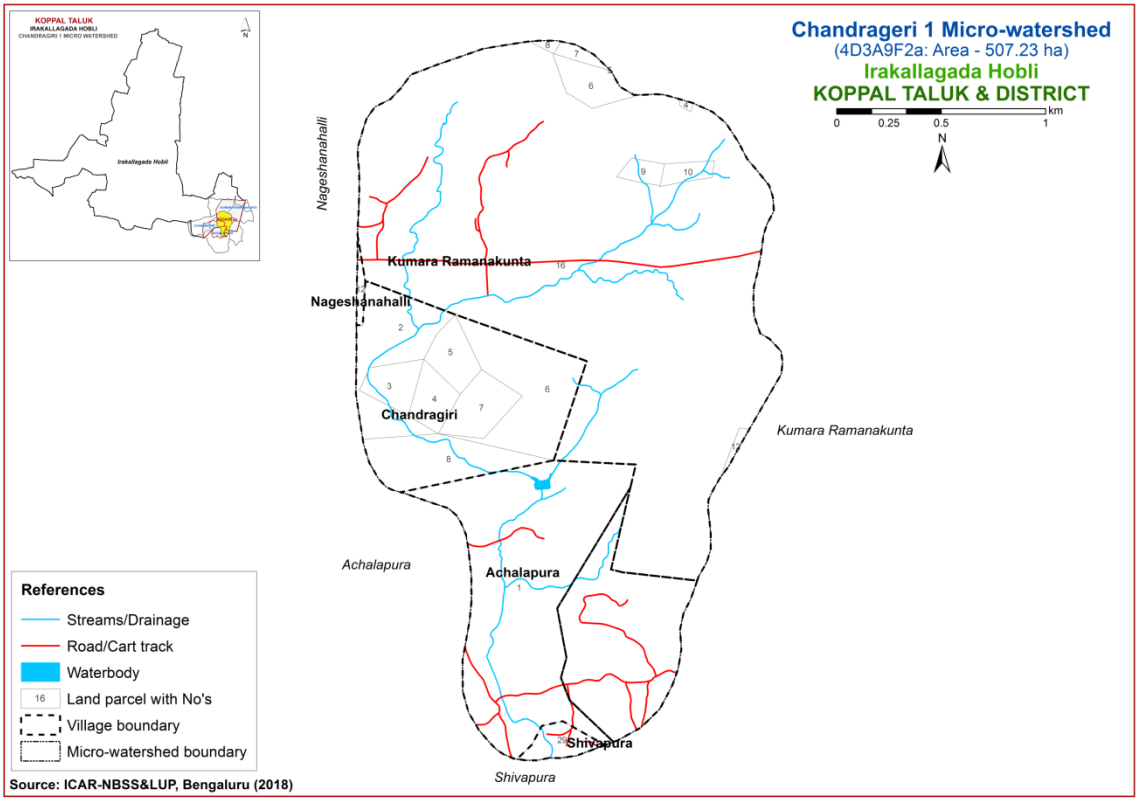


Fig 3.1 Scanned and Digitized Cadastral map of Chandrageri-1 Microwatershed

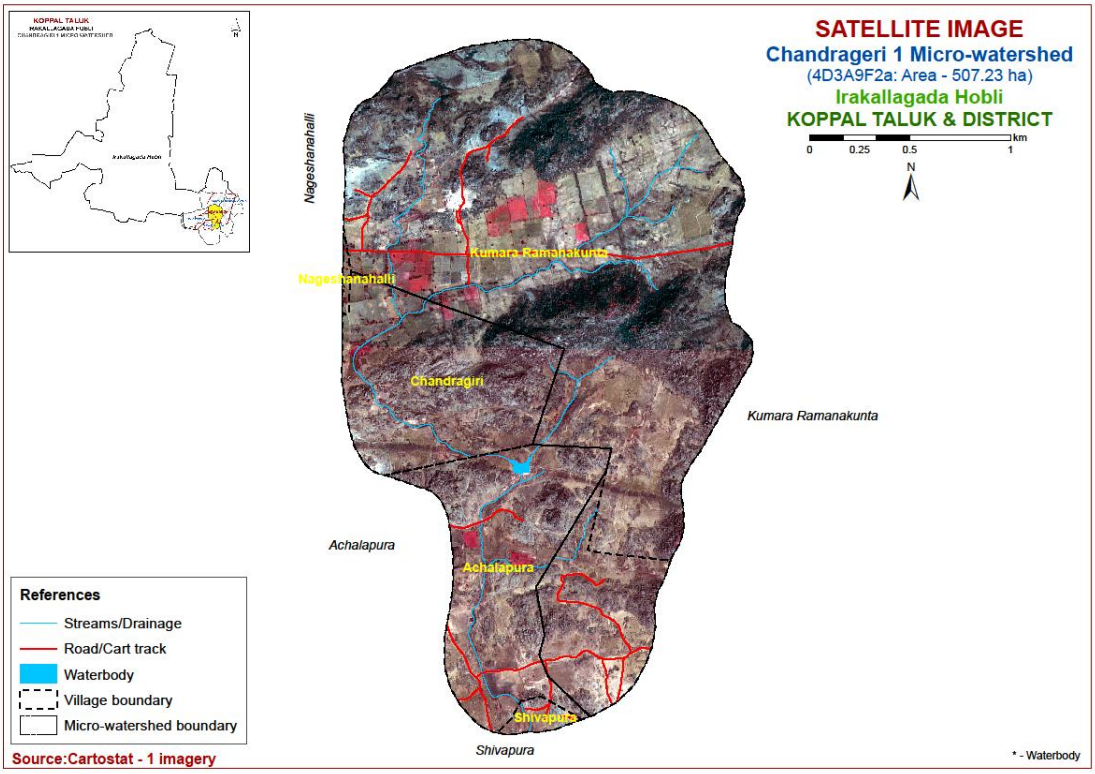


Fig.3.2 Satellite Image of Chandrageri-1 Microwatershed

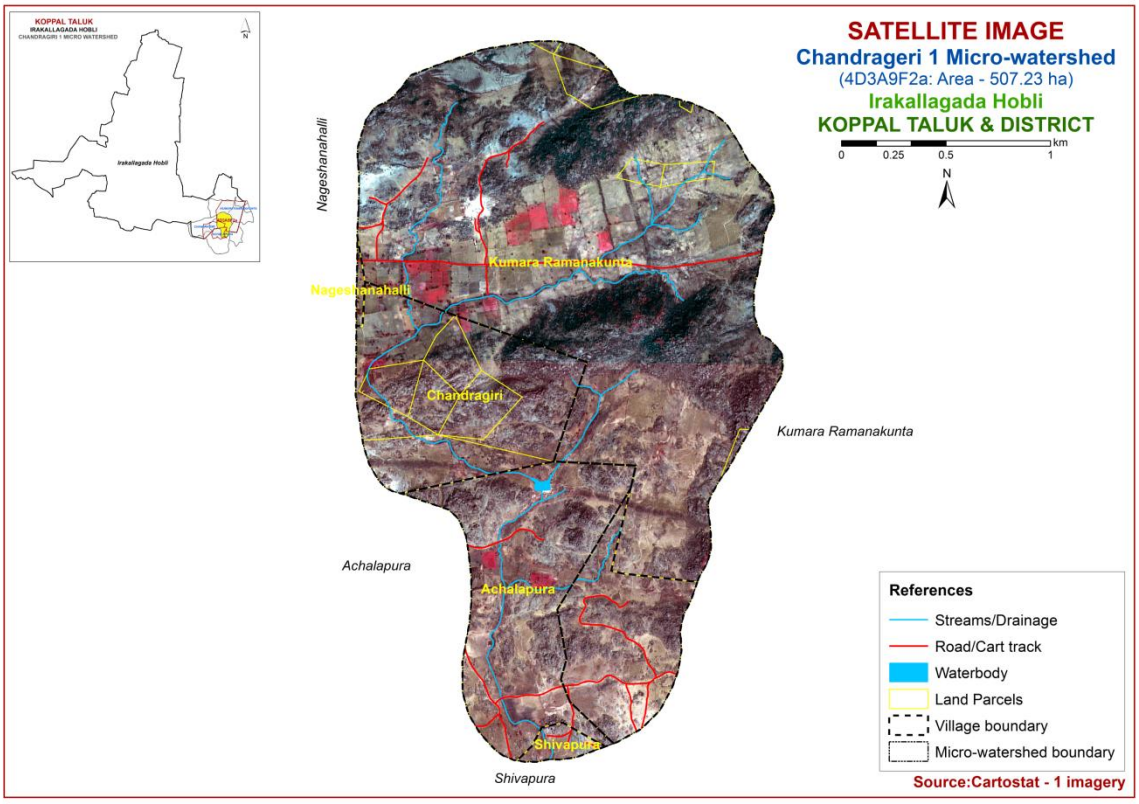


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Chandrageri-1 Microwatershed

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, uplands and plains was carried out. Based on the variability observed on the surface, transects (Fig 3.4) were selected across the slope covering all the landform units in the microwatershed (Natarajan and Dipak Sarkar, 2010).

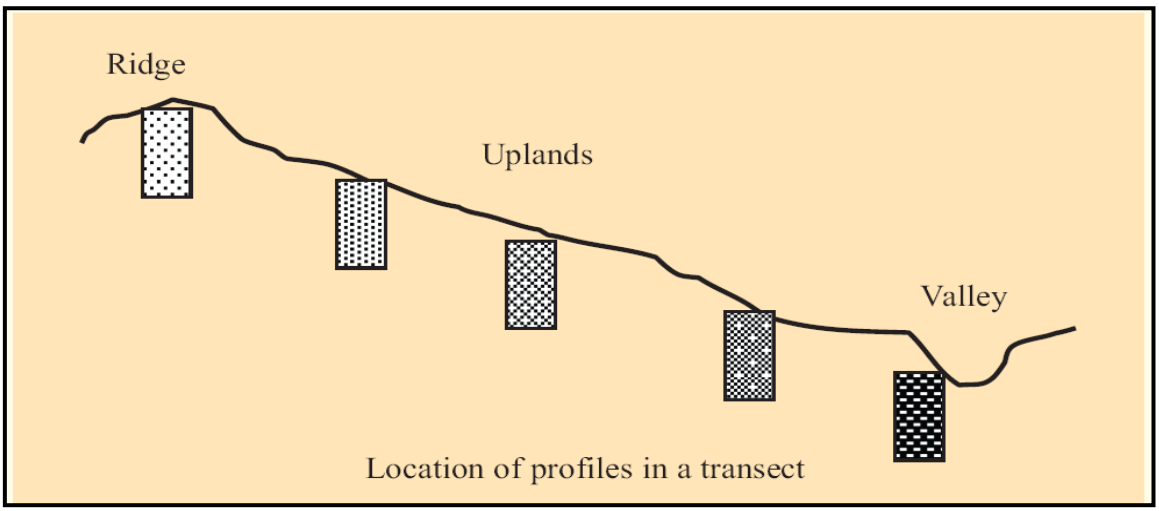


Fig: 3.4. Location of profiles in a transect

In the selected transect, soil profiles (Fig.3.4) were located at closely spaced intervals to take care of any change in the land features like break in slope, erosion, gravel, stones etc. In the selected sites, profiles (vertical cut showing the soil layers from surface to the rock) were opened upto 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all profile sites on a standard proforma as per the guidelines given in USDA Soil Survey Manual (Soil Survey Staff, 2012). Apart from the transect study, profiles were also studied at random, almost like in a grid pattern, outside the transect areas to validate the soil map unit boundaries.

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

identifying the soil series are given in Table 3.1. Based on the above characteristics, 5 soil series were identified in Chandrageri-1 microwatershed.

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

Soils of Granite Gneiss Landscape							
Sl. No	**Soil Series**	**Depth (cm)**	**Colour (moist)**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcareo-usness**
1	Belagatti (BGT)	<25	10 YR3/1, 3/2, 4/2	gc	>35	Ap-Crk	es
2	Chikkasavanur (CSR)	25-50	7.5YR3/2,3/3,3/4	scl	<15	Ap-Bw-Cr	-
3	Kutegoudanahundi (KGH)	50-75	7.5YR3/2,3/3,3/4	gscl	15-35	Ap-Bt-Cr	-
4	Hooradhahalli (HDH)	75-100	2.5YR2.5/4,3/4, 3/6	gsc-gc	>35	Ap-Bt-Cr	-
5	Bisarahalli (BSR)	75-100	5 YR 3/3, 3/4	gsc	15-35	Ap-Bt-Cr	-

3.4 Soil Mapping

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.3.5) in the form of symbols. During the survey many soil profile pits, few mini pits and a few auger bores representing different landforms occurring in the microwatershed were studied. In addition to the profile study, spot observations in the form of mini pits, road cuts, terrace cuts etc., were studied to validate the soil boundaries on the soil map.

The soil map shows the geographic distribution of 9 mapping units representing 5 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 9 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one soil phase will have similar management needs and have to be treated accordingly.

3.5 Laboratory Characterization

Soil samples for each series were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected in the year 2017 from farmer's fields in Chandrageri-1 microwatershed for fertility status (major and micronutrients) at 320 m

grid interval were analyzed in the laboratory (Katyal and Rattan, 2003). By linking the soil fertility data to the survey numbers through GIS, soil fertility maps were generated using Kriging method for the microwatershed.

Table 3.2 Soil map unit description of Chandrageri-1 Microwatershed

Soil map unit No*	Soil Series	Soil Phase Symbol	Mapping Unit Description	Area in ha (%)
Soils of Granite and Granite gneiss				
4	BGT	Belagatti soils are very shallow (<25 cm), well drained, have very dark gray to very dark grayish brown, calcareous gravelly clay black soils occurring on very gently sloping uplands under cultivation		**23 (4.53)**
		BGThB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	23 (4.53)
36	CSR	Chikkasavanur soils are shallow (25-50 cm), well drained, have dark brown to light yellowish brown, red sandy clay loam soils occurring on nearly level to very gently sloping uplands under cultivation		**57 (11.31)**
37		CSRcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	48 (9.48)
		CSRhB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	9 (1.83)
	KGH	Kutegoudanahundi soils are moderately shallow (50-75 cm), well drained, have brown to dark brown red gravelly sandy clay loam soils occurring on very gently to gently sloping uplands under cultivation		**22(4.2)**
62		KGHbB2g1	Loamy sand surface, slope1-3%, moderate erosion, gravelly (15-35%)	11 (2.1)
65		KGHcB2g1	Sandy loam surface, slope1-3%, moderate erosion, gravelly (15-35%)	11 (2.1)
	HDH	Hooradhahalli soils are moderately deep (75-100 cm), well drained, have dark red to dark reddish brown, red gravelly sandy clay to clay soils occurring on nearly level to moderately sloping uplands under cultivation		**15 (2.91)**
123		HDHhB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	15 (2.91)
	BSR	Bisarahalli soils are moderately deep (75-100 cm), well drained, have dark reddish brown red gravelly sandy clay soils occurring on very gently sloping uplands under cultivation		**5(1.04)**
158		BSRbB2g1	Loamy sand surface, slope1-3%, moderate erosion, gravelly (15-35%)	1 (0.2)
160		BSRhB1g1	Sandy clay loam surface, slope1-3%, slight erosion, gravelly (15-35%)	4 (0.84)
999		Rock out crops	Rock lands, both massive and bouldery	**385**

			with little or no soil	**(75.93)**
1000		Others	Waterbody	**0.42 (0.08)**

*Soil map unit numbers are continuous for the taluk, not the microwatersheds

3.6 Land Management Units

The 9 soil phases identified and mapped in the microwatershed were regrouped into five Land Management Units (LMU's) for the purpose of preparing a Proposed Crop Plan for sustained development of the microwatershed. The database (soil phases) generated under LRI was utilized for identifying Land Management Units (LMU's) based on the management needs. One or more than one soil site characteristic having influence on the management have been chosen for identification and delineation of LMUs. For Chandrageri-1 microwatershed, five soil and site characteristics, namely the 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.

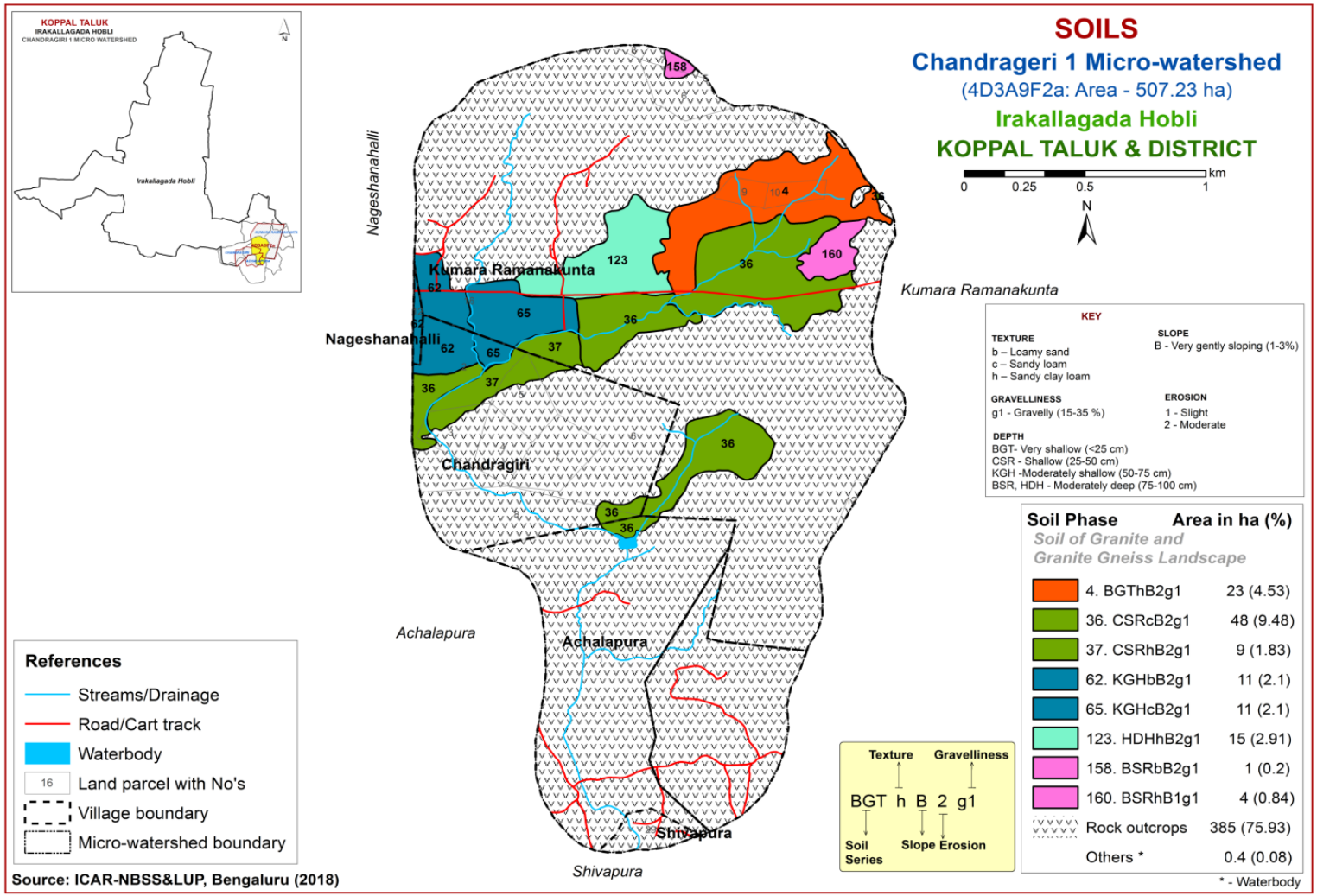


Fig 3.5 Soil Phase or Management Units- Chandrageri-1 Microwatershed

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Chandrageri-1 microwatershed is provided in this chapter. The microwatershed area has been identified as granite gneiss and alluvial landscapes based on geology. In all, 5 soil series were identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. The soil formation is dominantly influenced by the parent material, climate, time and relief.

A brief description of each of the 5 soil series identified followed by 9 soil phases (management units) mapped (Fig. 3.5) are furnished below. The physical and chemical characteristics of soil series identified in Chandrageri-1 microwatershed are given in Table 4.1 along with soil classification. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristic that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

4.1 Soils of Granite and Granite gneiss landscape

In this landscape, 5 soil series were identified and mapped. Of these series, Chikkasavanur (CSR) series occupies maximum area of 57 ha (11%) followed by Belagatti (BGT) series 23 ha (5%). The brief description of the soil series along with the soil phases identified and mapped is given below.

4.1.1 Belagatti (BGT) Series: Belagatti soils are very shallow (< 25 cm), well drained, have dark gray to dark grayish brown, calcareous gravelly clay soils. They have developed from granite gneiss and occur on very gently sloping uplands. Belagatti series has been classified as a member of the clayey, mixed, (calcareous), isohyperthermic family of Lithic Ustorthents.

The thickness of the soil is less than 25 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 2. The texture is clay with more than 35 per cent gravel and the available water capacity is low (50-100 mm/m). One soil phase was identified and mapped.

Landscape and soil profile characteristics of Belagatti (BGT) Series

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

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

Landscape and soil profile characteristics of Chikkasavanur (CSR) Series

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

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

Landscape and soil profile characteristics of Kutegoudanahundi (KGH) Series

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

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

Landscape and soil profile characteristics of Hooradhahalli (HDH) Series

4.1.5 Bisarahalli (BSR) Series: Bisarahalli soils are moderately deep (75-100 cm), well drained, have dark reddish brown gravelly sandy clay red soils. They have developed from weathered granite gneiss and occur on very gently sloping uplands under cultivation. The Bisarahalli series has been classified as a member of the fine, mixed, isohypertyhermic family of Typic Paleustalfs.

The thickness of the solum ranges from 75 to 98 cm. The thickness of A horizon ranges from 17 to 25 cm. Its colour is in 5 YR hue with value 3 to 4 and chroma 3 to 6. The texture ranges from sandy clay loam to sandy clay with 15 to 35 per cent gravel. The thickness of B horizon ranges from 61 to 79 cm. Its colour is in 5 YR hue with value 3 and chroma 3 to 4. Its texture is gravelly sandy clay with gravel content of 15-35 per cent. The available water capacity is low (50-100 mm/m). Two soil phases were identified and mapped.

Landscape and soil profile characteristics of Bisarahalli (BSR) Series

Table: 4.1 Physical and Chemical Characteristics of Soil Series identified in Chandrageri-1 microwatershed

Series Name: Belagatti (BGT), Pedon: A2/RM-5
Location: $15^0$19'10.8"N, $75^0$57'48.1"E, Kavalura village, Koppal taluk and district
Analysis at: NBSS&LUP, Regional Centre, Bangalore. **Classification:** Clayey mixed, isohyperthermic (calcareous) Lithic Ustorthents

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-23	Ap	36.14	20.34	43.52	10.87	6.93	5.97	8.42	3.94	40	c	29.53	17.97

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-23	8.4			0.157	0.12	18.24			0.73	0.50		44.84	1.03	-	1.11

Contd…

Soil Series: Hooradhahalli (HDH), Pedon: RM-69
Location: 13^{0}24'31"N, 76^{0}33'41"E, (4D3D8G2d), Hesarahalli village, Chikkanayakanahalli taluk, Tumukur district
Analysis at: NBSS&LUP, Regional Centre, Bengaluru **Classification:** Clayey-skeletal, mixed isohyperthermic Rhodic Paleustalfs

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-18	Ap	72.56	15.17	12.27	4.57	8.33	17.38	23.88	18.39	35	sl	-	-
18-33	Bt1	56.29	10.75	32.96	7.88	10.24	13.41	14.43	10.34	55	scl	-	-
33-58	Bt2	46.66	10.79	42.55	10.79	9.87	8.43	9.04	8.53	55	sc	-	-
58-90	Bt3	43.09	13.63	43.27	9.90	8.25	7.32	8.76	8.87	45	c	-	-

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-18	6.54	-	-	0.07	0.60	0.00	2.68	1.38	0.44	0.42	4.91	5.84	0.48	84.07	7.11
18-33	5.90	-	-	0.07	0.52	0.00	3.99	1.27	0.09	0.37	5.71	8.61	0.26	66.32	4.29
33-58	6.16	-	-	0.07	0.44	0.00	4.92	1.67	0.08	0.55	7.22	10.00	0.24	72.23	5.50
58-90	6.39	-	-	0.06	0.40	0.00	4.30	2.02	0.08	0.46	6.87	9.21	0.21	74.61	5.05

Contd…

Series Name: Bisarahalli (BSR) **Pedon:** R-9
Location: $15^0$25'21.0"N, $76^0$11'42.0"E Hatti village, Koppal taluk and district
Analysis at: NBSS&LUP, Regional Centre, Bangalore. **Classification:** Fine, mixed isohyperthermic Typic Paleustalfs

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-14	Ap	70.11	9.29	20.60	22.31	15.97	11.98	9.83	10.03	20	scl	13.22	7.81
14-57	Bt1	47.27	7.52	45.20	27.04	8.28	4.61	2.10	5.24	25	sc	16.39	13.31
57-80	Bt2	41.93	8.67	49.40	21.95	6.83	4.76	4.66	3.73	30	c	21.41	15.41
80-99	Bt3	49.02	9.87	41.11	19.90	10.78	6.84	6.42	5.08	40	sc	21.82	14.24

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-14	6.59	-	-	0.12	0.73	-	4.47	1.77	0.06	0.53	6.82	8.80	0.43	77.55	6.00
14-57	7.02	-	-	0.04	0.48	-	5.85	2.31	0.06	0.20	8.43	14.70	0.33	57.32	1.36
57-80	7.00	-	-	0.05	0.28	-	11.74	2.26	0.08	0.22	14.31	15.60	0.32	91.73	1.44
80-99	6.90	-	-	0.06	0.18	-	13.70	2.16	0.08	0.14	16.08	16.50	0.40	97.44	0.83

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

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

5.1 Land Capability Classification

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

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

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

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

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

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

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

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

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

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

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

The 9 soil map units identified in the Chandrageri-1 microwatershed are grouped under three land capability classes and four land capability subclasses (Fig. 5.1).

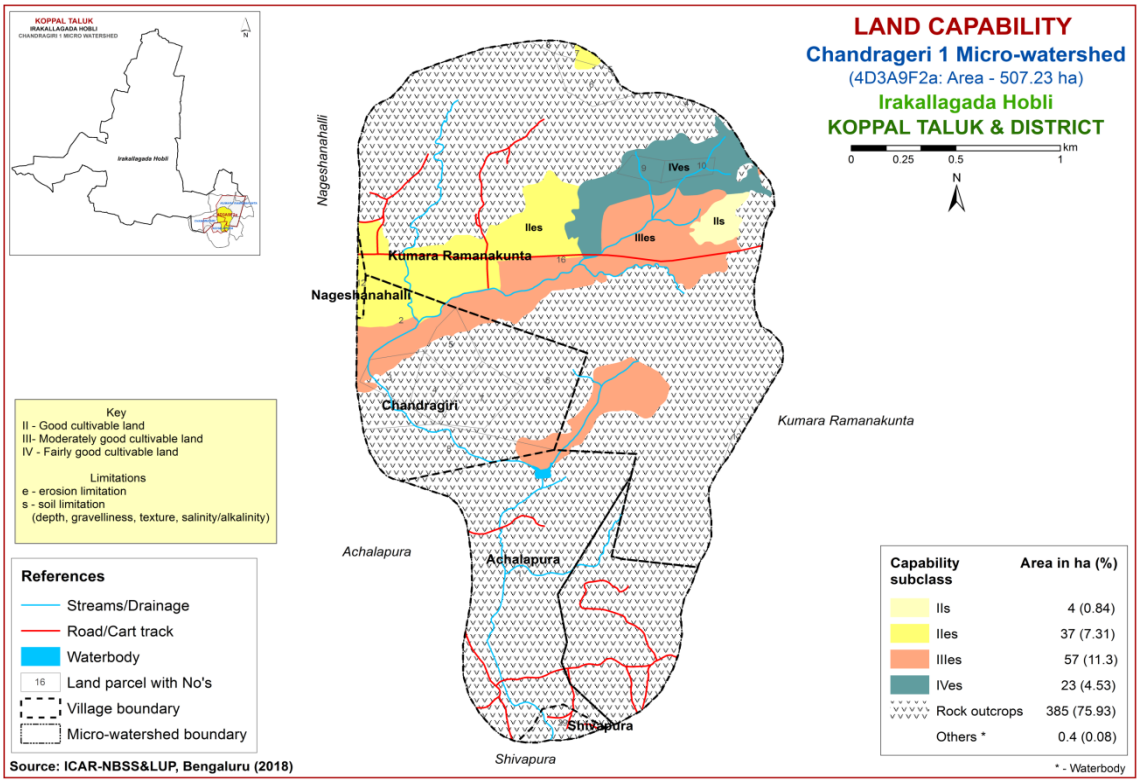


Fig. 5.1 Land Capability map of Chandrageri-1 Microwatershed

Entire area in the microwatershed is suitable for agriculture. Good lands (Class II) cover an area of about 41 ha (8%) and distributed in the northeastern, northern and western part of the microwatershed with minor problems of soil and erosion. Moderately good lands (Class III) occupy an area of about 57 ha (11 %) and distributed in the major part of the microwatershed with severe limitations of soil and erosion. Fairly good lands cover an area of about 23 ha (5%) and distributed in the eastern part of the microwatershed with very severe limitations of soil and erosion. A maximum area of about 385 ha (76%) is covered by rock lands and <1ha (<1%) is under water body.

5.2 Soil Depth

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

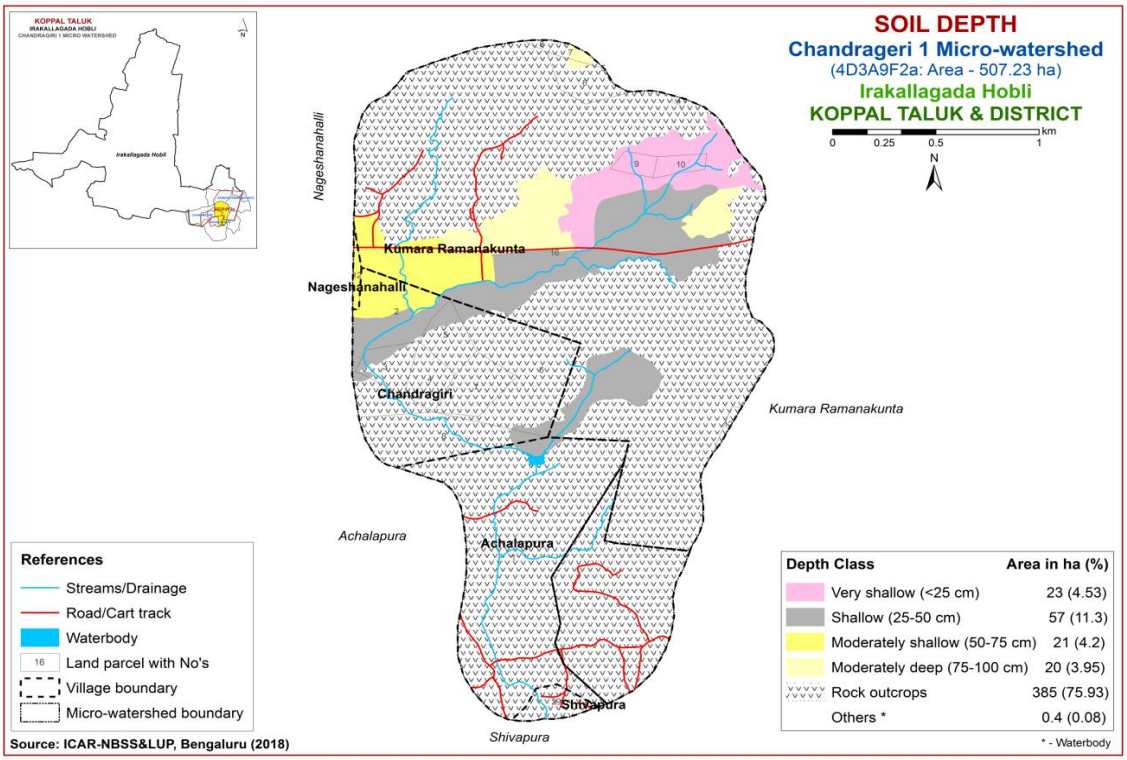


Fig. 5.2 Soil Depth map of Chandrageri-1 Microwatershed

An area of about 23 ha (5%) is very shallow (<25 cm) and distributed in the northeastern part of the microwatershed. An area of about 57 ha (11%) is shallow (25-50

cm) and distributed in the central part of the microwatershed. An area of about 41 ha (8%) are moderately shallow to moderately deep (50-100 cm) and distributed in the northwestern and central part of the microwatershed.

The problem lands cover about 80 ha (16%) where only short duration crops can be grown. The probability of crop failure is very high.

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 behavior, 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 Fig 5.3.

An area of about 12 ha (2%) is sandy at the surface and distributed in the western part of the microwatershed. An area of about 110 ha (22%) is loamy (sandy loam and sandy clay loam) at the surface and distributed in the major part of the microwatershed.

The loamy (22%) soils have high potential for soil- water retention and nutrient availability but have no drainage or other physical problems. The problem soils are sandy covering 2 per cent area that has moisture and nutrient constraints.

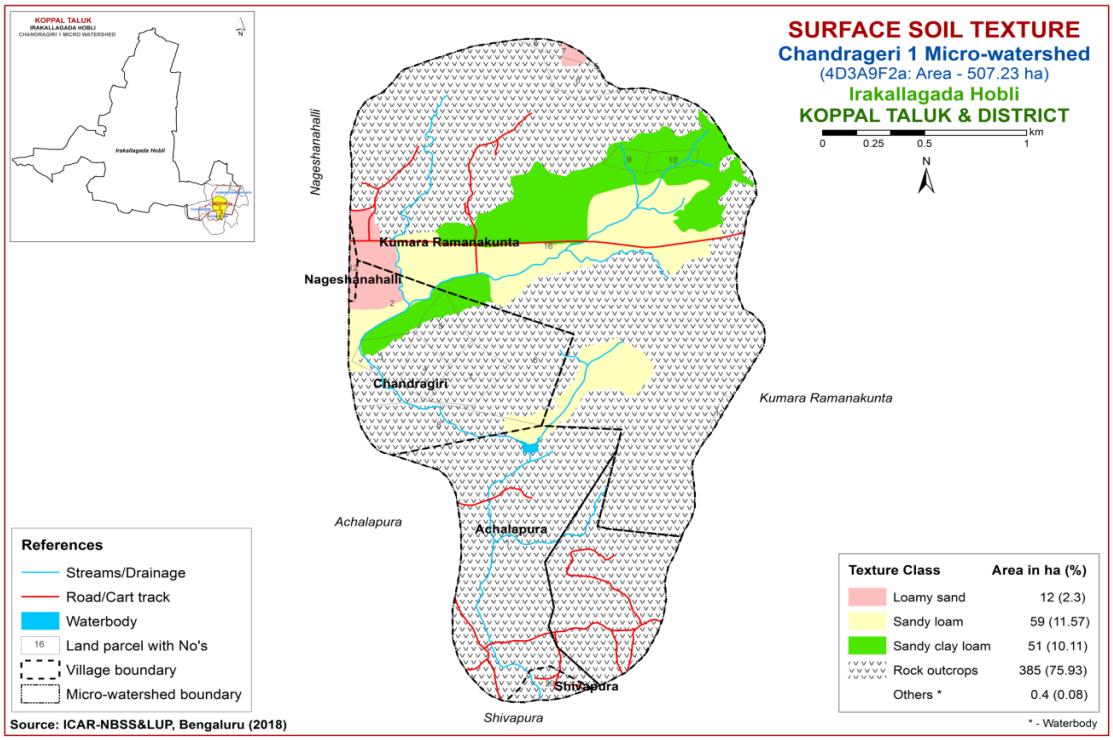


Fig. 5.3 Surface Soil Texture map of Chandrageri-1 Microwatershed

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 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 geographic distribution in the microwatershed is shown in Fig. 5.4.

Entire cultivated area of about 122 ha (24 %) is covered by gravelly (15-35% gravel) soils and are distributed in all parts of the microwatershed (Fig. 5.4).

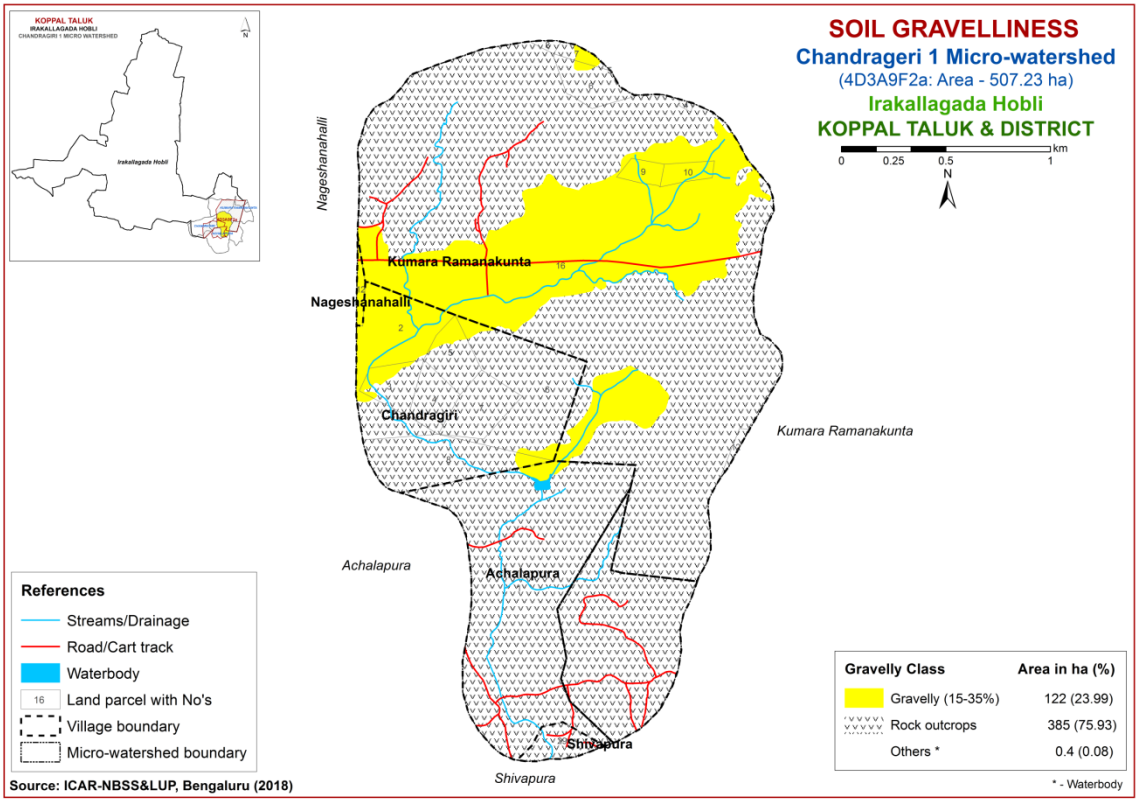


Fig. 5.4 Soil Gravelliness map of Chandrageri-1 Microwatershed

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) as estimated by considering the soil texture, mineralogy, soil depth and gravel content (Sehgal *et al.*, 1990) and accordingly the soil map units were grouped into five AWC classes *viz*, very low (<50 mm/m), low (50-100 mm/m), medium (100-150 mm/m), high (150-200 mm/m) and very high (>200 mm/m) and using these values, an AWC map was generated. The

area extent and their geographic distribution of different AWC classes in the microwatershed is shown in Fig. 5.5.

Entire area of the microwatershed has soils that are very low to low (<50 -100 mm/m) in available water capacity

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

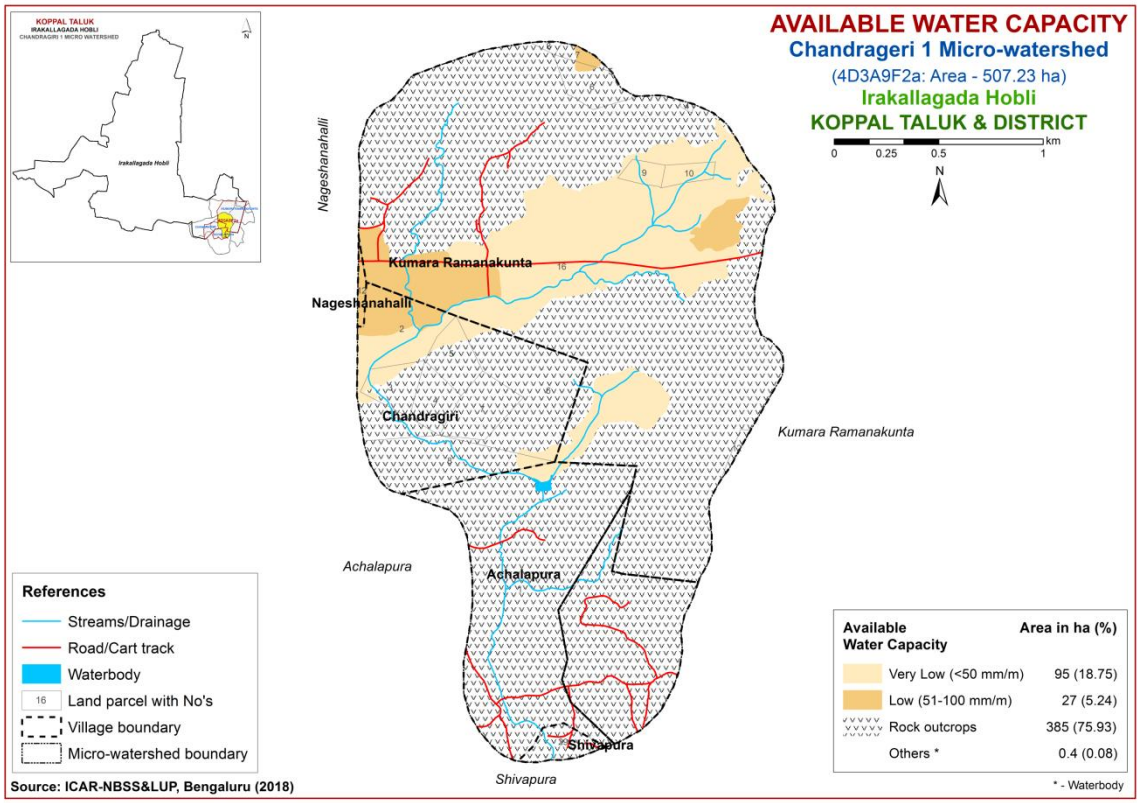


Fig. 5.5 Soil Available Water Capacity map of Chandrageri-1 Microwatershed

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 single slope class and a slope map was generated showing the area extent and their geographic distribution of different slope classes in the microwatershed (Fig. 5.6).

Very gently sloping (1-3%) lands cover an entire area of the microwatershed. In all these areas, all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

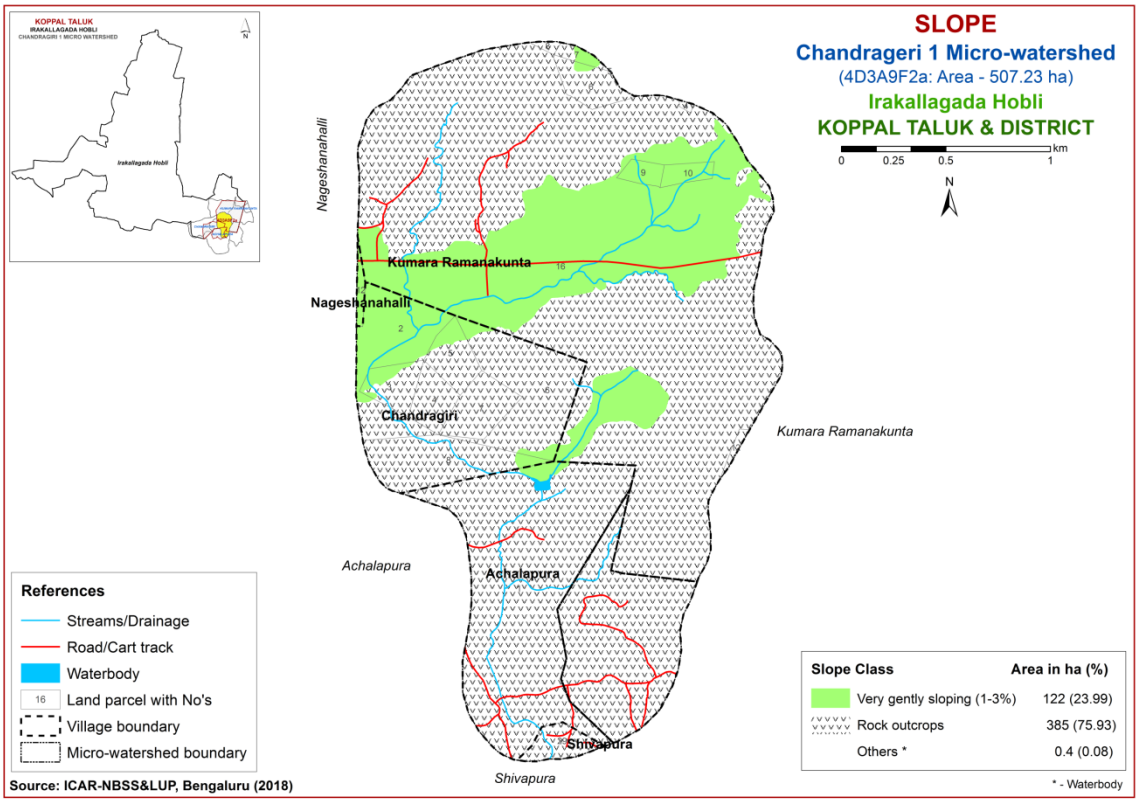


Fig. 5.6 Soil Slope map of Chandrageri-1 Microwatershed

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 a soil erosion map generated. The area extent and their spatial distribution in the microwatershed is given in Figure 5.7.

Slightly eroded lands cover an area of about 4 ha (<1 %) and distributed in the eastern part of the microwatershed. Maximum area of about 117 ha (23 %) is moderately eroded (e2 class) and distributed in the major part of the microwatershed.

Moderately eroded lands are problematic and need appropriate soil and water conservation and other land development measures.

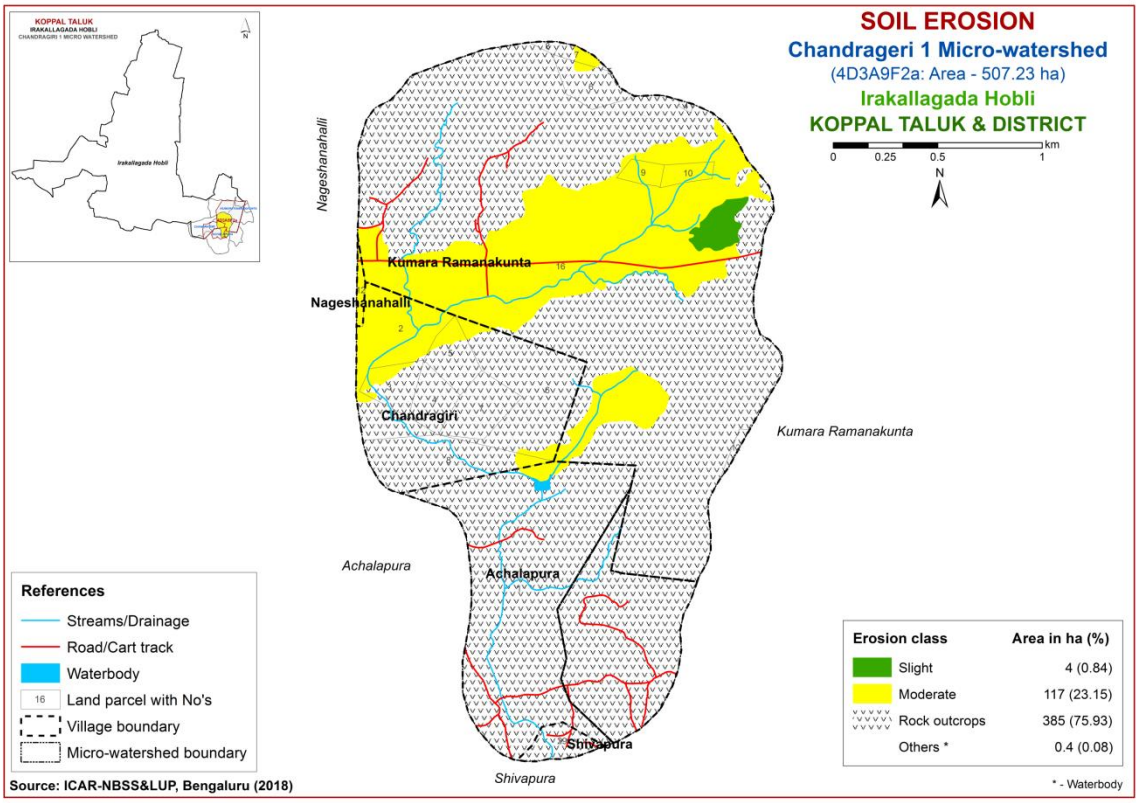


Fig. 5.7 Soil Erosion map of Chandrageri-1 Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status, as these areas are characterized by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected from the grid points (one soil sample at every 350 m grid interval) all over the microwatershed through land resource inventory in the year 2017 were analyzed for pH, EC, organic carbon, available phosphorus and potassium, and for micronutrients like zinc, boron, copper, iron and manganese, and secondary nutrient sulphur.

Soil fertility data generated has been assessed and individual maps for all the nutrients for the microwatershed have been generated by using the 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 Chandrageri-1 microwatershed for soil reaction (pH) showed that slightly acid soils (pH 6.0-6.5) cover an area of about 5 ha (1%) and distributed in the western part of the microwatershed. Neutral soils (pH 6.5-7.3) cover an area of about 21 ha (4%) and distributed in the western and central part of the microwatershed. An area of about 77 ha (15%) is slightly to moderately alkaline (pH 7.3-8.4) and is distributed in the northern and northeastern part of the microwatershed. Strongly alkaline (pH 8.4-9.0) soils cover an area of about 18 ha (4%) and are distributed in the central 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 non-saline.

6.3 Organic Carbon

An area of about 30 ha (6%) is medium (0.5-0.75%) in organic carbon content and distributed in the central and northwestern part of the microwatershed. About 92 ha (18%) area is high (>0.75%) in OC and distributed in the northwestern, northeastern and central part of the microwatershed (Fig.6.3).

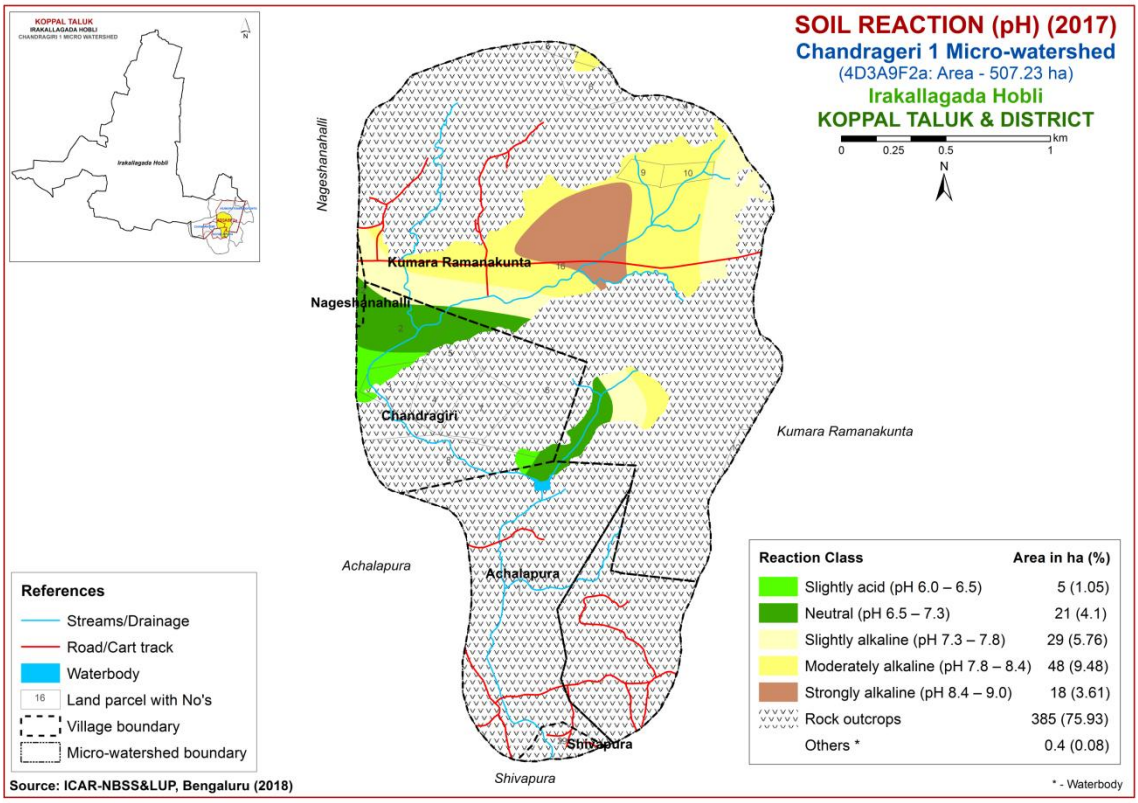


Fig.6.1 Soil Reaction (pH) map of Chandrageri-1 Microwatershed

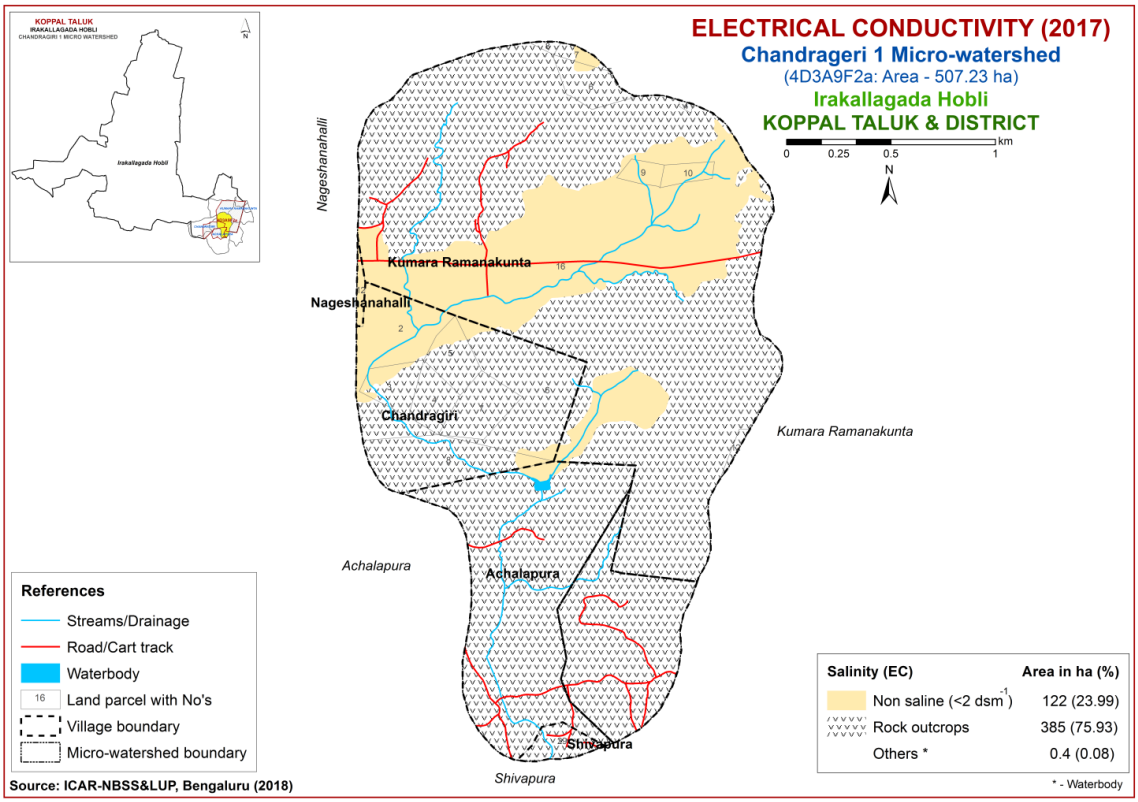


Fig.6.2 Electrical Conductivity (EC) map of Chandrageri-1 Microwatershed

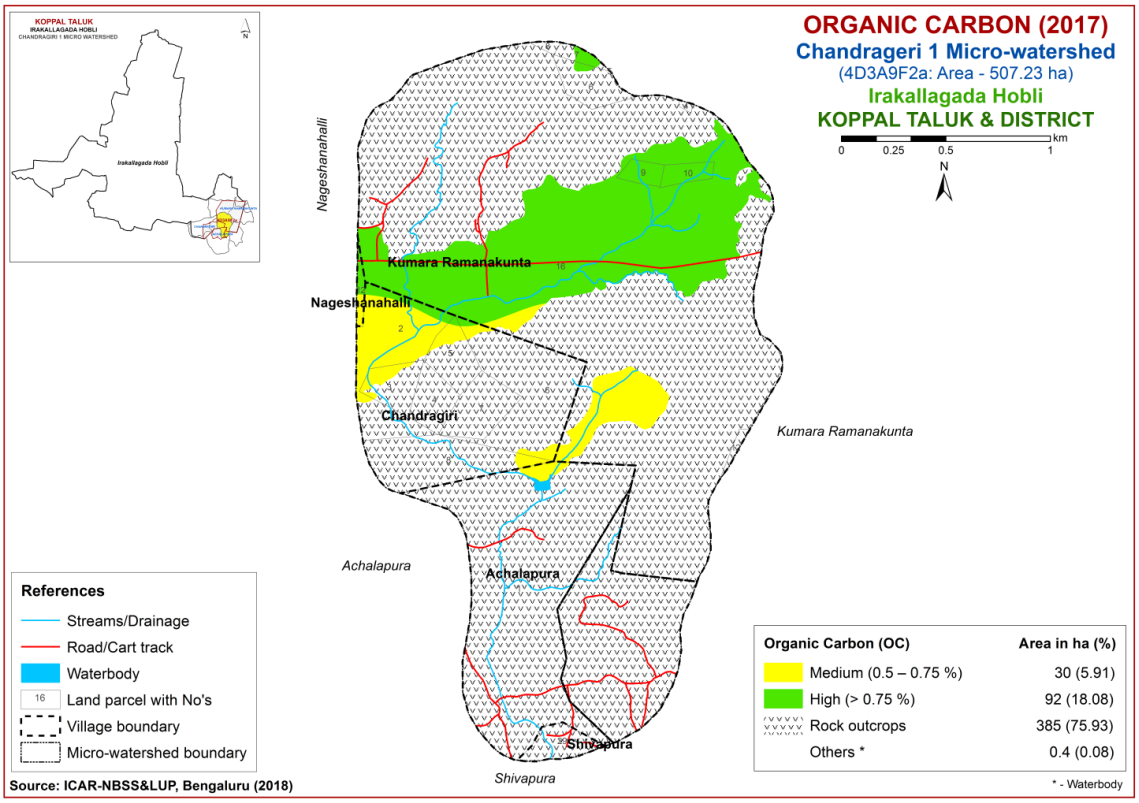


Fig.6.3 Soil Organic Carbon map of Chandrageri-1 Microwatershed

6.4 Available Phosphorus

An area of about 31 ha (6 %) is low (<23 kg/ha) in available phosphorus and distributed in the northeastern and central part of the microwatershed. Maximum area of about 91 ha (18 %) is medium (23-57 kg/ha) and distributed in the major part of the microwatershed. Apply additional 25% phosphorus in areas where it is low and medium (Fig 6.4).

6.5 Available Potassium

An area of about 32 ha (6 %) is low (<145 kg/ha) in available potassium and distributed in the central part of the microwatershed. Maximum area of about 84 ha (17%) is medium (145-337 kg/ha) in available potassium content and distributed in the major part of the microwatershed. An area of about 5 ha (1%) is high in available potassium content and distributed in the western part of the microwatershed. The areas with high potassium content reduce 25 per cent from the recommended dose to avoid the excess application of fertilizer and apply additional 25% potassium in areas where it is low and medium (Fig 6.5).

6.6 Available Sulphur

Soil analysis of available sulphur content in Chandrageri-1 microwatershed showed that a maximum area of about 88 ha (17 %) is low and distributed in the major part of the microwatershed. An area of about 33 ha (7%) is medium (10-20 ppm) in

available sulphur content and distributed in the western and central part of the microwatershed (Fig.6.6).The areas that are low and medium in available sulphur need to be applied with magnesium sulphate or gypsum or factomphos (p) fertilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.

6.7 Available Boron

Available boron content in Chandrageri-1 microwatershed is low (< 0.5ppm) in the maximum area of about 82 ha (16%) and distributed in the major part of the microwatershed. An area of about 40 ha (8%) is medium (0.5-1.0 ppm) in available boron and distributed in the eastern part of the microwatershed (Fig.6.7).

6.8 Available Iron

Available iron content in the soils of the Chandrageri-1 microwatershed is deficient (<4.5 ppm) in the entire area of the microwatershed (Fig 6.8).

6.9 Available Manganese

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

6.10 Available Copper

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

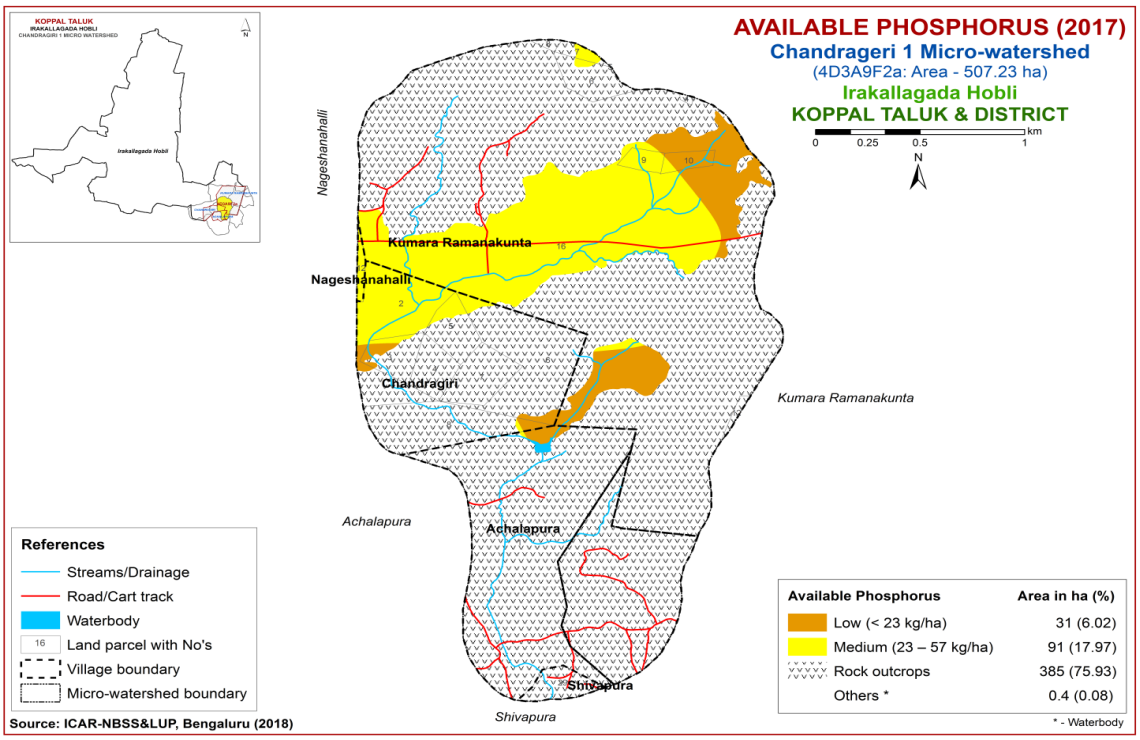


Fig.6.4 Soil Available Phosphorus map of Chandrageri-1 Microwatershed

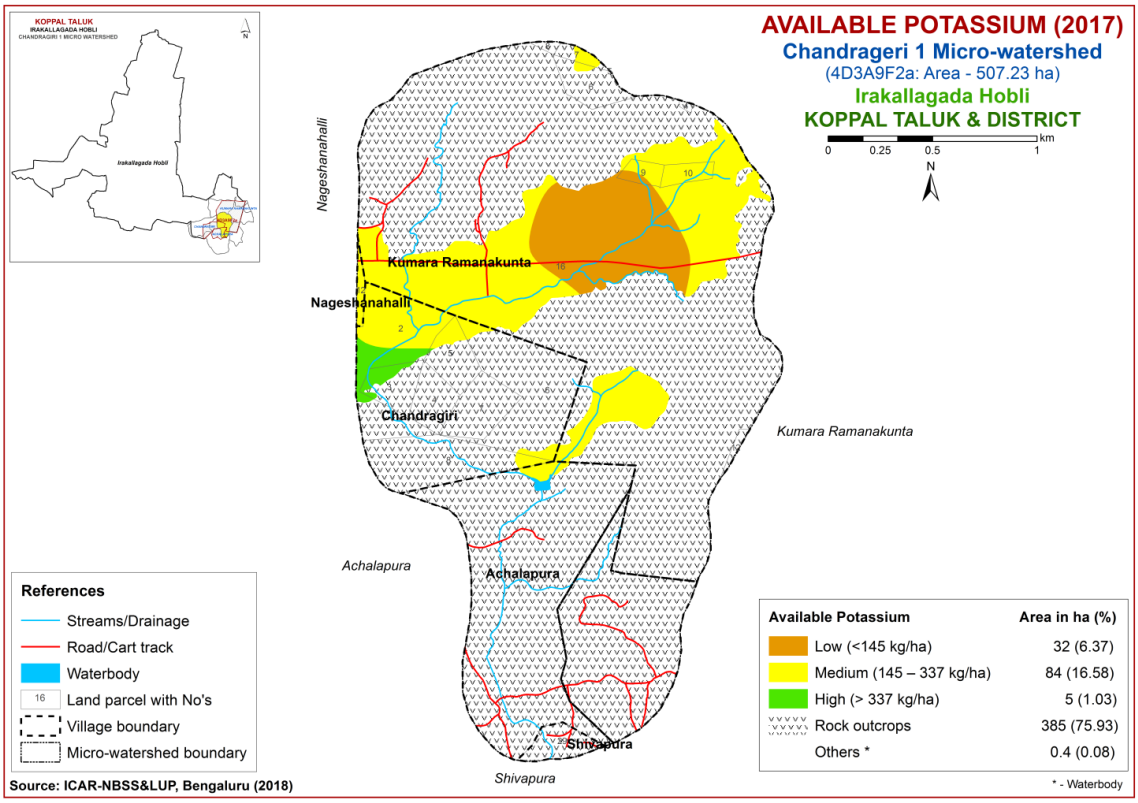


Fig.6.5 Soil Available Potassium map of Chandrageri-1 Microwatershed

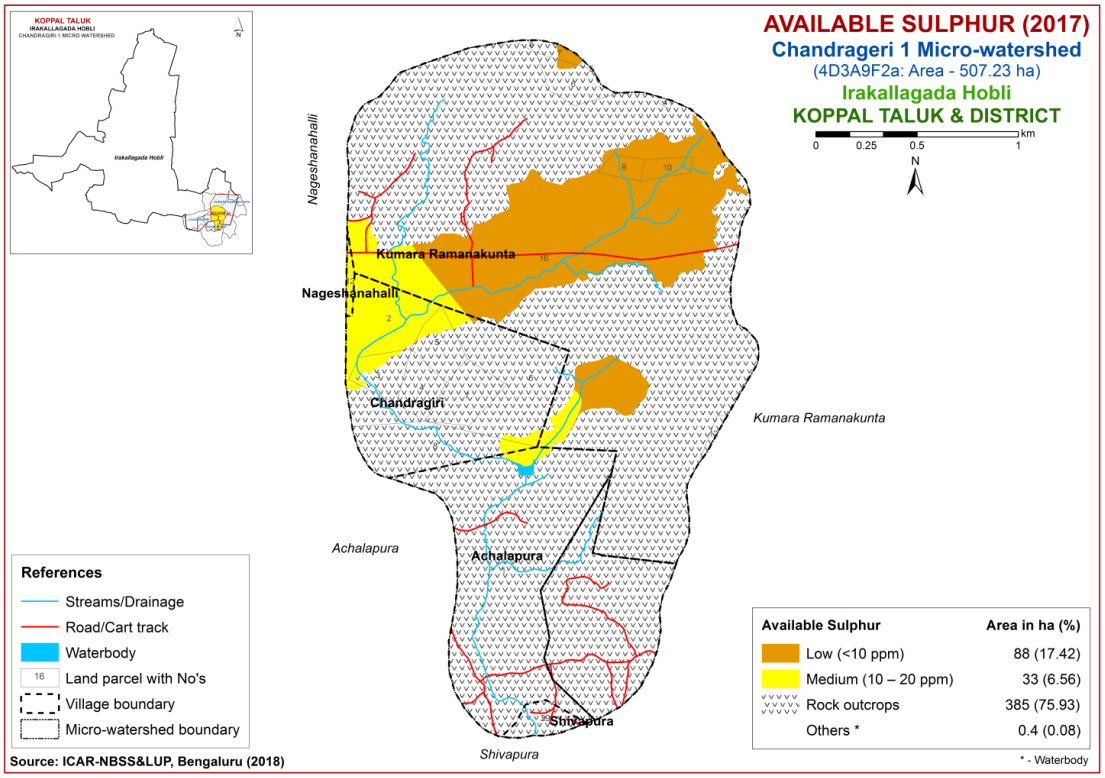


Fig.6.6 Soil Available Sulphur map of Chandrageri-1 Microwatershed

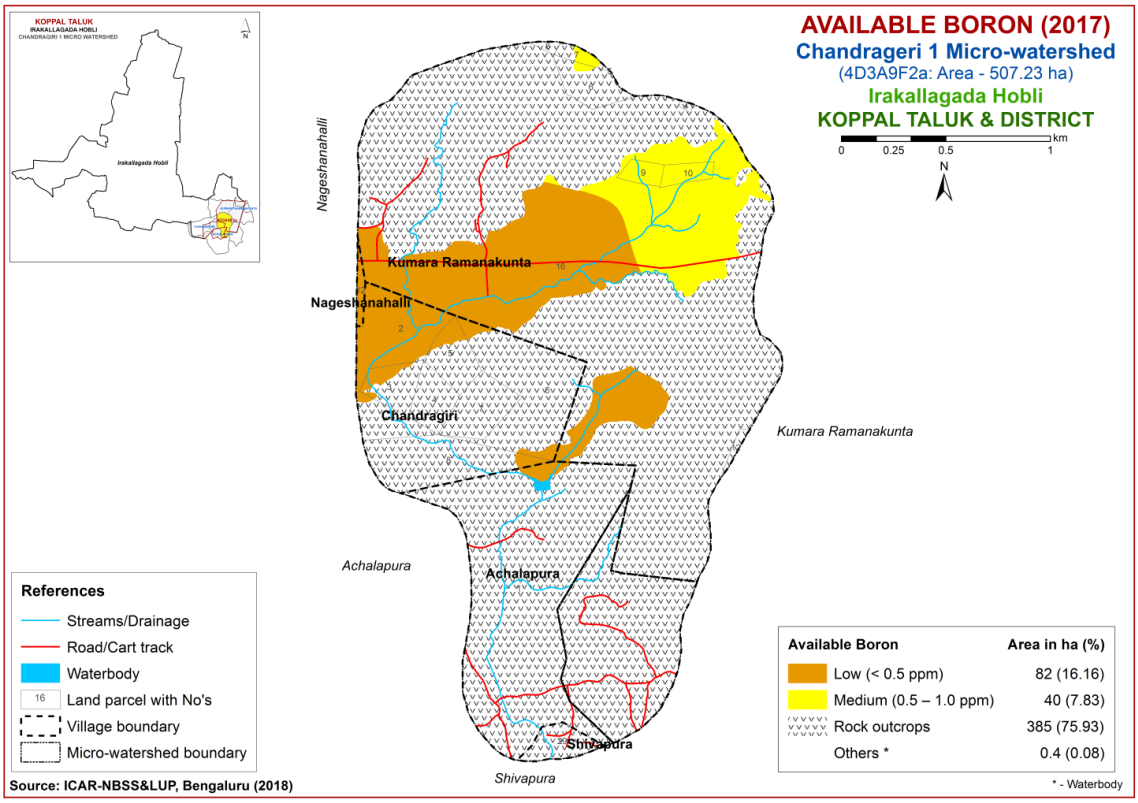


Fig.6.7 Soil Available Boron map of Chandrageri-1 Microwatershed

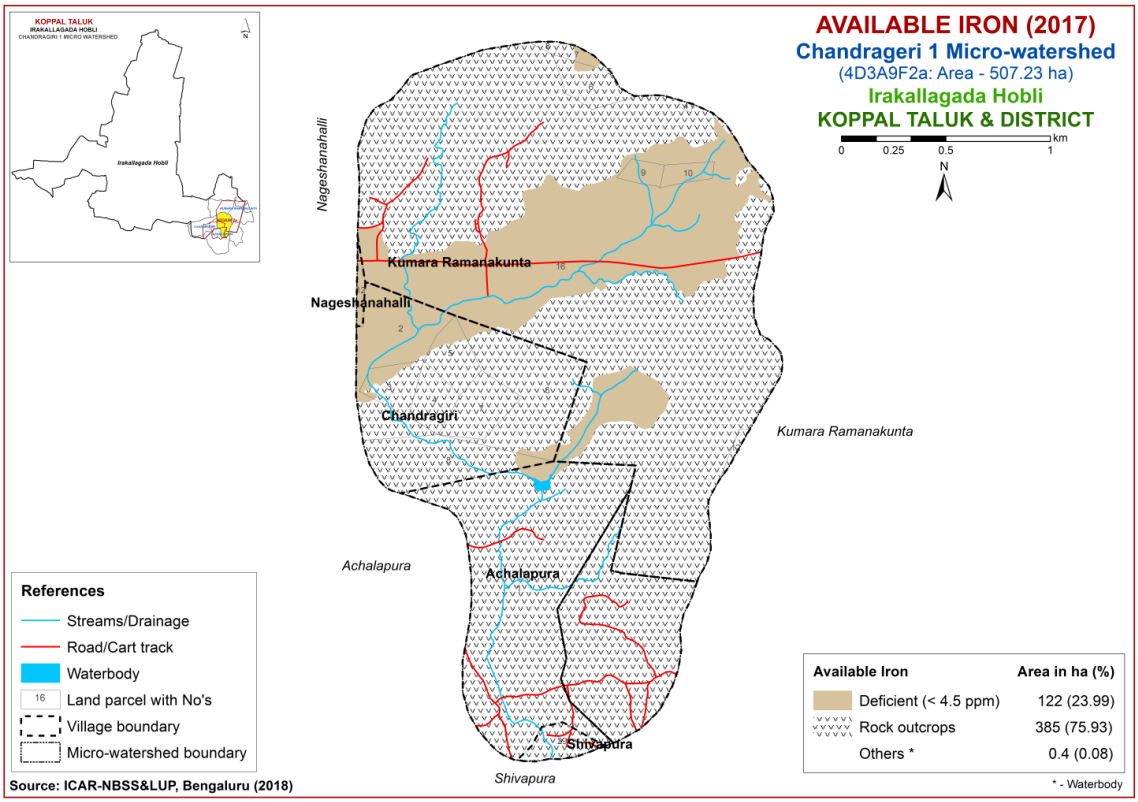


Fig.6.8 Soil Available Iron map of Chandrageri-1 Microwatershed

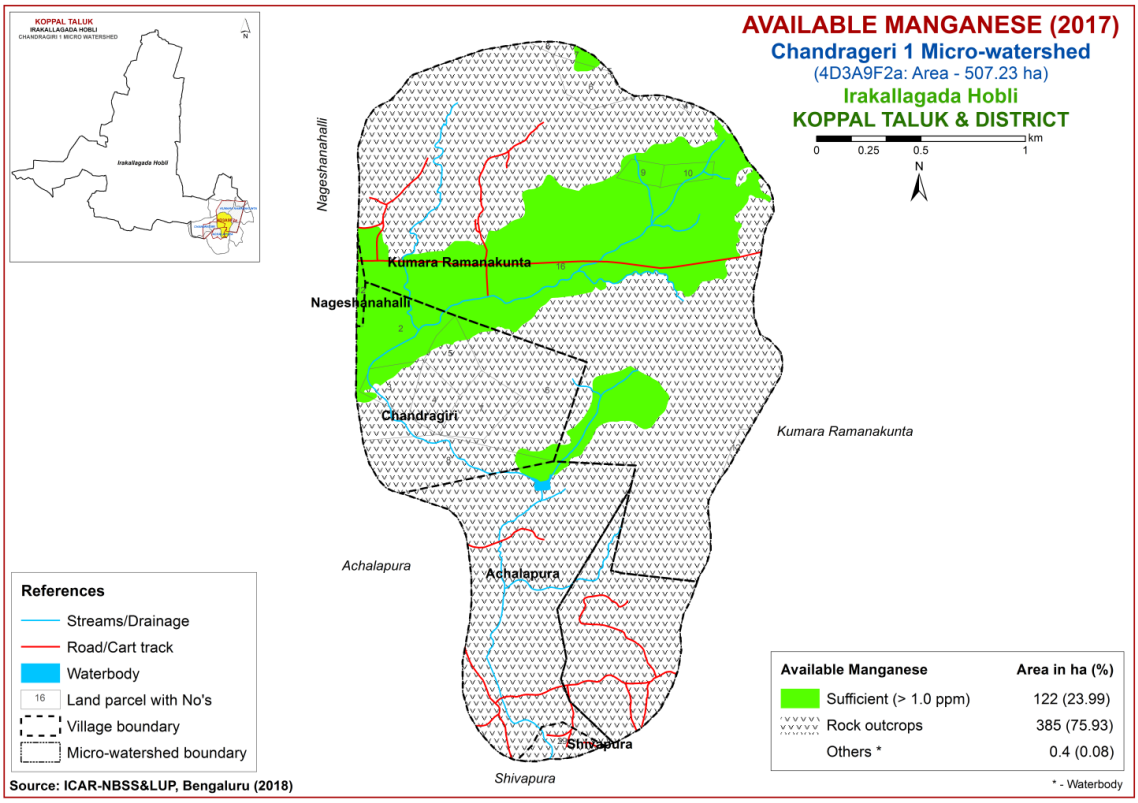


Fig.6.9 Soil Available Manganese map of Chandrageri-1 Microwatershed

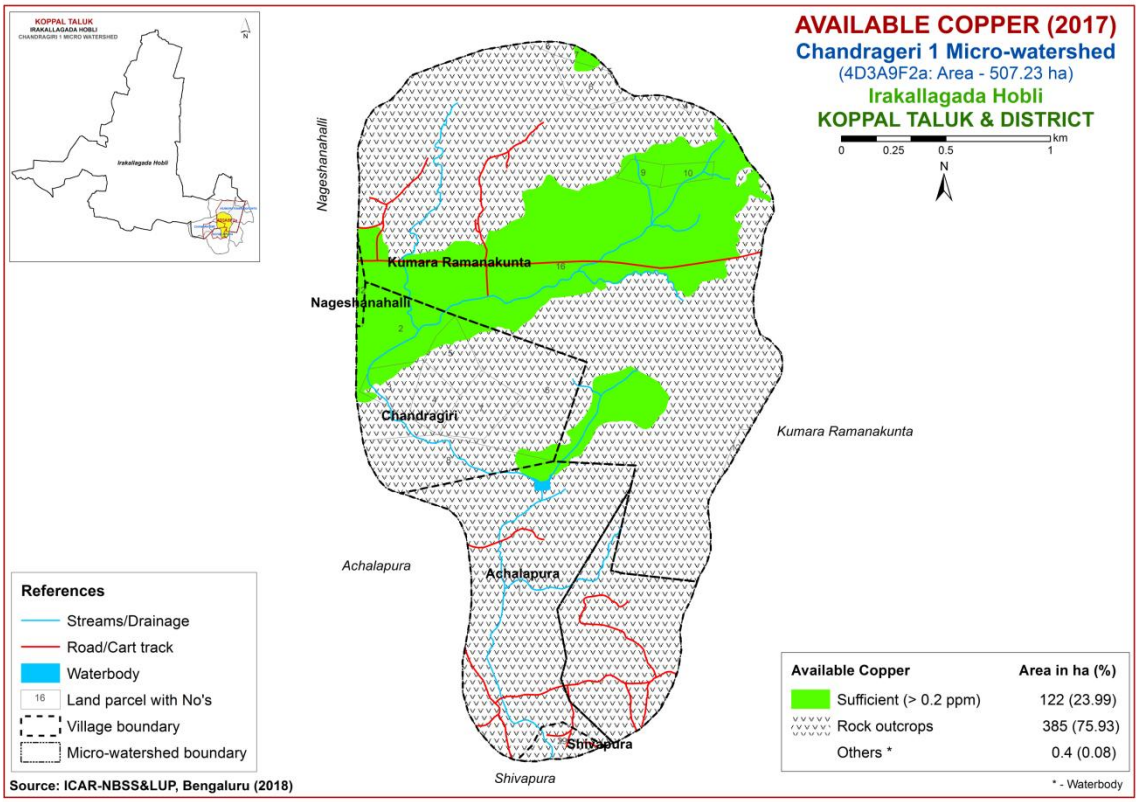


Fig.6.10 Soil Available Copper map of Chandrageri-1 Microwatershed

6.11 Available Zinc

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

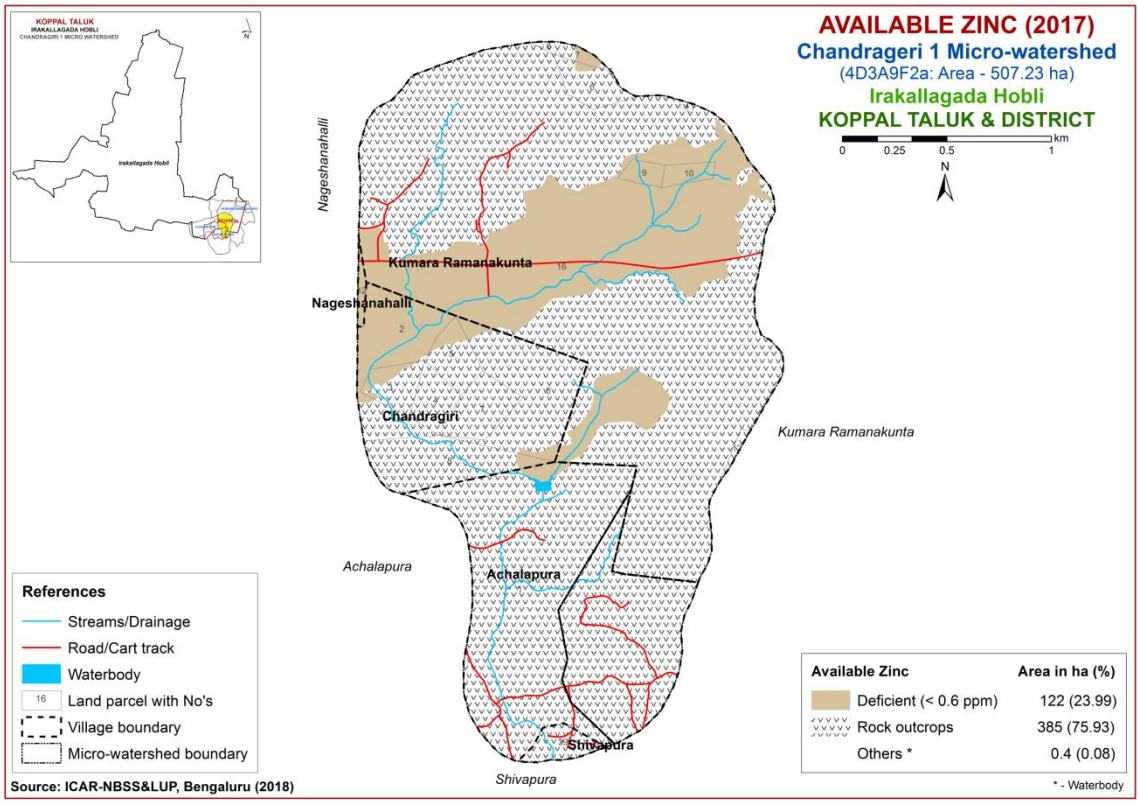


Fig.6.11 Soil Available Zinc map of Chandrageri-1 Microwatershed

Chapter 7

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Chandrageri-1 microwatershed were assessed for their suitability for growing food, fodder, f ibre 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 soil and land characteristics (Table 7.1) were matched with the crop requirements (Tables 7.2 to 7.29) to arrive at the crop suitability. The soil and land characteristics table and crop requirements tables (Tables 7.2-7.29) are given at the end. 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, S3 and N1 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, 's' for sodium 'z' for calcareousness and 'w' for drainage. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable lands 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 28 major agricultural and horticultural crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-IV.

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

Sorghum is one of the major crop grown in Karnataka in an area of 10.47 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 a land suitability map for growing sorghum was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.1.

An area of about 26 ha (5 %) is moderately suitable (Class S2) for growing sorghum and distributed in the eastern and western part of the microwatershed with minor limitations of rooting depth and gravelliness. Maximum area of about 72 ha (14%) is marginally suitable (Class S3) for growing sorghum and distributed in the major part of the microwatershed. They have moderate limitations of gravellines and rooting depth. An area of about 23 ha (5%) is currently not suitable (Class N1) for growing sorghum and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

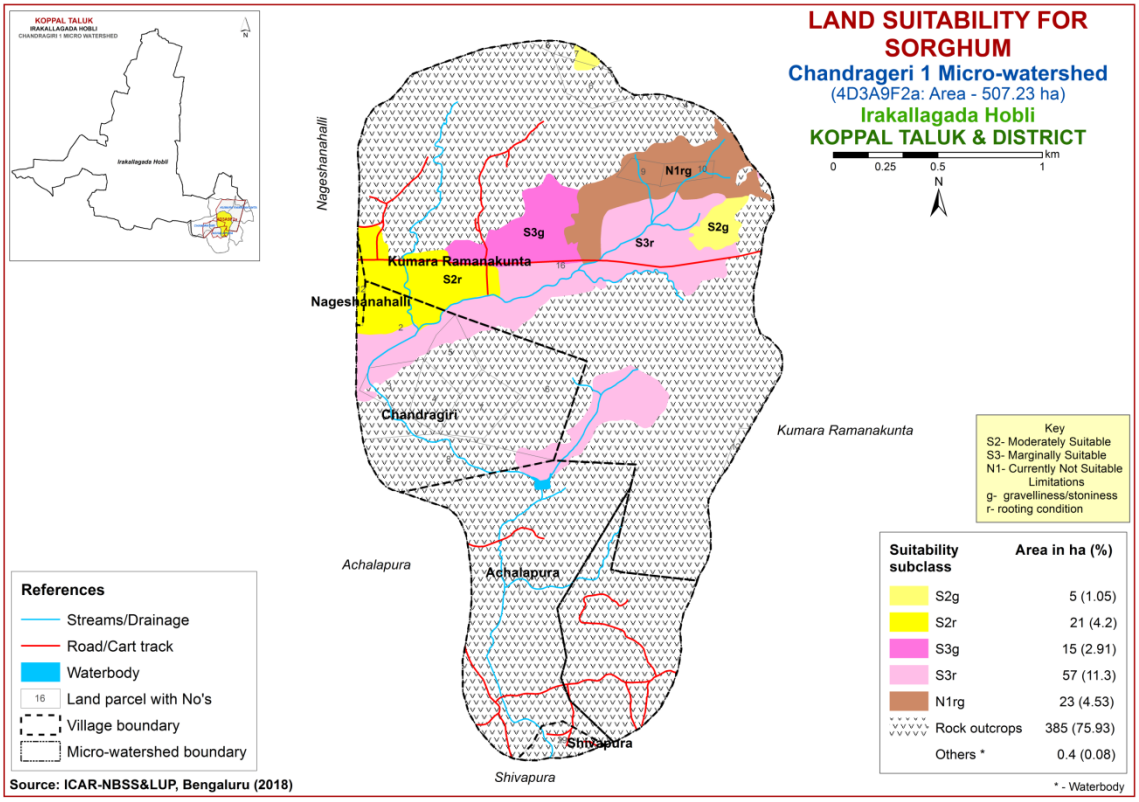


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

An area of about 26 ha (5 %) is moderately suitable (Class S2) for growing maize and distributed in the eastern and western part of the microwatershed with minor limitations of rooting depth and gravelliness. Maximum area of about 72 ha (14%) is marginally suitable (Class S3) for growing maize and distributed in the major part of the microwatershed. They have moderate limitations of gravellines and rooting depth. An area of about 23 ha (5%) is currently not suitable (Class N1) for growing maize and

distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

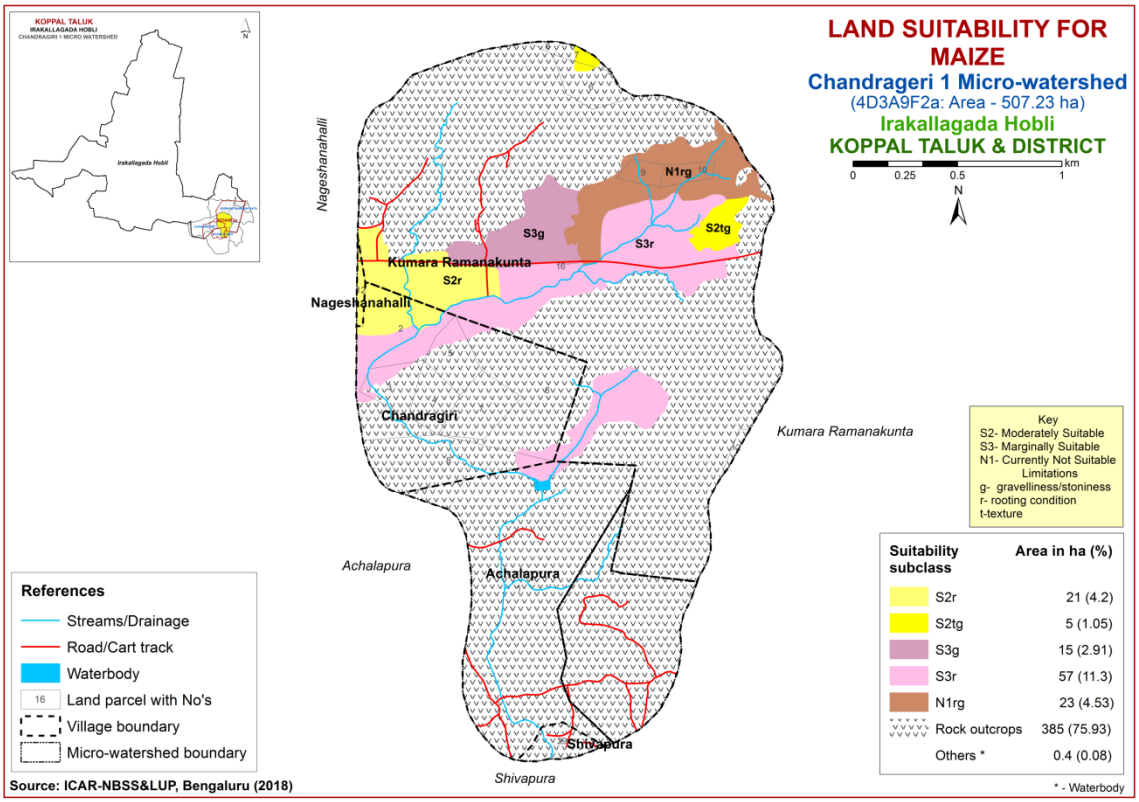


Fig. 7.2 Land Suitability map of Maize

7.3 Land Suitability for Bajra (*Pennisetum glaucum)*

Bajra is one of the major food crop grown in an area of 2.34 lakh ha in Karnataka in the northern districts. The crop requirements (Table 7.4) for growing bajra were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing bajra was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.3.

Highly suitable (Class S1) lands occupy an area of about 4 ha (<1 %) for growing bajra and occur in the northeastern part of the microwatershed. An area of about 37 ha (7%) is moderately suitable (Class S2) for growing bajra and distributed in the northwestern and central part of the microwatershed with minor limitations of texture, rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 57 ha (11%) and occur in the central part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing bajra cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

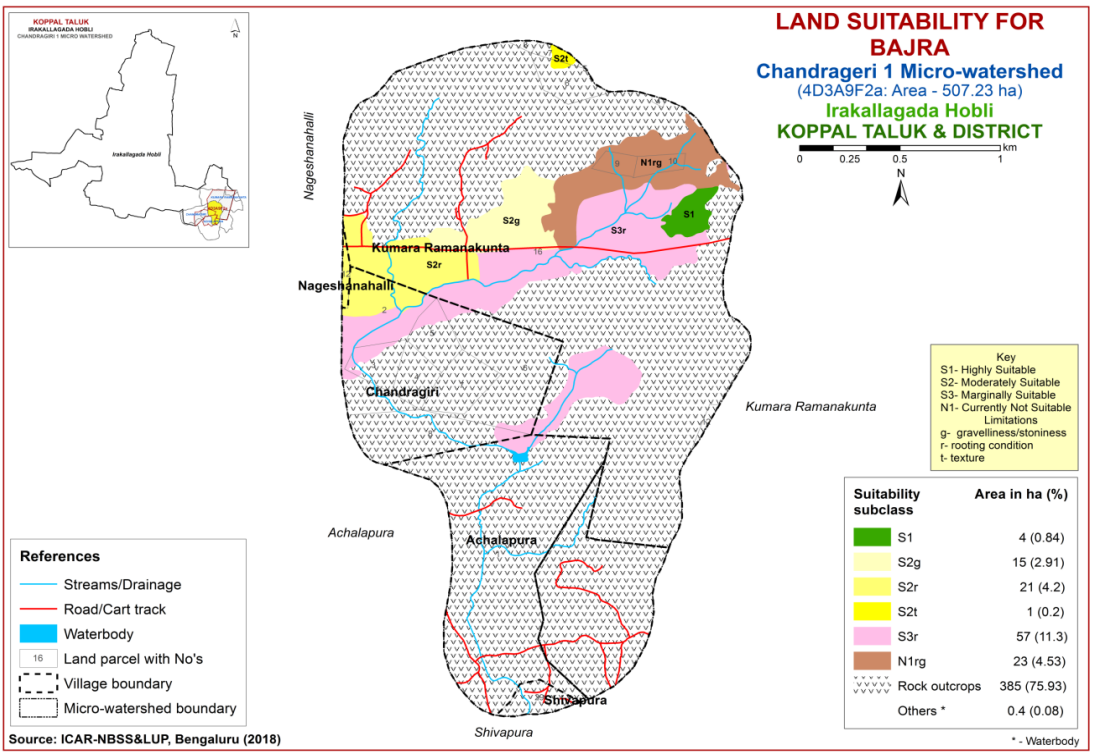


Fig. 7.3 Land Suitability map of Bajra

7.4 Land Suitability for Redgram (*Cajanus cajan*)

Redgram is one of the most important pulse crop grown in an area of 7.28 lakh ha in almost all the districts of the State. The crop requirements for growing redgram (Table 7.5) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing redgram was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.4.

An area of about 5 ha (1 %) is moderately suitable (Class S2) for growing redgram and occur in the eastern part of the microwatershed. They have minor limitations of gravelliness and texture. Marginally suitable lands (Class S3) occupy an area of about 36 ha (7%) and occur in the northwestern and central part of the microwatershed. They have moderate limitations of rooting depth and gravelliness. Area currently not suitable (Class N1) for growing redgram cover about 80 ha (16%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

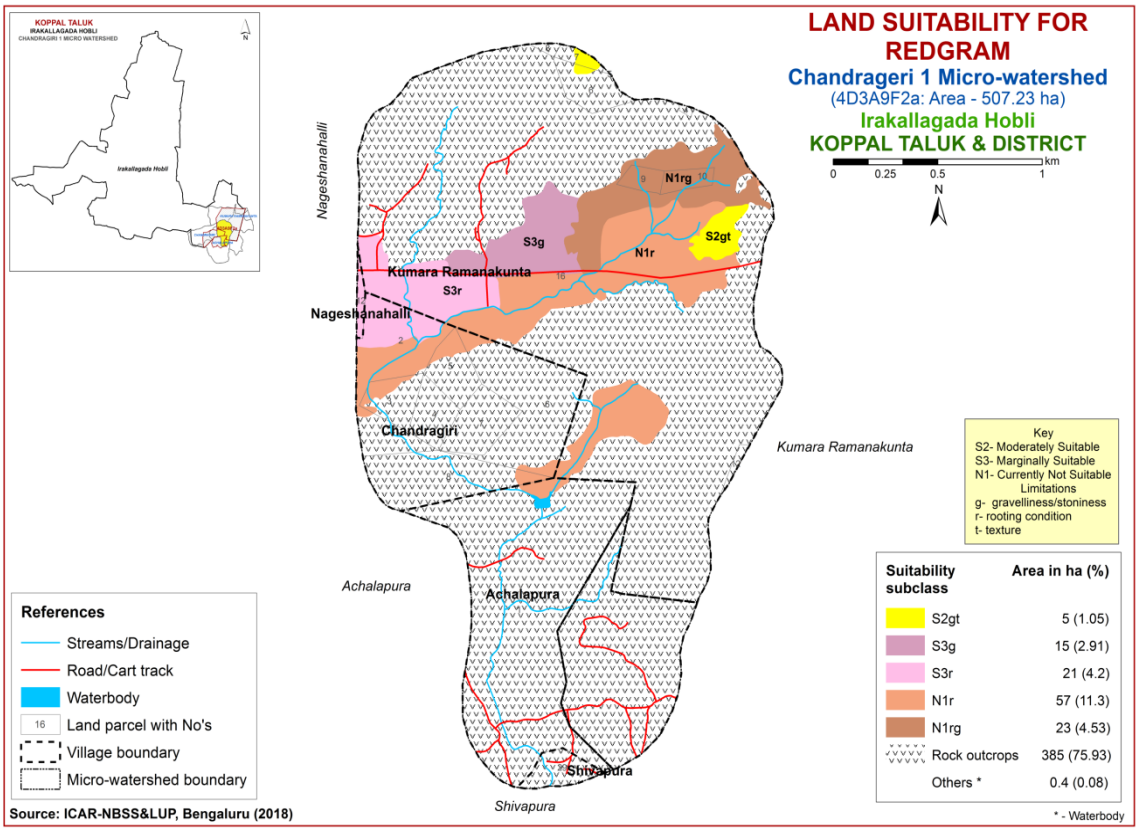


Fig. 7.4 Land Suitability map of Redgram

7.5 Land Suitability for Bengal gram (*Cicer arietinum*)

Bengal gram is one of the major pulse crop grown in an area of 9.39 lakh ha in northern Karnataka in Bijapur, Gulbarga, Raichur, Bidar, Belgaum, Dharwad and Bellary districts. The crop requirements for growing Bengal gram (Table 7.6) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing Bengal gram was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.5.

An area of about 26 ha (5%) is moderately suitable (Class S2) for growing bengalgram and are distributed in the northwestern part of the microwatershed. They have minor limitations of rooting depth, texture and gravelliness. Marginally suitable (Class S3) lands cover an area of about 72 ha (14%) and are distributed in the central part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing bengalgram cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

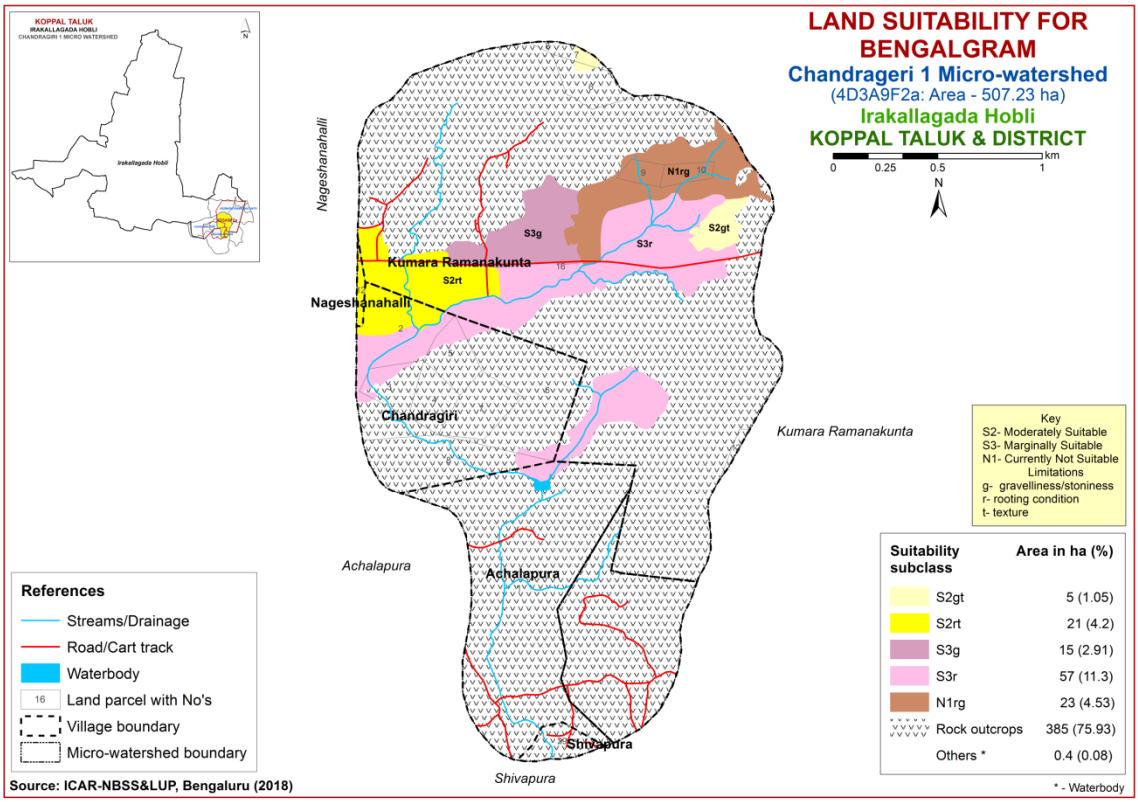


Fig. 7.5 Land Suitability map of Bengal gram

7.6 Land Suitability for Groundnut (*Arachis hypogaea*)

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

An area of about 41 ha (8 %) is moderately suitable (Class S2) for growing groundnut and distributed in the western and central part of the microwatershed. They have minor limitations of gravelliness, rooting depth and texture. Maximum area of about 57 ha (11 %) is marginally suitable (Class S3) for growing groundnut and are distributed in the central part of the microwatershed with moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing groundnut cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

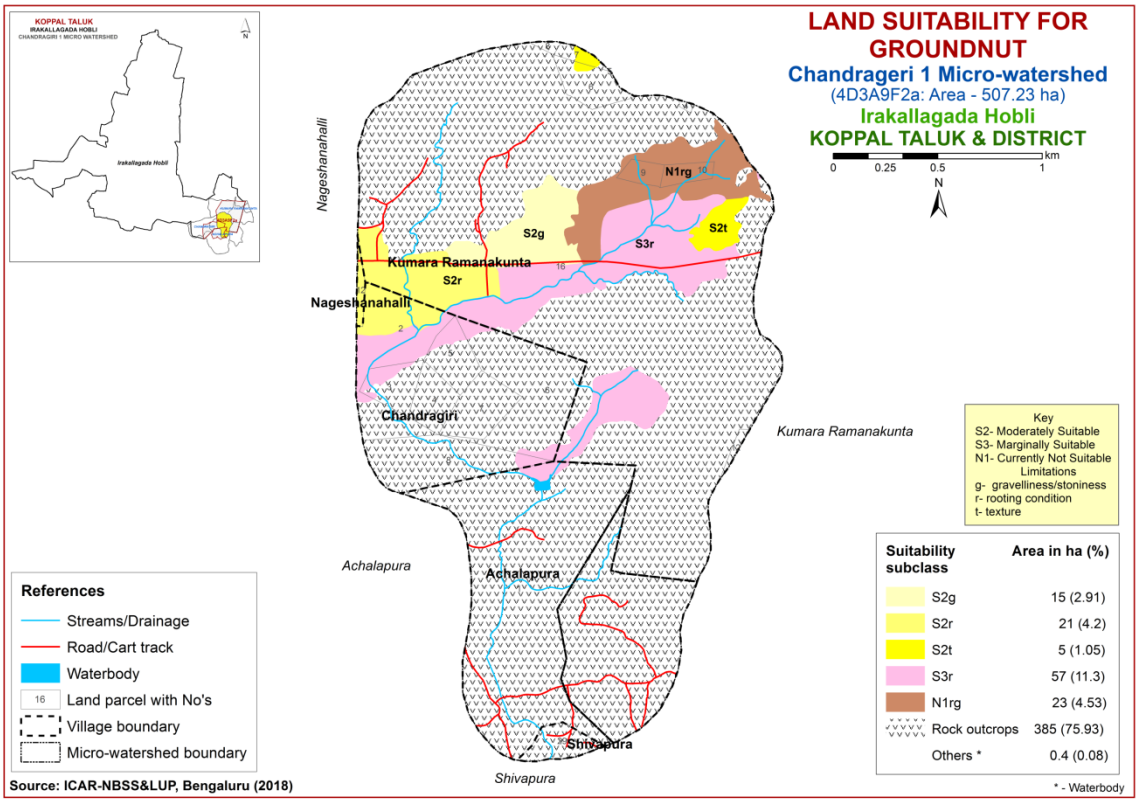


Fig. 7.6 Land Suitability map of Groundnut

7.7 Land Suitability for Sunflower (*Helianthus annus*)

Sunflower is one of the most important oilseed crop grown in an area of 3.56 lakh ha in the State in all the districts. The crop requirements for growing sunflower (Table 7.8) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sunflower was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.7.

An area of about 5 ha (1%) is moderately suitable (Class S2) and are distributed in the eastern part of the microwatershed. They have minor limitation of rooting depth. Marginally suitable (Class S3) lands occupy an area of about 36 ha (7%) and are distributed in the western part of the microwatershed with moderate limitations of rooting depth and gravelliness. Area currently not suitable (Class N1) for growing sunflower cover about 80 ha (16 %) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

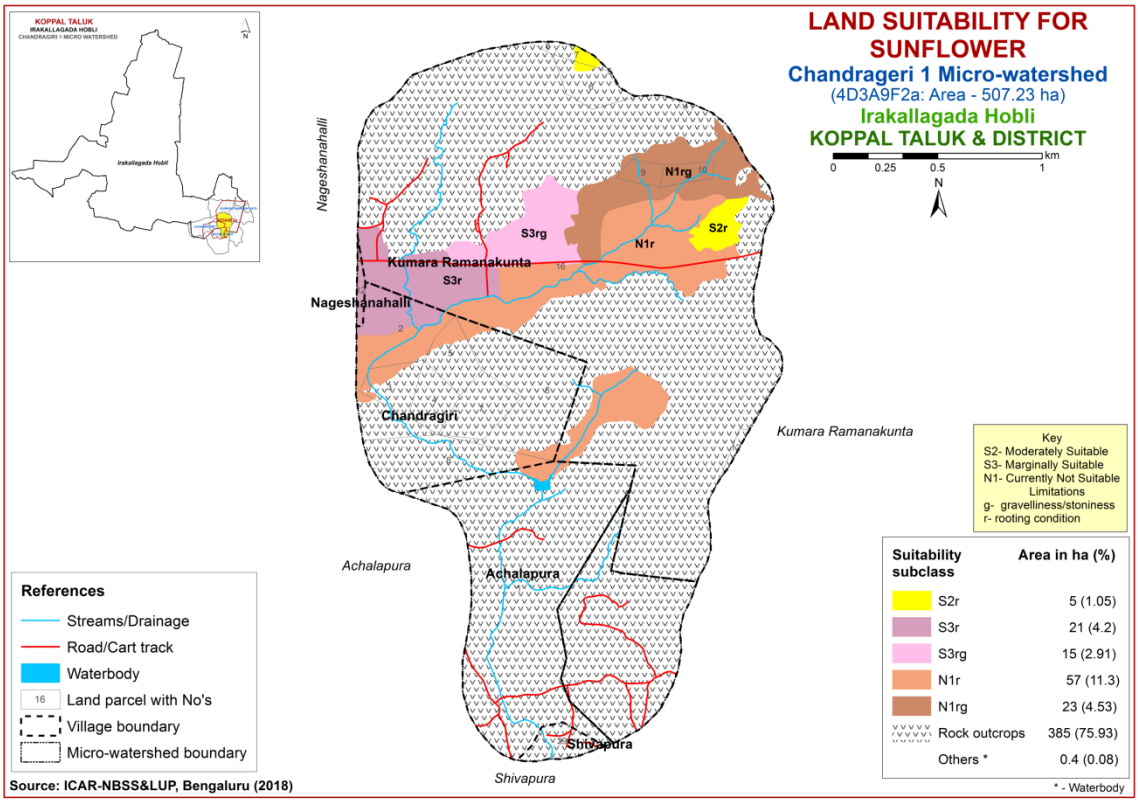


Fig. 7.7 Land Suitability map of Sunflower

7.8 Land Suitability for Cotton (*Gossypium hirsutum*)

Cotton is one of the most important fibre crop grown in the State in about 8.75 lakh ha area in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and Chamarajnagar districts. The crop requirements for growing cotton (Table 7.9) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cotton was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.8.

An area of about 26 ha (5 %) in the microwatershed has soils that are moderately suitable (Class S2) for growing cotton and are distributed in the eastern and western part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 72 ha (14%) and are distributed in the central part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing cotton cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

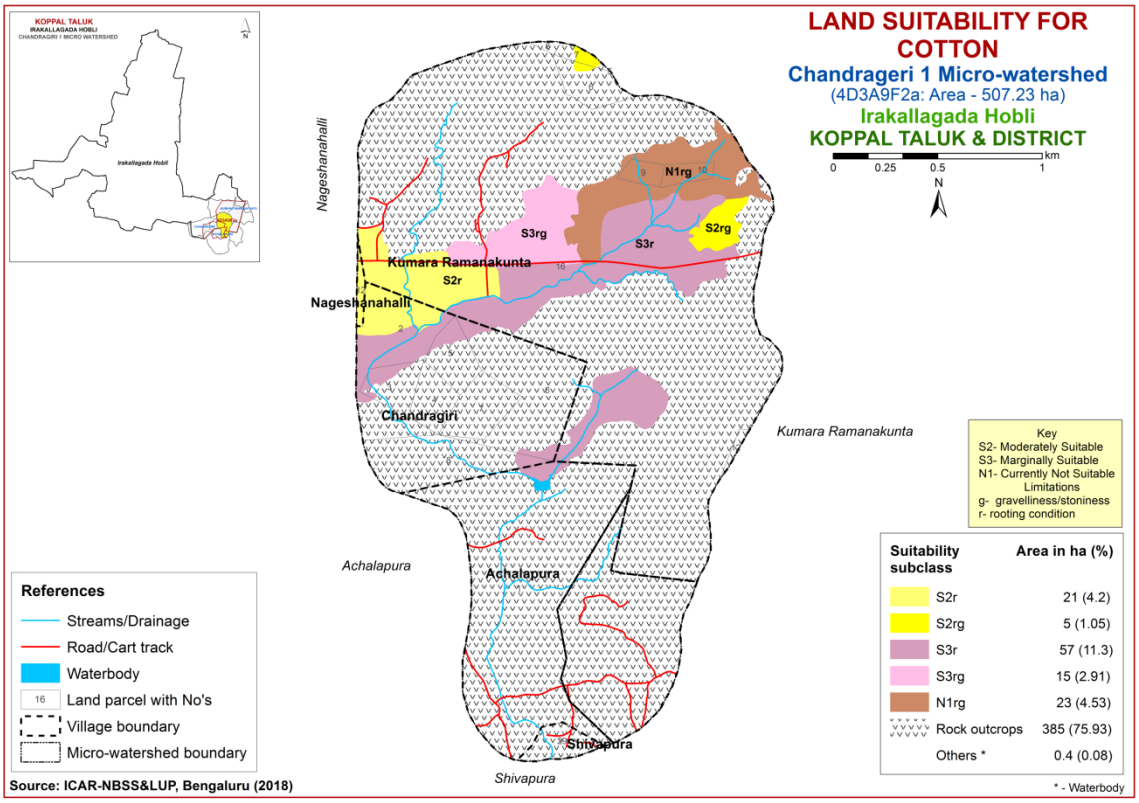


Fig. 7.8 Land Suitability map of Cotton

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

Chilli is one of the major fruit and spice crop grown in an area of 0.42 lakh ha in Karnataka State. The crop requirements for growing chilli (Table 7.10) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing chilli was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.9.

An area of about 4 ha (<1%) in the microwatershed has soils that are highly suitable (Class S1) for growing chilli and are distributed in the eastern part of the microwatershed. An area of about 22 ha (4 %) is moderately suitable (Class S2) for growing chilli and are distributed in the eastern part of the microwatershed. They have minor limitations of rooting depth and texture. Marginally suitable (Class S3) lands cover a maximum area of about 72 ha (14%) and distributed in the major part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing chilli cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

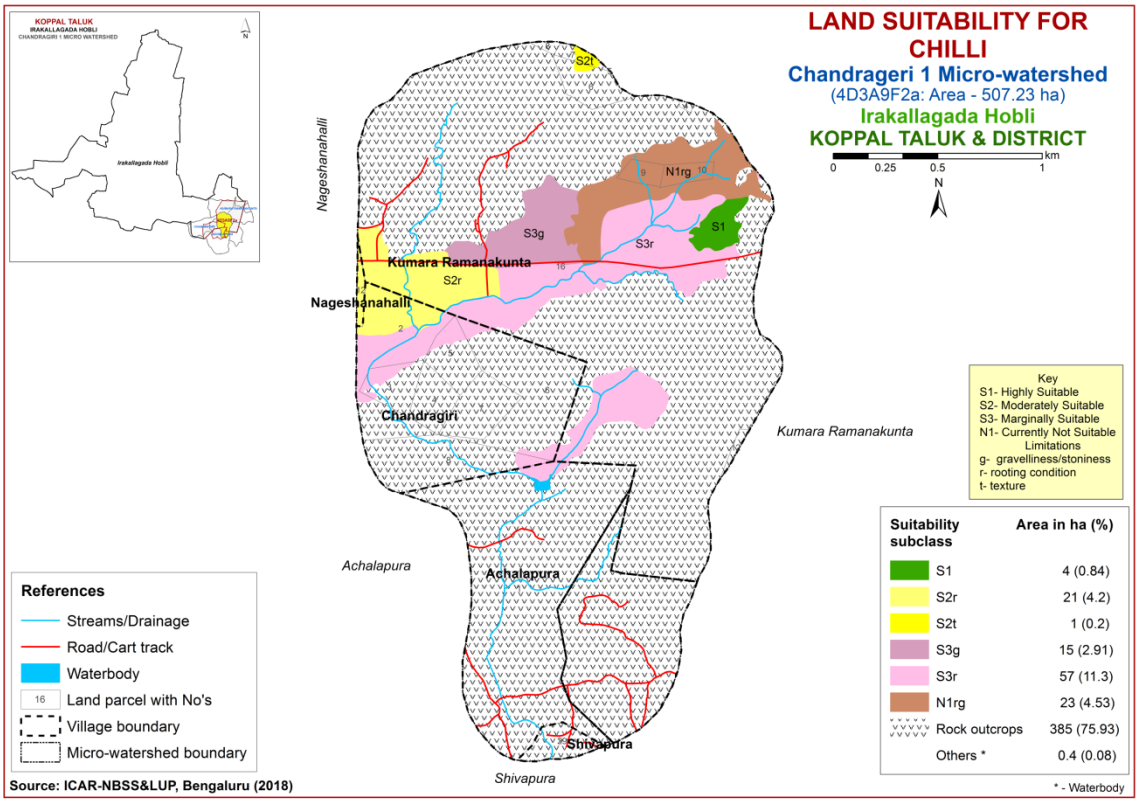


Fig. 7.9 Land Suitability map of Chilli

7.10 Land Suitability for Tomato (*Solanum lycopersicum*)

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

An area of about 4 ha (<1 %) in the microwatershed has soils that are highly suitable (Class S1) for growing tomato and are distributed in the eastern part of the microwatershed. An area of about 22 ha (4 %) is moderately suitable (Class S2) for growing tomato and are distributed in the western part of the microwatershed. They have minor limitations of rooting depth and texture. Marginally suitable (Class S3) lands cover a maximum area of about 72 ha (14%) and distributed in the major part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing tomato cover about 23 ha (5%) and distributed in the northeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

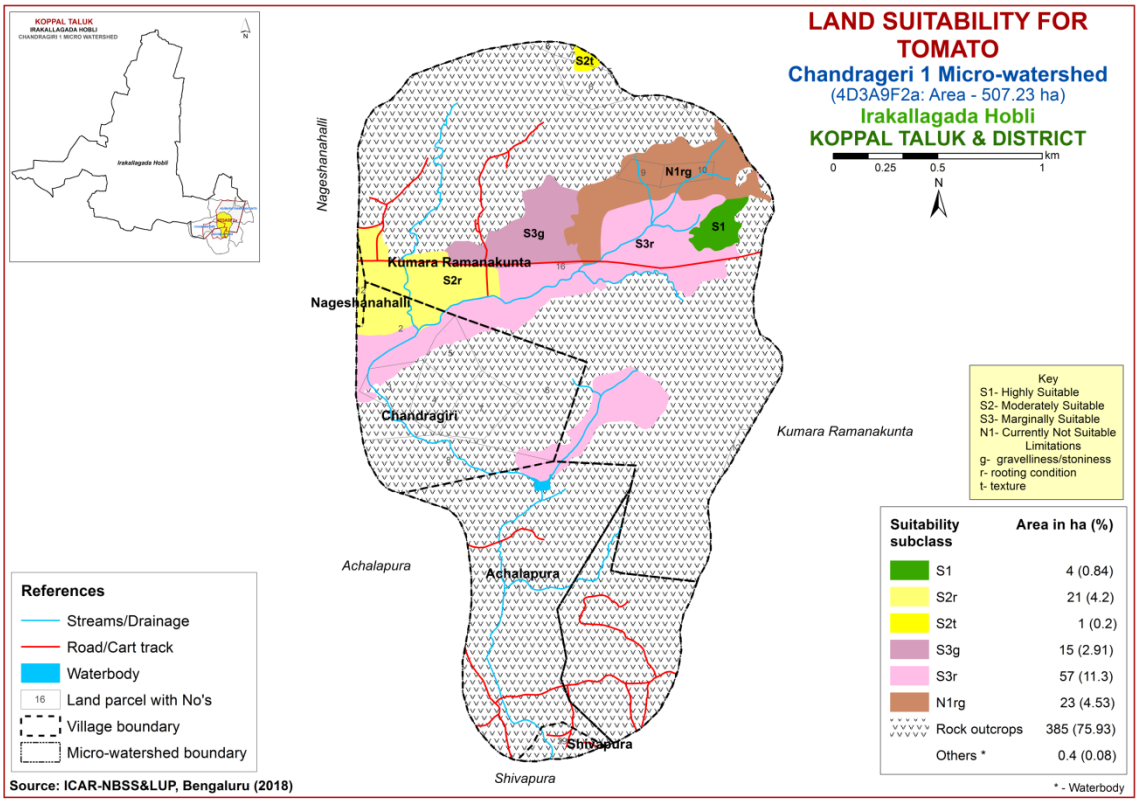


Fig. 7.10 Land Suitability map of Tomato

7.11 Land Suitability for Drumstick (*Moringa oleifera)*

Drumstick is one of the most important vegetable crop grown in 2403 ha area in the state. The crop requirements for growing drumstick (Table 7.12) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing drumstick was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.11.

An area of about 5 ha (1%) in the microwatershed has soils that are moderately suitable (Class S2) lands and are distributed in the eastern part of the microwatershed. They have minor limitation of rooting depth. Marginally suitable (Class S3) lands cover an area of about 36 ha (7%) and occur in the western and central part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing drumstick cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

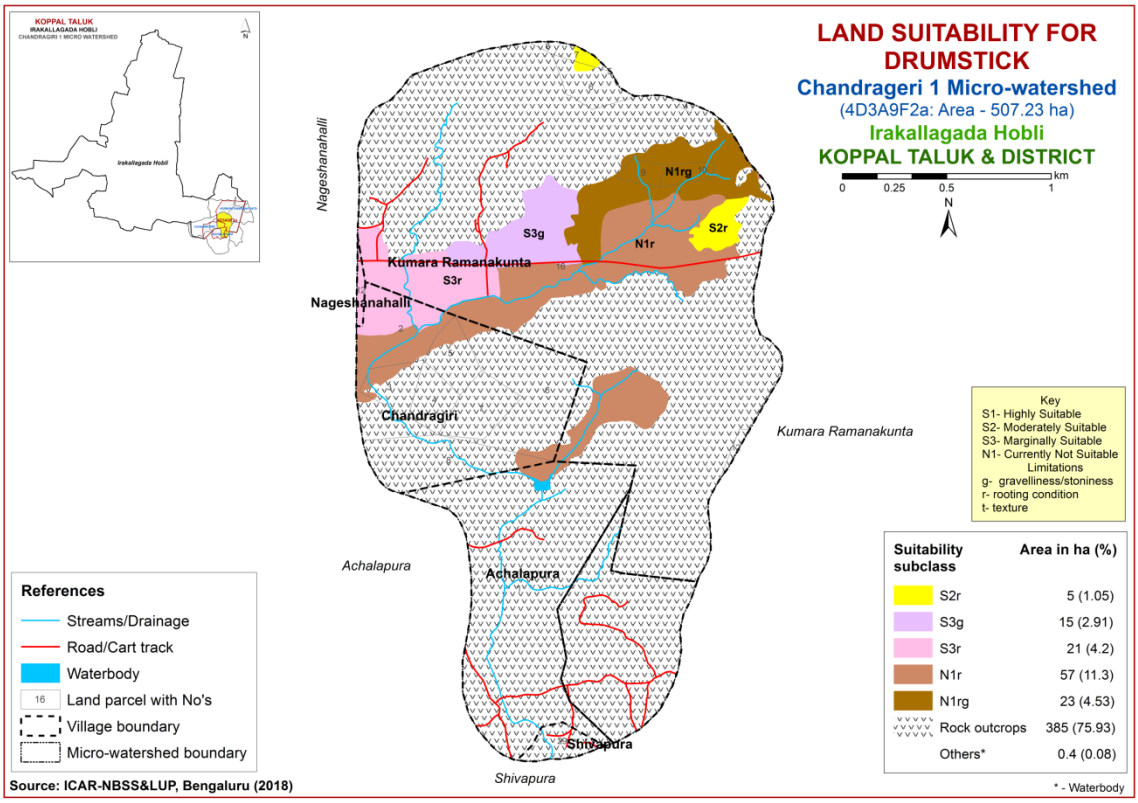


Fig. 7.11 Land Suitability map of Drumstick

7.12 Land Suitability for Mulberry (*Morus nigra*)

Mulberry is the most important leaf crop grown for rearing silkworms in about 1.66 lakh ha in all the districts of the state. The crop requirements for growing mulberry (Table 7.13) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mulberry was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in

An area of about 20 ha (4 %) in the microwatershed has soils that are moderately suitable (Class S2) and distributed in the eastern, central and northern part of the microwatershed. They have minor limitations of gravelliness and rooting depth. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the western part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing mulberry cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

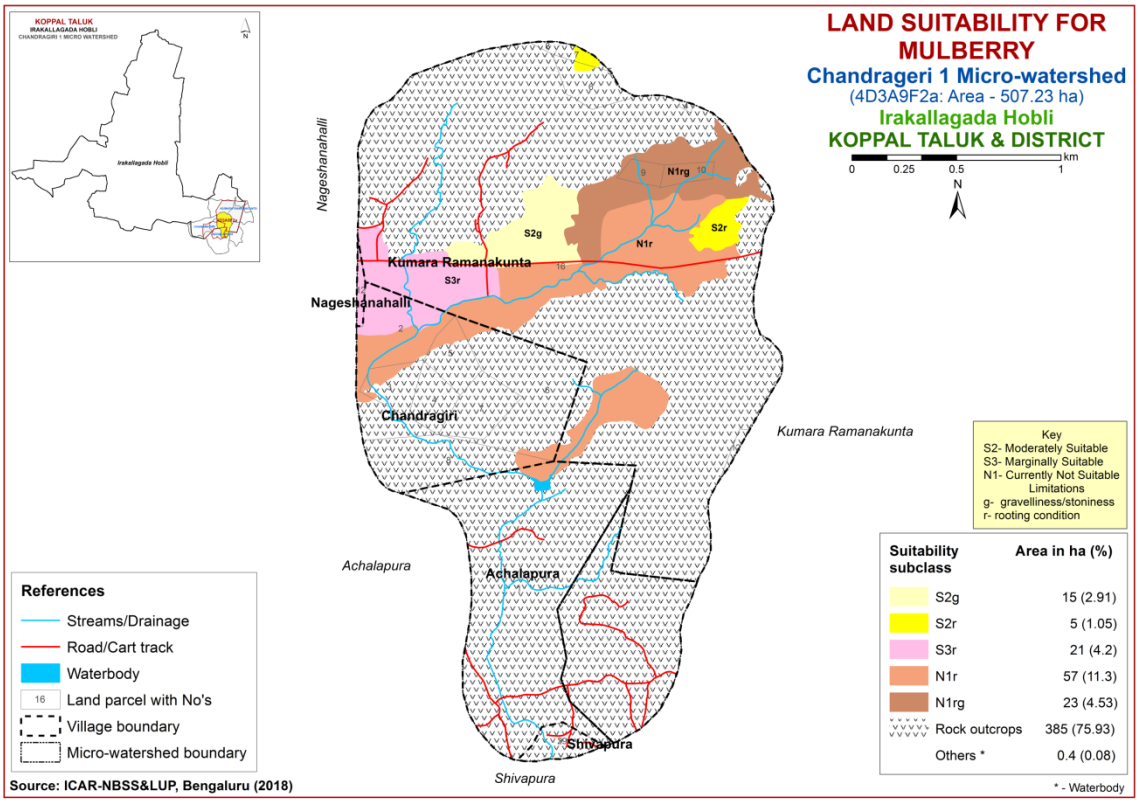


Fig. 7.12 Land Suitability map of Mulberry

7.13 Land suitability for Mango (*Mangifera indica*)

Mango is one of the most important fruit crop grown in about 1.73 lakh ha in almost all the districts of the State. The crop requirements (Table 7.14) for growing mango were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mango was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.13.

Marginally suitable (Class S3) lands cover an area of about 20 ha (4%) and occur in the northern part of the microwatershed. They have moderate limitations of rooting depth and gravellines. Area currently not suitable (Class N1) for growing mango cover about 102 ha (20%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

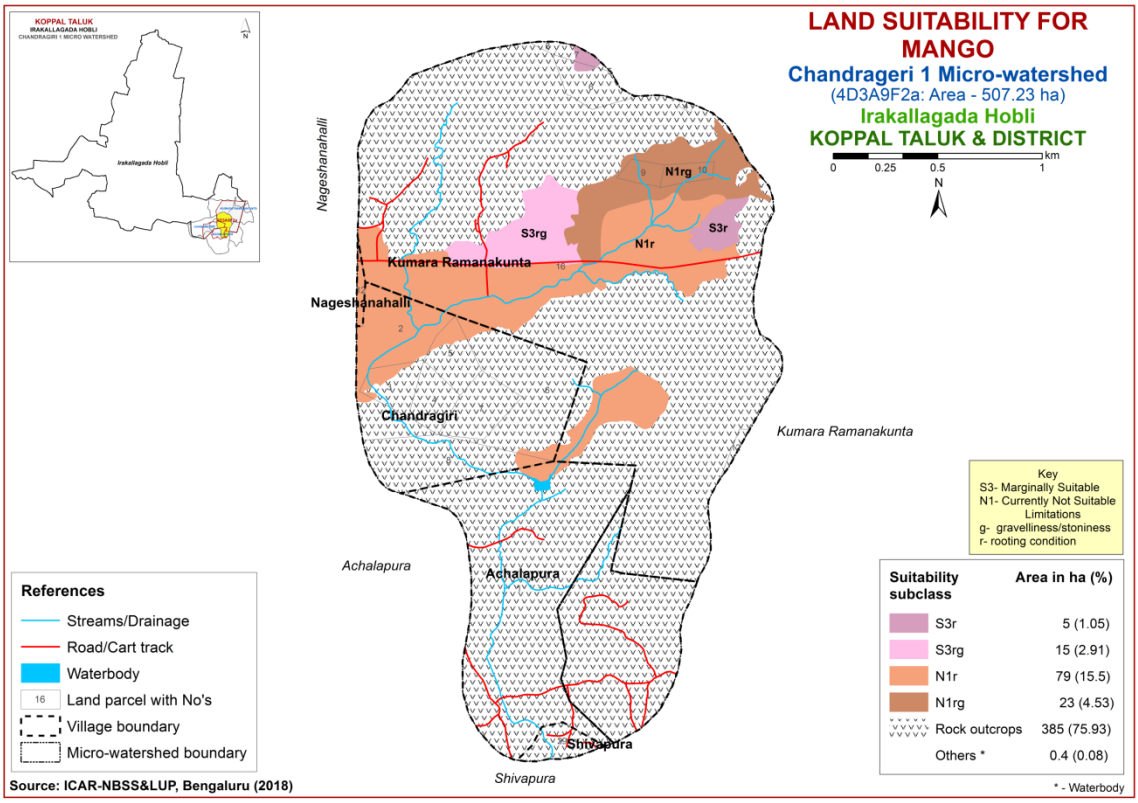


Fig. 7.13 Land Suitability map of Mango

7.14 Land suitability for Sapota (*Manilkara zapota*)

Sapota is one of the most important fruit crop grown in an area of about 29373 ha in almost all the districts of the state. The crop requirements (Table 7.15) for growing sapota were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sapota was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.14.

An area of about 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing sapota and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing sapota cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

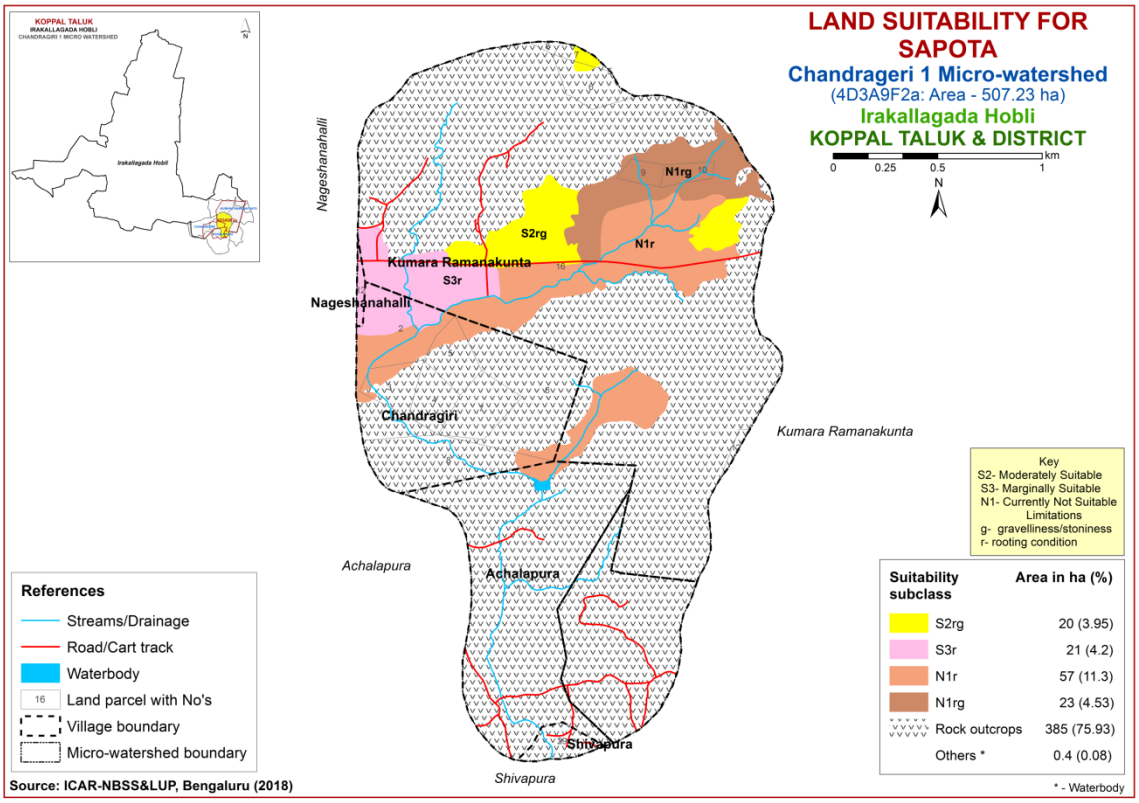


Fig. 7.14 Land Suitability map of Sapota

7.15 Land Suitability for Pomegranate (*Punica granatum*)

Pomegranate is one of the commercially grown fruit crop in about 18488 ha in Karnataka mainly in Bijapur, Bagalkot, Koppal, Gadag and Chitradurga districts. The crop requirements for growing pomegranate (Table 7.16) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing pomegranate was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.15.

An area of about 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing pomegranate and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing pomegranate cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

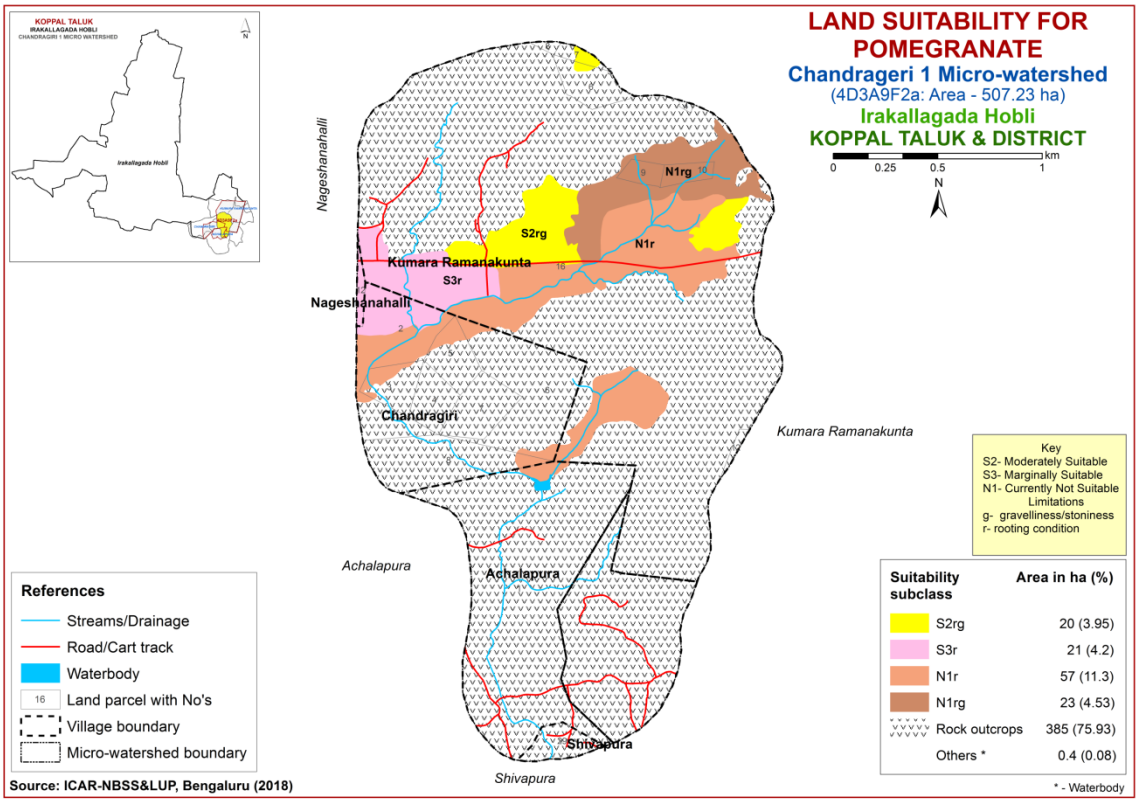


Fig. 7.15 Land Suitability map of Pomegranate

7.16 Land suitability for Guava (*Psidium guajava*)

Guava is one of the most important fruit crop grown in an area of about 6558 ha in almost all the districts of the state. The crop requirements (Table 7.17) for growing guava were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing guava was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.16.

An area of about 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing guava and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing guava cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

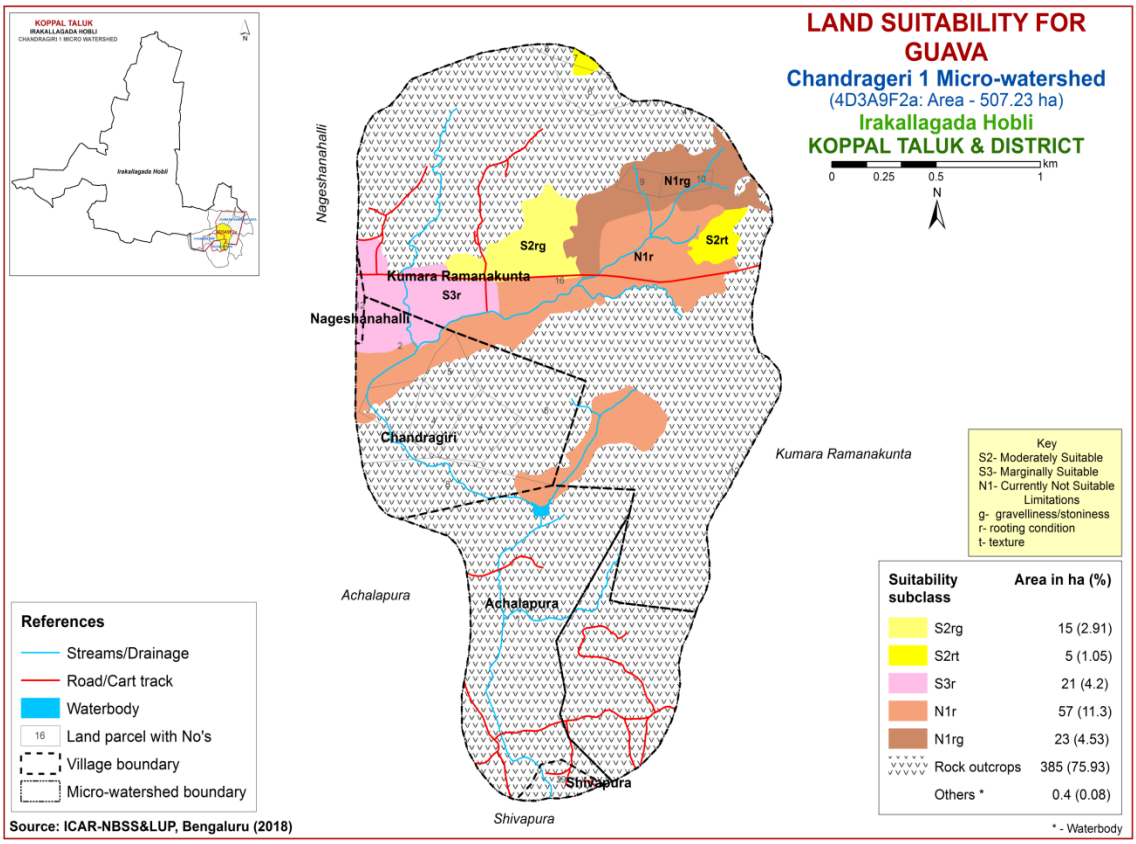


Fig. 7.16 Land Suitability map of Guava

7.17 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is one of the most important fruit crop grown in 5368 ha in all the districts of the state. The crop requirements (Table.7.18) for growing jackfruit were matched with the soil-site characteristics (Table 7.1) 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 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing jackfruit and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing jackfruit cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

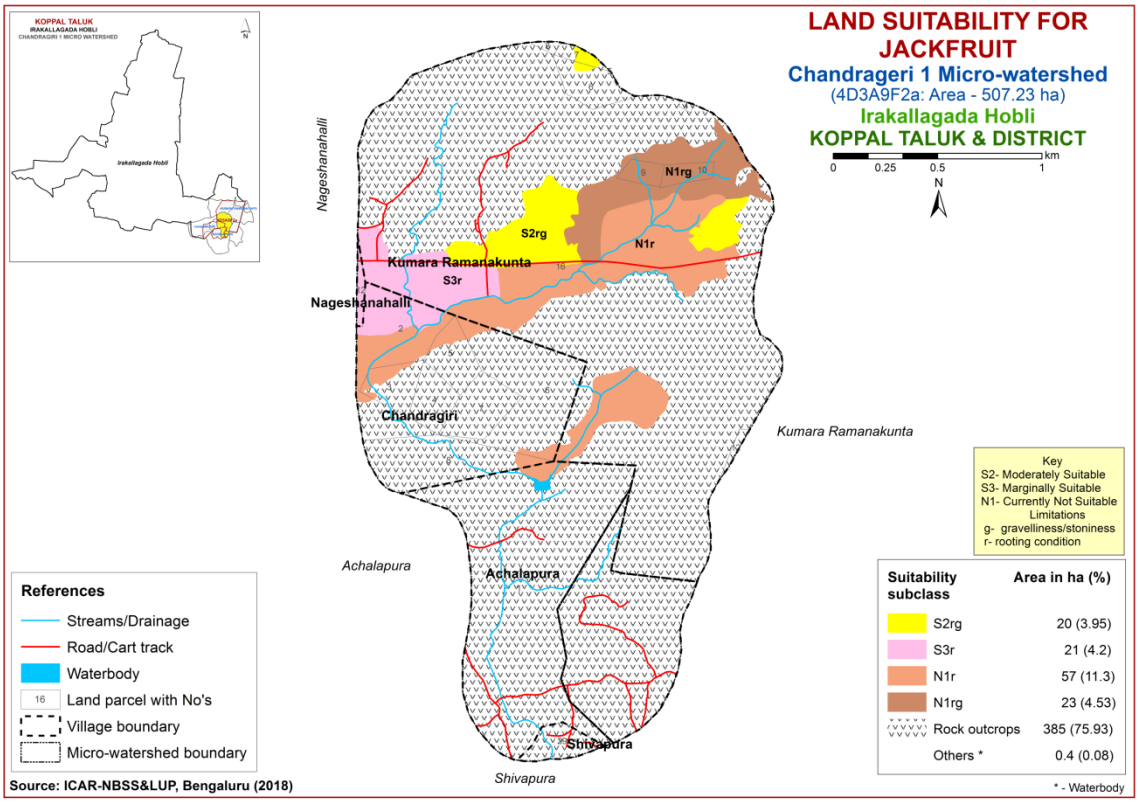


Fig. 7.17 Land Suitability map of Jackfruit

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 (Table 7.19) 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 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing jamun and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing jamun cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

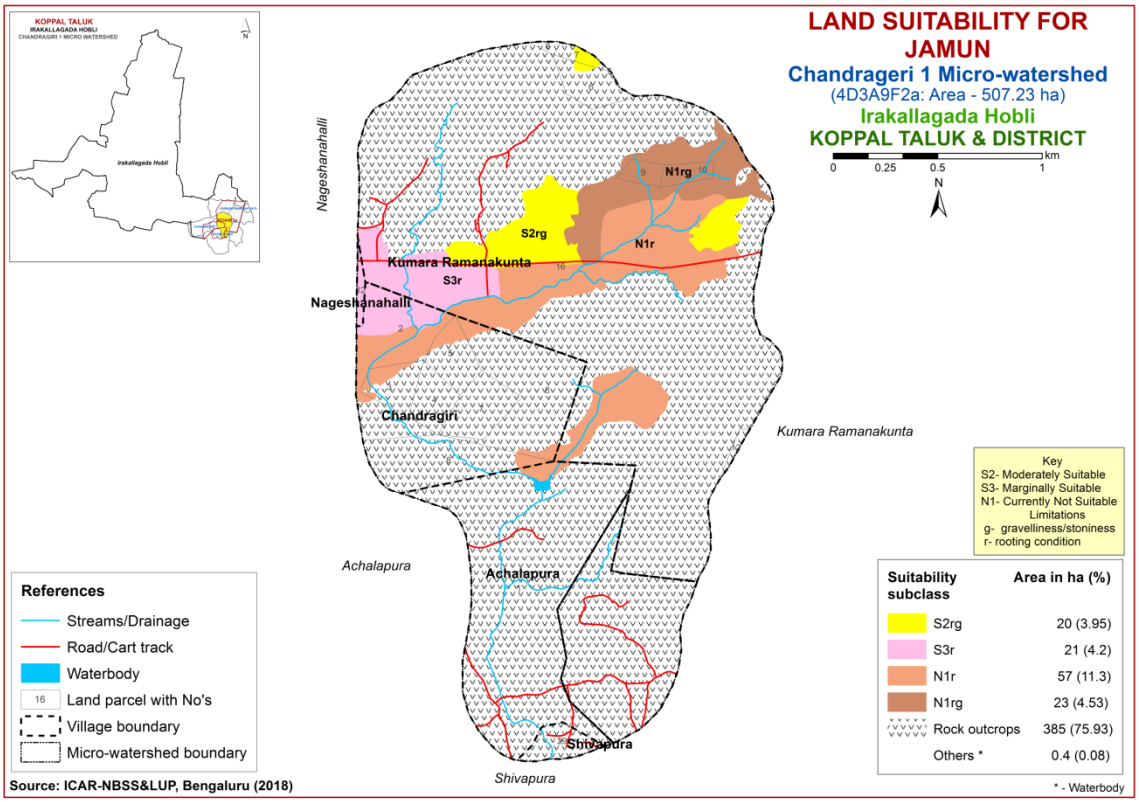


Fig. 7.18 Land Suitability map of Jamun

7.19 Land Suitability for Musambi (*Citrus limetta*)

Musambi is one of the most important fruit crop grown in an area of 5446 ha in almost all the districts of the state. The crop requirements (Table 7.20) for growing musambi were matched with the soil-site characteristics (Table 7.1) 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 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing musambi and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing musambi cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

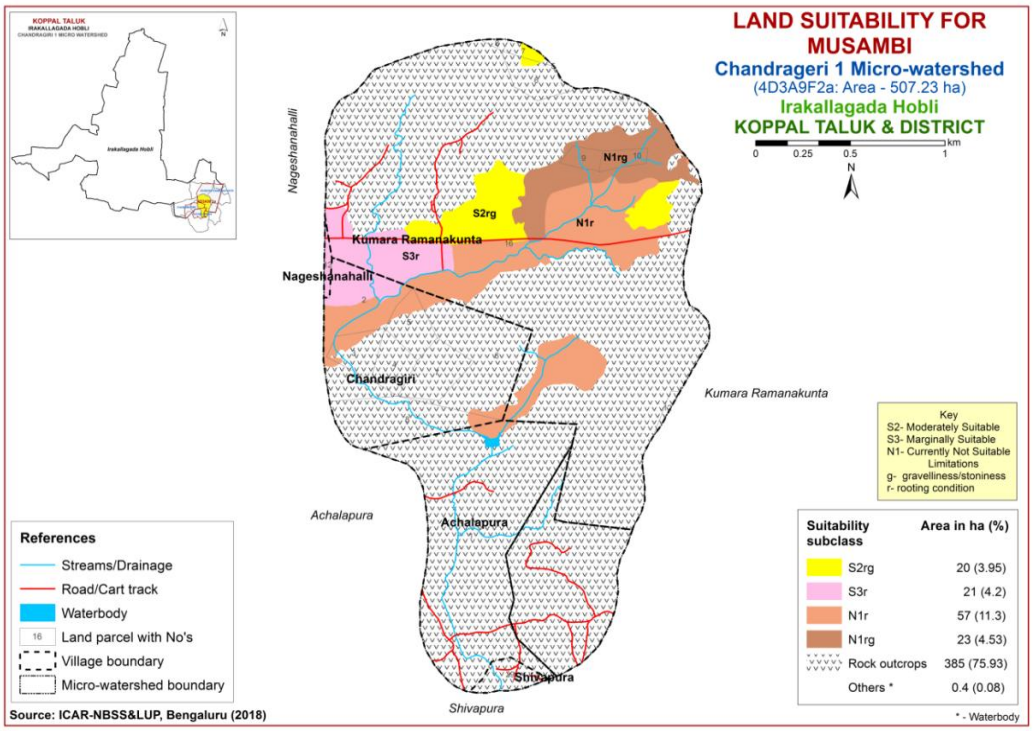


Fig. 7.19 Land Suitability map of Musambi

7.20 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 11752 ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.21) were matched with the soil-site characteristics (Table 7.1) 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 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing lime and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing lime cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

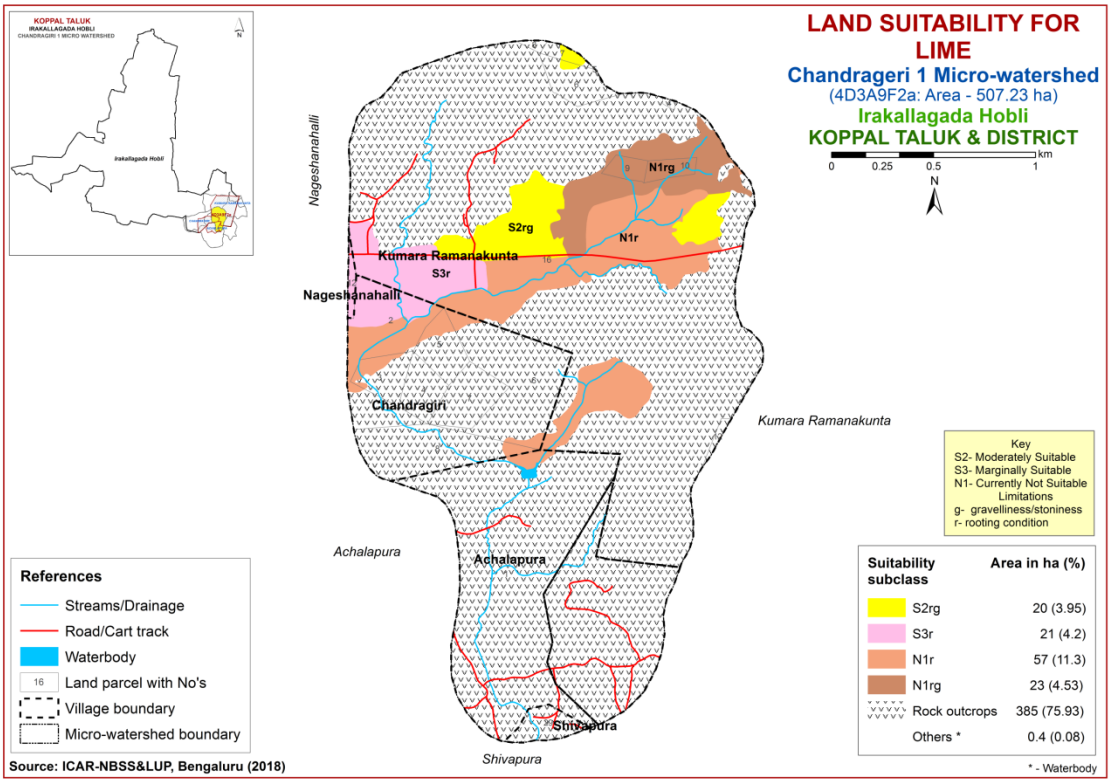


Fig. 7.20 Land Suitability map of Lime

7.21 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important nut crop grown in an area of 7052 ha in almost all the districts of the State. The crop requirements for growing cashew (Table 7.22) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cashew was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.21.

An area of about 20 ha (4%) in the microwatershed has soils that are moderately suitable (S2) for growing cashew and are distributed in the central and northeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 21 ha (4%) and occur in the eastern part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing cashew cover about 80 ha (16%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

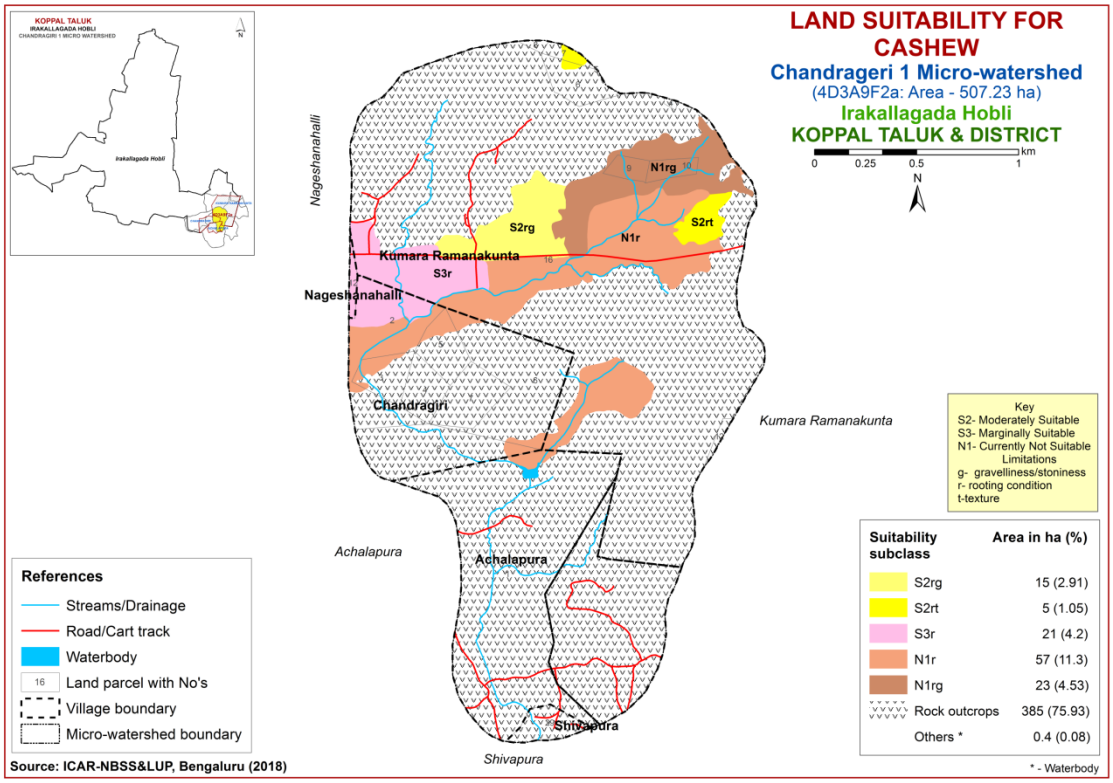


Fig. 7.21 Land Suitability map of Cashew

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

Custard apple is one of the most important fruit crop grown in 1426 ha in almost all the districts of the State. The crop requirements(Table 7.23) for growing custard apple were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing custard apple was generated .The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.22.

An area of about 5 ha (1%) is highly suitable (Class S1) for growing custard apple and are distributed in the eastern part of the microwatershed. Moderately suitable (Class S2) lands cover an area of about 36 ha (7%) and occur in the western and central part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover an area of about 57 ha (11%) and occur in the central part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing custard apple cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

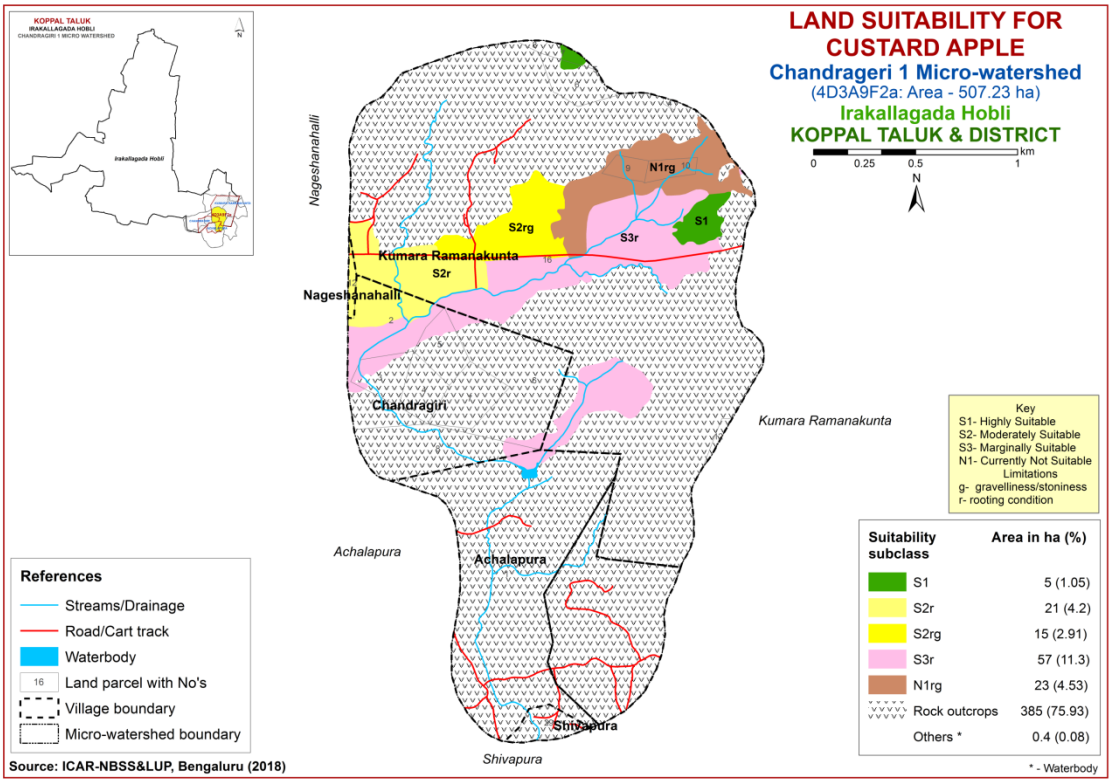


Fig. 7.22 Land Suitability map of Custard Apple

7.23 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the most important fruit and medicinal crop grown in an area of 151 ha and distributed in almost all the districts of the state. The crop requirements (Table 7.24) for growing amla were matched with the soil-site characteristics (Table 7.1) 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 4 ha (<1%) is highly suitable (Class S1) for growing amla and are distributed in the eastern part of the microwatershed. Moderately suitable (Class S2) lands cover an area of about 37 ha (7%) and occur in the western and northern part of the microwatershed. They have minor limitations of rooting depth, texture and gravelliness. Marginally suitable (Class S3) lands cover an area of about 57 ha (11%) and occur in the central part of the microwatershed. They have moderate limitation of rooting depth. Area currently not suitable (Class N1) for growing amla cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

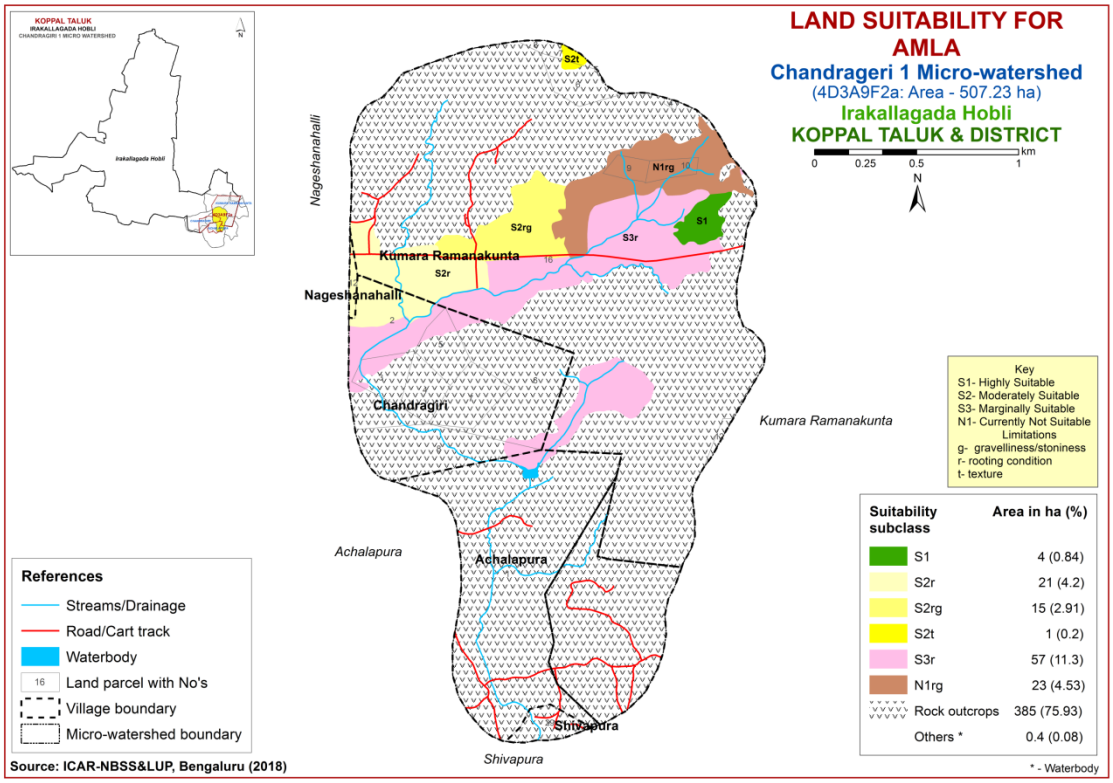


Fig. 7.23 Land Suitability map of Amla

7.24 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is one of the most important spice crop grown in 14897 ha in all the districts of the state. The crop requirements (Table 7.25) for growing tamarind were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing tamarind was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.24.

An area of about 20 ha (4%) is marginally suitable (Class S3) for growing tamarind and are distributed in the central and eastern part of the microwatershed with moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing tamarind cover about 102 ha (20%) and distributed in the major part of the microwatershed with severe limitations of rooting depth and gravelliness.

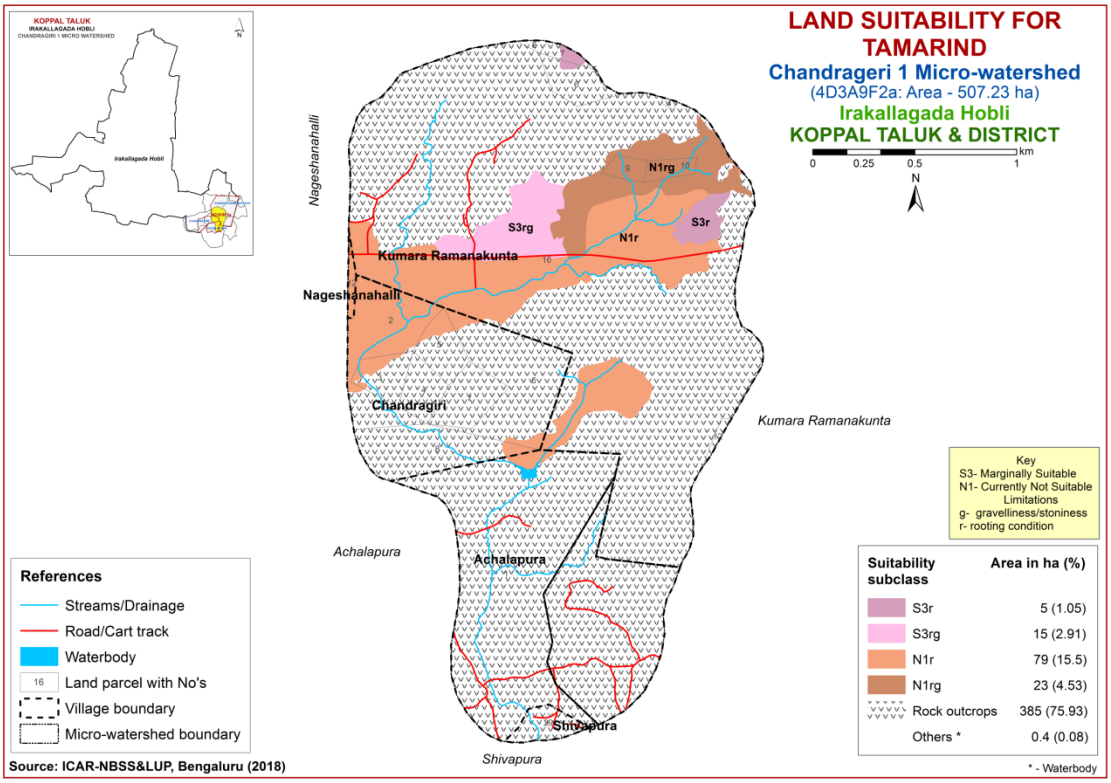


Fig. 7.21 Land Suitability map of Tamarind

7.25 Land Suitability for Marigold (*Tagetes erecta*)

Marigold is one of the most important flower crop grown in an area of 9108 ha in almost all the districts of the state. The crop requirements (Table 7.26) for growing marigold were matched with the soil-site characteristics and a land suitability map for growing marigold was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.25.

An area of about 26 ha (5 %) is moderately suitable (Class S2) and occur in the eastern and western part of the microwatershed. They have minor limitations of gravelliness, texture and rooting depth. An area of about 72 ha (14%) is marginally suitable (Class S3) for growing marigold and are distributed in the central part of the microwatershed with moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing marigold cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

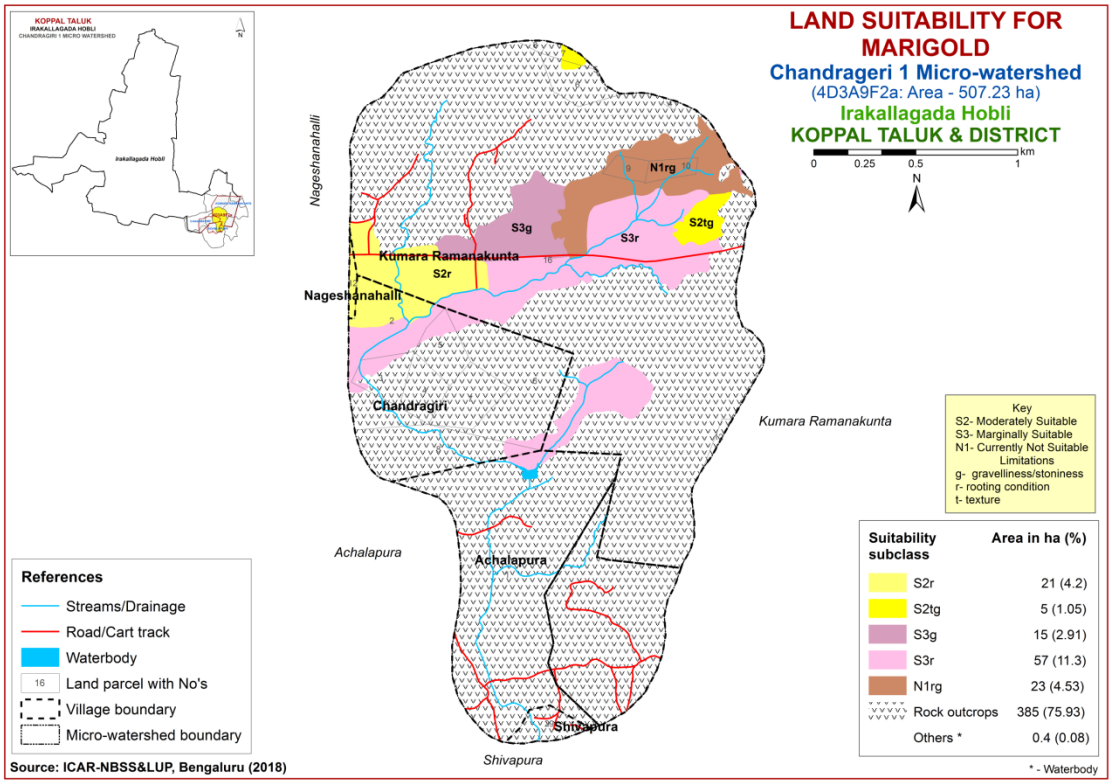


Fig. 7.25 Land Suitability map of Marigold

7.26 Land Suitability for Chrysanthemum (*Chrysanthemum indicum*)

Chrysanthemum is one of the most important flower crop grown in an area of 4978 ha in almost all the districts of the State. The crop requirements (Table 7.27) 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 geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.26.

An area of about 26 ha (5 %) is moderately suitable (Class S2) and occur in the eastern and western part of the microwatershed. They have minor limitations of gravelliness, texture and rooting depth. An area of about 72 ha (14%) is marginally suitable (Class S3) for growing chrysanthemum and are distributed in the central part of the microwatershed with moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing chrysanthemum cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

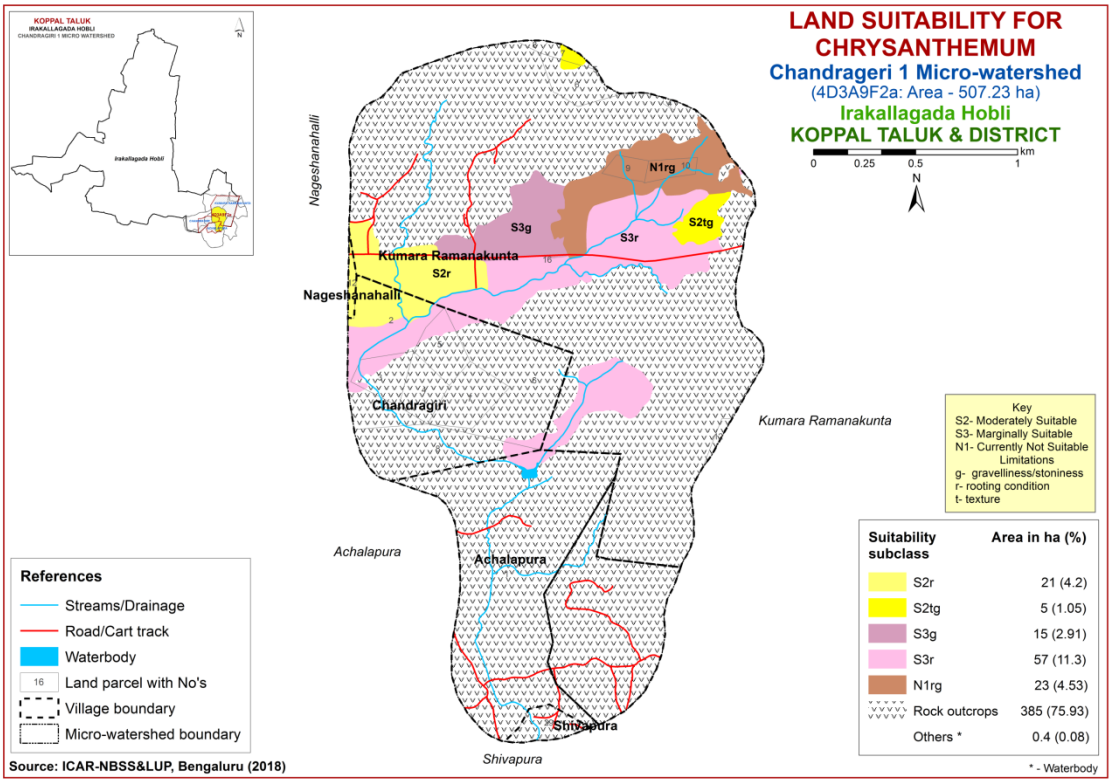


Fig. 7.26 Land Suitability map of Chrysanthemum

7. 27 Land Suitability for Jasmine *(Jasminum sp.)*

Jasmine is one of the most important flower crop grown in an area of 803 ha in almost all the districts of the State. The crop requirements (Table 7.28) for growing jasmine were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing jasmine was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.27.

An area of about 26 ha (5 %) is moderately suitable (Class S2) and occur in the eastern and western part of the microwatershed. They have minor limitations of gravelliness, texture and rooting depth. An area of about 72 ha (14%) is marginally suitable (Class S3) for growing jasmine and are distributed in the central part of the microwatershed with moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing jasmine cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

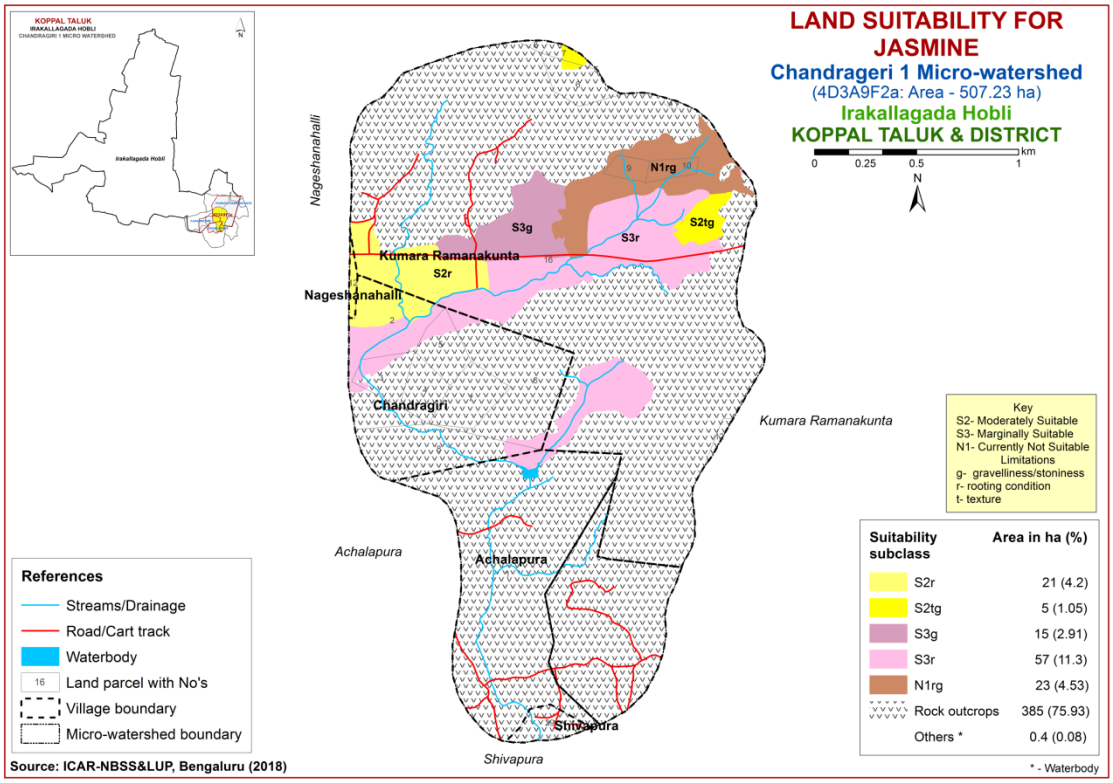


Fig. 7.27 Land Suitability map of Jasmine

7. 28 Land Suitability for Crossandra *(Crossandra infundibuliformis)*

Crossandra is one of the most important flower crop grown in almost all the districts of the State. Land suitability map for growing crossandra was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.28.

An area of about 26 ha (5 %) is moderately suitable (Class S2) and occur in the eastern and western part of the microwatershed. They have minor limitations of gravelliness, texture and rooting depth. An area of about 72 ha (14%) is marginally suitable (Class S3) for growing crossandra and are distributed in the central part of the microwatershed with moderate limitations of gravelliness and rooting depth. Area currently not suitable (Class N1) for growing crossandra cover about 23 ha (5%) and distributed in the eastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

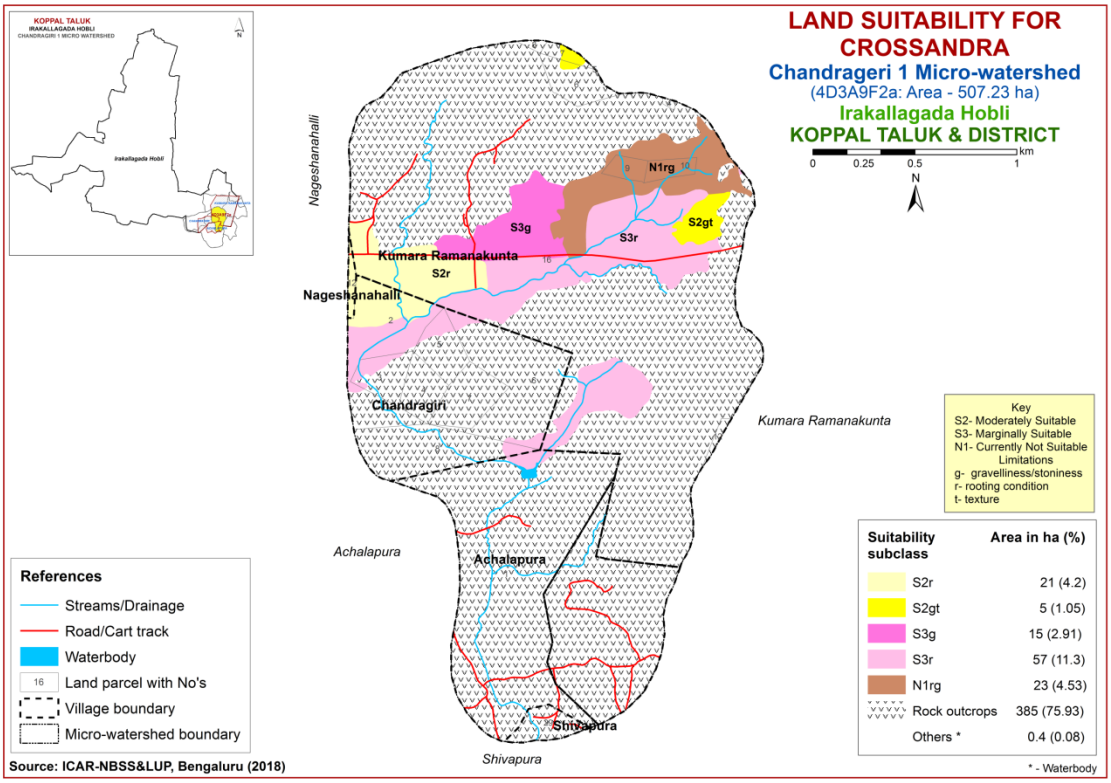


Fig. 7.28 Land Suitability map of Crossandra

Table 7.1 Soil-Site Characteristics of Chandrageri-1 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drainage Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m	Slope (%)	Erosion	pH	EC	ESP	CEC [Cmol (p+)kg-1]	BS (%)
					Surf-ace	Sub-surface	Sur-face	Sub-surface								
BGThB2g1	662	<90	WD	<25	scl	scl	15-35	<15	51-100	1-3	moderate	8.4	0.15	1.11	44.84	-
CSRcB2g1	662	<90	WD	25-50	sl	scl	15-35	<15	51-100	1-3	moderate	-	-	-	-	-
CSRhB2g1	662	<90	WD	25-50	scl	scl	15-35	<15	51-100	1-3	moderate	-	-	-	-	-
KGHbB2g1	662	<90	WD	50-75	ls	scl	15-35	15-35	51-100	1-3	moderate	-	-	-	-	-
KGHcB2g1	662	<90	WD	50-75	sl	scl	15-35	15-35	51-100	1-3	moderate	-	-	-	-	-
HDHhB2g1	662	<90	WD	75-100	scl	gsc-gc	15-35	>35	51-100	1-3	moderate	6.54	0.07	7.11	5.84	84.07
BSRbB2g1	662	<90	WD	75-100	ls	gsc	15-35	15-35	51-100	1-3	moderate	6.59	0.12	6.00	8.80	77.55
BSRhB1g1	662	<90	WD	75-100	scl	gsc	15-35	15-35	51-100	1-3	slight	6.59	0.12	6.00	8.80	77.55

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

Table 7.2 Land suitability criteria for Sorghum

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime1	Mean temperature in growing season	°C	26–30	30–34; 24–26	34–40; 20–24	>40; <20
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristics					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sc, c (red), c (black)	scl, cl	ls, sl	-
	pH	1:2.5	5.5-7.8	5.0-5.5 7.8-9.0	>9.0	-
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	10-15
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	5-10	10-15	>15	
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Table 7.3 Land suitability criteria for Maize

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	30-34	35-38 26-30	38-40 26-20	
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	Very poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc	c (red), c (black)	ls, sl	-
	pH	1:2.5	5.5-7.8	5.0-5.5 7.8-9.0	>9.0	-
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	ds/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	5-10	10-15	>15	-
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Table 7.4 Land suitability criteria for Bajra

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-32	33-38 24-27	39-40 20-23	<20
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm	500-750	400-500	200-400	<200
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	Very poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sl, scl, cl,sc,c (red)	C (black)	ls	-
	pH	1:2.5	6.0-7.8	5.0-5.5 7.8-9.0	5.5-6.0 >9.0	
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	15-35	35-60	>60	
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	5-10	10-15	>15	
Erosion hazard	Slope	%	1-3	3-5	5-10	>10

Table 7.5 Land suitability criteria for Groundnut

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	24–33	22–24; 33–35	20–22; 35–40	<20; >40
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod. Well drained	Poorly drained	Very Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl	sl,cl, sc	c (red), c (black), ls	-
	pH	1:2.5	6.0-7.8	5.5-6.0 7.8-8.4	5.0-5.5 8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<35	35-60	>60	
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.6 Land suitability criteria for Sunflower

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	24–30	30–34; 20–24	34–38; 16–20	>38; <16
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	mod. Well drained	-	Poorly to very drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	cl, sc,c (red), c (black)	scl	ls, sl	-
	pH	1:2.5	6.5-7.8	7.8-8.4 5.5-6.5	8.4-9.0; 5.0-5.5	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.7 Land suitability criteria for cotton

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	22-32	>32	<19	-
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well to moderately well	Poorly drained/Some what excessively drained	-	very poorly/ex cessively drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sc, c (red,black)	cl	scl	ls, sl
	pH	1:2.5	6.5-7.8	7.8-8.4	5.5-6.5 8.4->9.0	<5.5
	CEC	C mol (p+)Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	50-100	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	5-10	10-15	>15	
Erosion hazard	Slope	%	<3	3-5	-	>5

Table 7.8 Land suitability criteria for red gram

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	30-35(G) 20-25(AV) 15-18 (F&PS) 35-40(M)	25-30(G) 20-25 (AV) 12-15 (F&PS) 30-35(M)	20-25(G) 15-20(AV) 10-12 (F&PS) 25-30(M)	< 20 <15 <10 <25
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod. Well drained	Poorly drained	Very Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sc, c (red)	c (black),sl, scl, cl	ls	-
	pH	1:2.5	6.0-7.8	5.5-6.0 7.8-9.0	5.0-5.5 >9.0	-
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-50	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<1.0	1.0-2.0	>2.0	
	Sodicity (ESP)	%	5-10	10-15	>15	
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.9 Land suitability criteria for Bengal gram

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	20–25	25–30; 15–20	30–35; 10–15	>35; <10
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod. Well drained	Poorly drained	Very Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	C (black)	-	c (red), scl, cl, sc	ls, sl
	pH	1:2.5	6.0-7.8	5.0-6.0 7.8-9.0	>9.0	-
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	5-10	10-15	>15	-
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.10 Land suitability criteria for chilli

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	25-32	33-35 20-25	35-38 <20	>38
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	Very poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc	c (black), sl	ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.11 Land suitability criteria for Tomato

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	25-28	29-32 20-24	15-19 33-36	<15 >36
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sl, scl, cl, sc, c (red)	-	ls, c(black)	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.12 Land suitability criteria for Drumstick

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sc, scl, cl, c (red)	sl, c (black)	ls	s
	pH	1:2.5	6.0-7.3	5.0-5.5 7.3-7.8	5.5-6.0 7.8-8.4	>8.4
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<35	35-60	60-80	>80
Soil toxicity	Salinity (EC saturation extract)	dS/m				
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-10	-	>10

Table 7.13 Land suitability criteria for Mulberry

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	24–28	22–24; 28–32	32–38; 22–18	>38; <18
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V. Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sc, cl, scl	c (red)	c (black), sl, ls	-
	pH	1:2.5	5.5-7.3	5.0-5.5 7.8-8.4	7.3-8.4	>8.4
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	0-35	35-60	60-80	>80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Note: Suitability evaluation only for Mulberry leaf not for Silk worm rearing

Table 7.14 Land suitability criteria for Mango

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-32	24-27 33-35	36-40	20-24
	Min temp. before flowering	^{0}C	10-15	15-22	>22	-
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration	Days				
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	-	ls, sl, c (black)	-
	pH	1:2.5	5.5-7.3	5.0-5.5 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>150	100-150	75-100	<75
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.15 Land suitability criteria for Sapota

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-32	33-36 24-27	37-42 20-23	>42 <18
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	-	Poorly to very drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	sl	ls, c (black)	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.16 Land suitability criteria for Pomegranate

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	30-34	35-38 25-29	39-40 15-24	
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl,cl, sc, c (red)	c (black),sl	ls	-
	pH	1:2.5	5.5-7.8	7.8-8.4	5.0-5.5 8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.17 Land suitability criteria for Guava

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-32	33-36 24-27	37-42 20-23	
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	sl	c (black), ls	-
	pH	1:2.5	6.0-7.8	5.0-6.0	7.8-8.4	>8.4
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.18 Land suitability criteria for Jackfruit

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod. well	Poorly	V. Poorly
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	-	sl, ls, c (black)	-
	pH	1:2.5	5.5-7.3	5.0-5.5 7.3-7.8	7.8-8.4	>8.4
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	>60
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	5-10	>10-

Table 7.19 Land suitability criteria for Jamun

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well	Mod. well	Poorly	V.Poorly
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c(red)	sl, c (black)	ls	-
	pH	1:2.5	6.0-7.8	5.0-6.0	7.8-8.4	>8.4
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>150	100-150	50-100	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	>60
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Table 7.20 Land suitability criteria for Musambi

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-30	31-35 24-27	36-40 20-23	>40 <20
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately drained	poorly	Very poorly
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c	sl	ls	-
	pH	1:2.5	6.0-7.8	5.5-6.0 7.8-8.4	5.0-5.5 8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.21 Land suitability criteria for Lime

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	28-30	31-35 24-27	36-40 20-23	>40 <20
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately drained	poorly	Very poorly
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c	sl	ls	-
	pH	1:2.5	6.0-7.8	5.5-6.0 7.8-8.4	5.0-5.5 8.4-9.0	>9.0
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.22 Land suitability criteria for cashew

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	32 to 34	28 to 32; 34 to 38	24 to 28; 38 to 40	<20; >40
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	moderately well drained	Poorly drained	Very poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	-	sl, ls	c (black)
	pH	1:2.5	5.5-6.5	5.0-5.5 6.5-7.3	7.3-7.8	>7.8
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-10	>10	-

Table 7.23 Land suitability criteria for Custard apple

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod. well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	Scl, cl, sc, c (red), c (black)	-	Sl, ls	-
	pH	1:2.5	6.0-7.3	5.5-6.0 7.3-8.4	5.0-5.5 8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15-35	35-60	60-80	-
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	>5	-

Table 7.24 Land suitability criteria for Amla

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V. Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	c (black)	ls, sl	-
	pH	1:2.5	5.5-7.3	5.0-5.5 7.3-7.8	7.8-8.4	>8.4
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15-35	35-60	60-80	-
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Table 7.25 Land suitability criteria for Tamarind

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl,sc, c (red)	sl, c (black)	ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-7.8	7.8-8.4	>8.4
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>150	100-150	75-100	<75
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2	2-4	4-8	>8
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	0-3	3-5	5-10	>10

Table 7.26 Land suitability criteria for Marigold

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	18-23	17-15 24-35	35-40 10-14	>40 <10
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sl,scl, cl, sc, c (red)	c (black)	ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%				
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.27 Land suitability criteria for Chrysanthemum

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	18-23	17-15 24-35	35-40 10-14	>40 <10
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sl,scl, cl, sc, c (red)	c (black)	ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%				
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.28 Land suitability criteria for jasmine (irrigated)

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	18-23	17-15 24-35	35-40 10-14	-
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V.Poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c (red)	sl	ls, c (black)	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%				
Erosion hazard	Slope	%	<3	3-5	5-10	>10

7.29 Land suitability criteria for Crossandra

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C				
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	-	Poorly to very poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	scl, cl, sc, c(red)	sl,	c (black),ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-8.4	8.4-9.0	>9.0
	CEC	C mol (p+)/Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	dS/m	<2.0	2-4	4-8	>8.0
	Sodicity (ESP)	%				
Erosion hazard	Slope	%	<3	3-5	5-10	>10

7.29 Land Management Units (LMUs)

The 9 soil map units identified in Chandrageri-1 microwatershed have been grouped into five Land Management Units (LMUs) for the purpose of preparing a Proposed Crop Plan. Land Management Units are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land Management Units map (Fig.7.29) has been generated. These Land Management Units are expected to behave similarly for a given level of management.

The map units that have been grouped into five Land Management Units along with brief description of soil and site characteristics are given below.

LMU	Mapping unit	Soil and site characteristics
1	BSRbB2g1, BSRhB1g1	Moderately deep red sandy clay soils with slopes of 1-3%, slight to moderate erosion, gravelly (15-35%)
2	HDHhB2g1	Moderately deep, red gravelly sandy clay to clay soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)
3	KGHbB2g1, KGHcB2g1	Moderately shallow, red loamy soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)
4	CSRcB2g1, CSRhB2g1	Shallow, red loamy soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)
5	BGThB2g1	Very shallow, gravelly black clay soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)

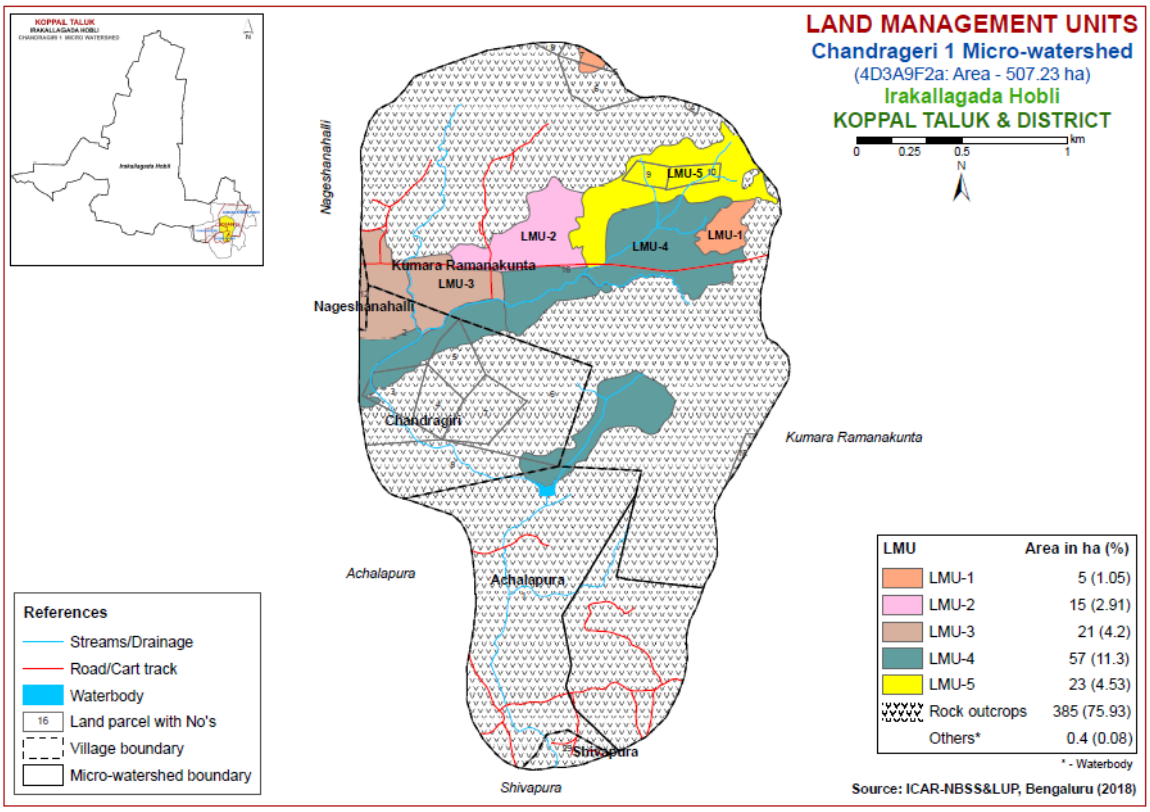


Fig 7.29 Land Management Units map of Chandrageri-1 microwatershed

7.30 Proposed Crop Plan for Chandrageri-1 Microwatershed

After assessing the land suitability for the 28 crops, the proposed crop plan has been prepared for the five identified LMUs by considering only the highly (Class S1) and moderately (Class S2) suitable lands for each of the 28 crops. The resultant proposed crop plan is presented in Table 7.29.

Table 7.29 Proposed Crop Plan for Chandrageri-1 Microwatershed

Proposed Land use Class	Soil Map Units	Survey Number	Field Crops	Horticulture Crops	Suitable Interventions
LMU 1 5 ha (1%)	158.BSRbB2g1 160.BSRhB1g1 (Moderately deep red sandy clay soils)	**Kumara Ramanakunta:** 7	Maize, Sorghum, Bajra, Groundnut, Redgram, Castor	**Fruit crops:** Pomegranate, Guava, Sapota, Jackfruit, Tamarind, Lime, Musambi, Amla, Custard apple **Vegetable crops:** Drumstick, Tomato, Chilli, Brinjal **Flower crops:** Marigold, Chrysanthemum, Jasmine	Drip irrigation, mulching, suitable soil and water conservation practices (Crescent Bunding with Catch Pit etc)
LMU 2 15 ha (3%)	123.HDHhB2g1 (Moderately deep, red gravelly sandy clay to clay soils)	**Kumara Ramanakunta:** 16	Groundnut, Redgram, Bajra, Horsegram, Castor	**Fruit crops:** Lime, Musambi, Jackfruit, Jamun, Amla, Cashew, Custard apple **Vegetable crops:** Drumstick	Drip irrigation, mulching, suitable soil and water conservation practices (Crescent Bunding with Catch Pit etc)
LMU 3 21 ha (4%)	62.KGHbB2g1 65.KGHcB2g1 (Moderately shallow, red loamy soils)	**Chandragiri :** 2 **Nageshanahalli:** 12	Maize, Sorghum, Groundnut, Bajra, Castor	**Fruit crops:** Amla, Custard apple **Flower crops:** Marigold, Chrysanthemum **Vegetable crops:** Drumstick	Drip irrigation, mulching, suitable soil and water conservation practices (Crescent Bunding with Catch Pit etc)
LMU 4 57 ha (11%)	36.CSRcB2g1 37.CSRhB2g1 (Shallow, red loamy soils)	**Kumara Ramanakunta:** 16 **Chandragiri:** 1,2,3,5,6,8	Horsegram, Bajra	**Agri-Silvi-Pasture:** Custard apple, Amla, Hybrid Napier, *Styloxanthes hamata*, Glyricidia, *Styloxanthes scabra*	Use of short duration varieties, sowing across the slope and split application of nitrogen fertilizers
LMU 5 23 ha (5%)	4.BGThB2g1 (Very shallow, gravelly black clay soils)	**Kumara Ramanakunta:** 9,10	Bengal gram	**Agri-Silvi-Pasture:** Hybrid Napier, *Styloxanthes hamata*, *Styloxanthes scabra*	Sowing across the slope, drip irrigation and mulching is recommended

Chapter 8

SOIL HEALTH MANAGEMENT

8.1 Soil Health

Soil health is basic to plant health and plant health is basic to human and bovine 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 Chandrageri-1 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of CSR (57 ha), BGT (23 ha), KGH (22 ha), HDH (15 ha) and BSR (5 ha). As per land capability classification, entire area in the microwatershed falls under arable land category (Class II III and IV). The major limitations identified in the arable lands were soil and erosion.
- On the basis of soil reaction, an area of about 5 ha (1%) is slightly acid (pH 6.0-6.5), 21 ha (4%) is neutral (pH 6.5-7.3), 29 ha (6%) is slightly alkaline (pH 7.3-7.8), 48 ha (9 %)

is moderately alkaline (pH 7.8-8.4) and 18 ha (4 %) under strongly alkaline (pH 8.4-9.0) in reaction.

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.

Acid soils

Acid soils occupy an area of about 5 ha (1%) in the microwatershed. The following measures are recommended for reclaiming acid soils.

1. Growing of crops suitable for a particular soil pH.
2. Ameliorating the soils through the application of amendments (liming materials).

Liming materials:

1. $CaCO_3$ (Calcium Carbonate). More than 90% use in India.
2. Dolomite [Ca Mg $(Co_3)_2$]
3. Quick lime (Cao)
4. Slaked lime [Ca $(OH)_2$]

For normal pH and pH-4.8 (35 t/ha) and pH 6 .0-7.0 (4 t/ha) lime is required

Alkaline soils

Alkaline soils occupy an area of about 95 ha (19%) in the microwatershed. The following actions are recommended.

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 – 5 kg/ha (once in three years).

Neutral soils

Neutral soils cover about 21 ha (4%) and the following actions are recommended.

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 factors affecting the soil health in the microwatershed. An area of about 117 ha (23 %) is under moderate erosion. The areas with moderate erosion need immediate soil and water conservation and, other land development and land husbandry practices for restoring soil health.

Dissemination of Information and Communication of 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 the younger farmers.

Inputs for Net Planning (Saturation Plan) and Interventions needed

Net planning in IWMP is focusing on preparation of

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

In this connection, how various outputs of Sujala-III are of use in addressing these objectives of Net Planning 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 and soil are the major constraints in Chandrageri-1 Microwatershed.
- **Organic Carbon:** An area of about 30 ha (6 %) is medium (0.5-0.75%) and 92 ha (18%) is high (>0.75) in OC content. The areas that are 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 30 ha area where OC is less than 0.75 per cent. 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**: Available phosphorus is low (<23 kg/ha) in 31 ha (6%) and medium (23-57 kg/ha) in 91 ha (18%) %) area of the soils. Apply additional 25% phosphorus in areas where it is low and medium.
- **Available Potassium:** Available potassium is low (<145 kg/ha) in 32 ha (6%), medium (145-337 kg/ha) in 84 ha (17%) and high (>337 kg/ha) in 5 ha (1%) area of the microwatershed. The areas with high potassium content reduce 25% from the RDF to avoid the excess application of fertilizer and apply additional 25% potassium in areas where it is low and medium.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. Available sulphur is low (<10 ppm) in 88 ha (17%) and medium in 33 ha (7%) area of the microwatershed. Areas with low and medium in available sulphur 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 (<4.5 ppm) in entire area of the microwatershed. To manage iron deficiency iron sulphate @ 25 kg/ha needs to be applied for 2-3 years.
- **Available Zinc:** It is deficient (<0.6 ppm) in entire area of the microwatershed. Application of zinc sulphate @ 25kg/ha is to be followed in areas that are deficient in available zinc.
- **Available Boron:** Maximum area 82 ha (16%) in the microwatershed is low (<0.5 ppm) in and medium(0.5-1.0 ppm) in 40 ha (8%). The areas with low in boron content need to be applied with sodium borate @ 10kg/ha as soil application or 0.2% borax as foliar spray to correct the deficiency.

- **Available manganese**: It is sufficient in the entire area of the microwatershed**.**
- **Available copper:** It is sufficient in the entire area of the microwatershed**.**
- **Soil acidity:** The microwatershed has 5 ha (1%) area with soils that are slightly acid. These areas need application of lime (Calcium Carbonate).
- **Soil alkalinity:** An area of about 95 ha (19%) in the microwatershed has soils that are slightly to very strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acasia, Neem, Ber etc, are recommended.

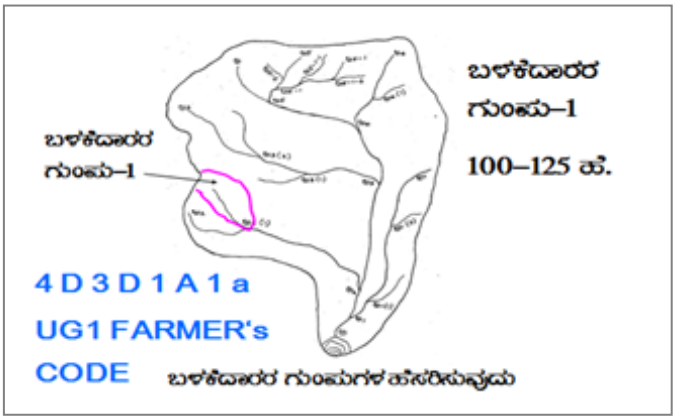
Land Suitability for various crops: Areas that are highly, moderately and marginally suitable and not suitable for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth and salinity/alkalinity are the major constraints in various plots. With suitable management interventions, the productivity can be enhanced. In order to increase water holding capacity of light textured soils, growing of green manure crops and application of organic manure is recommended.

Chapter 9

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Chandrageri-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
- Available water capacity
- Soil slope
- Soil gravelliness
- 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 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.

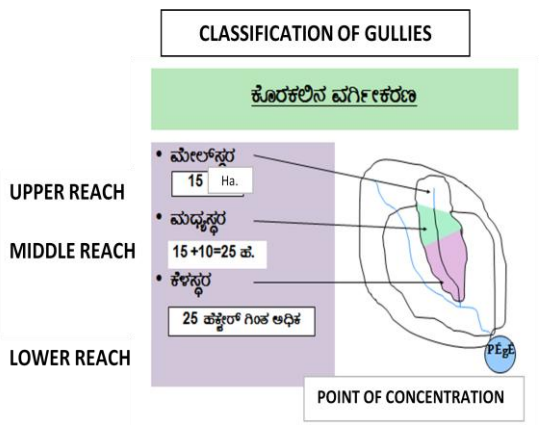
- Naming of user groups and farmers
- Identification of arable and non arable lands
- Identification of drainage lines and gullies
- Identification of non treatable areas
- Identification of priority areas in the arable lands
- Treatment plan for arable lands
- Location of water harvesting and recharge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

9.1 Treatment Plan

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

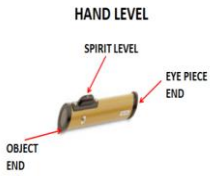
9.1.1 Arable Land Treatment

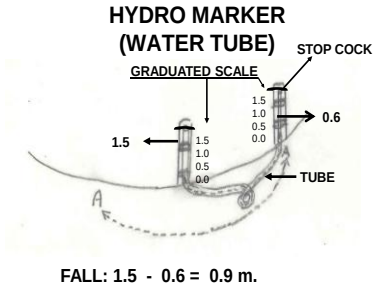
A. BUNDING

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 Hydromarker.





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

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

Note: i) The above intervals are maximum.

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

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

Section of the Bund

Bund section is decided considering the soil texture class and gravelliness class (bg_0 .....b = loamy sand, g_0 = <15% gravel). The recommended sections for different soils are given below.

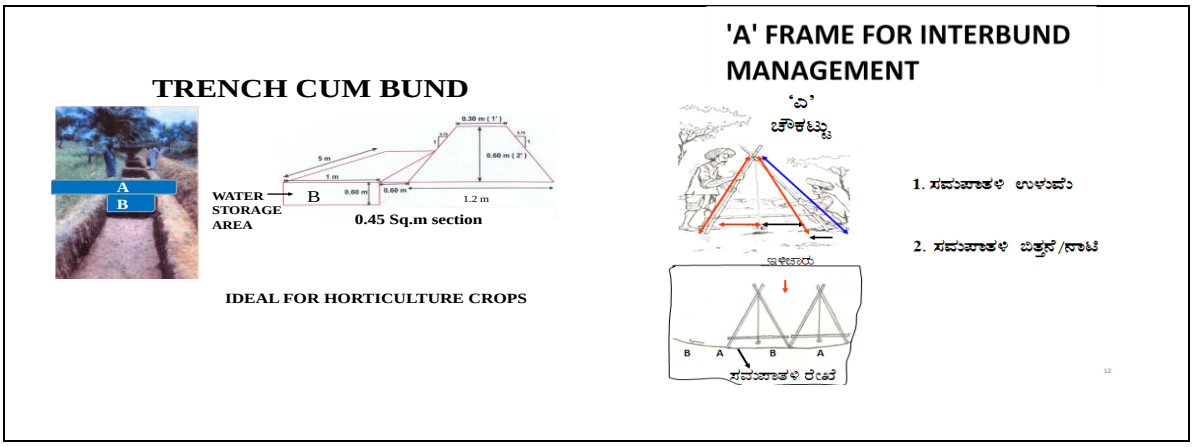
Recommended Bund Section

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 soils	
0.3	1.2	0.6	0.75:1	0.45		
0.3	1.5	0.6	01:01	0.54	Red sandy loam	
0.3	2.1	0.6	1.5:1	0.72	Very shallow clayey black soils	
0.45	2	0.75	01:01	0.92		
0.45	2.4	0.75	1.3:1	1.07	Shallow clayey black soils	
0.6	3.1	0.7	1.78:1	1.29	Medium clayey black soils	
0.5	3	0.85	1.47:1	1.49		

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below



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

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

B. Waterways

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

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

c) The design details are given in the Manual.

C. Farm Ponds

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

D. Diversion Channel

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

9.1.2 Non-Arable Land Treatment

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

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 (Fig.9.1).

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 the site-specific designs as shown in the Manual.

f) The location of ground water recharge structures are decided by examining the lineaments and fracture zones from geological maps.

g) Rainfall intensity data of the nearest Rain Gauge Station is considered for Hydrologic Designs.

h) Silt load to the Storage/Recharge Structures is reduced by providing vegetative, boulder and earthern checks in the natural water course. Location and design details are given in the Manual.

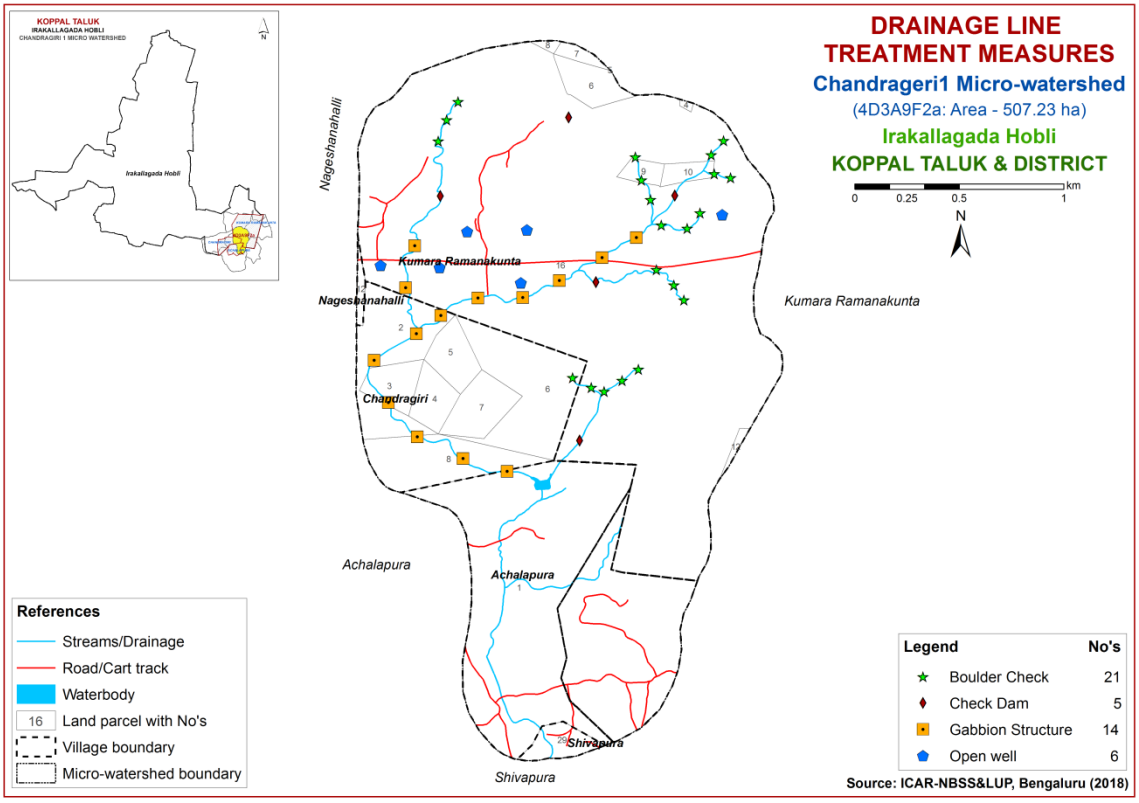


Fig. 9.1 Drainage line treatment map of Chandrageri-1 Microwatershed

9.2 Recommended Soil and Water Conservation Measures

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

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

A map (Fig. 9.2) showing soil and water conservation plan with different kinds of structures recommended has been prepared which shows the spatial distribution and extent of area. Entire area in the microwatershed needs trench cum bunding. The conservation plan prepared may be presented to all the stakeholders including farmers and after considering their suggestions, the conservation plan for the microwatershed may be finalised in a participatory approach.

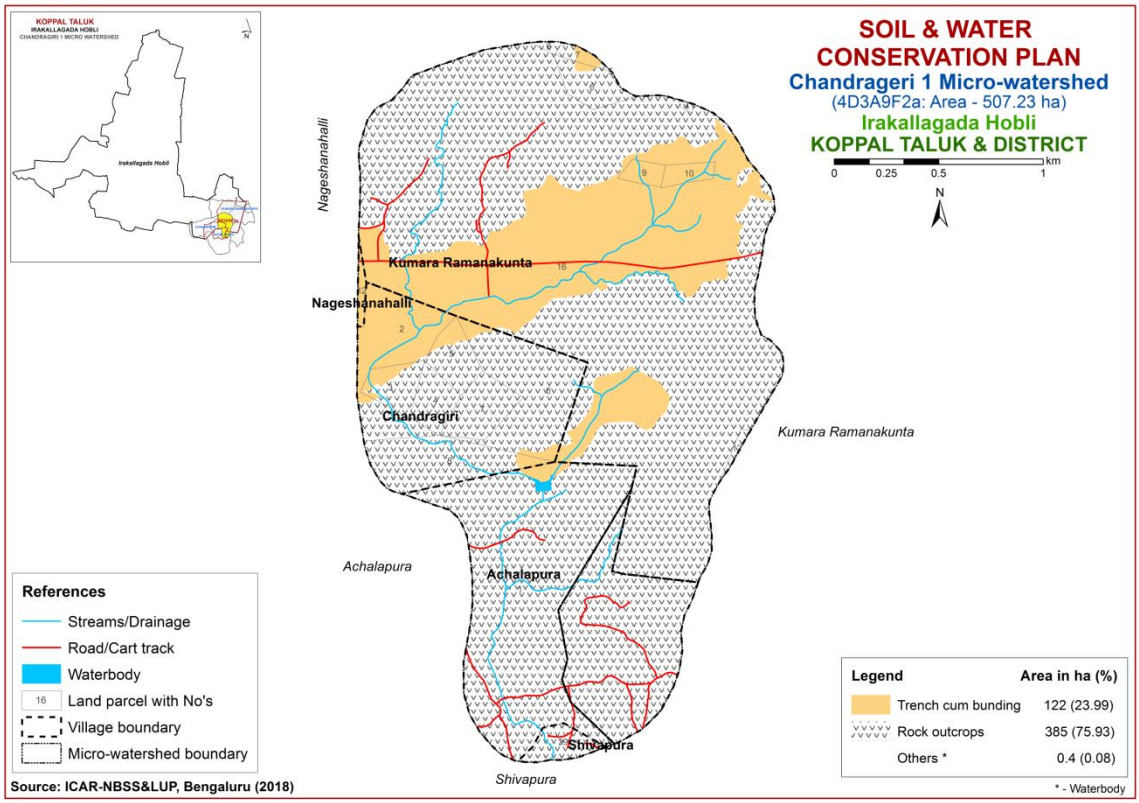


Fig. 9.2 Soil and Water Conservation Plan map of Chandrageri-1 Microwatershed

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

VII and VIII) and also the lands that are not suitable or marginally suitable for growing annual and perennial crops. The method of planting these trees is given below.

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

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

Dry Deciduous Species			Temp (°C)	Rainfall (mm)
1.	Bevu	*Azadiracta indica*	21–32	400 –1,200
2.	Tapasi	*Holoptelia integrifolia*	20-30	500 - 1000
3.	Seetaphal	*Anona Squamosa*	20-40	400 - 1000
4.	Honge	*Pongamia pinnata*	20 -50	500–2,500
5.	Kamara	*Hardwikia binata*	25 -35	400 - 1000
6.	Bage	*Albezzia lebbek*	20 - 45	500 - 1000
7.	Ficus	*Ficus bengalensis*	20 - 50	500–2,500
8.	Sisso	*Dalbargia Sissoo*	20 - 50	500 -2000
9.	Ailanthus	*Ailanthus excelsa*	20 - 50	500 - 1000
10.	Hale	*Wrightia tinctoria*	25 - 45	500 - 1000
11.	Uded	*Steriospermum chelanoides*	25 - 45	500 -2000
12.	Dhupa	*Boswella Serrata*	20 - 40	500 - 2000
13.	Nelli	*Emblica Officinalis*	20 - 50	500 -1500
14.	Honne	*Pterocarpus marsupium*	20 - 40	500 - 2000
Moist Deciduous Species			**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

Chandrageri1 (9F2a) Microwatershed

Soil Phase Information

Village	Survey No	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	Wells	Land Capability	Conservation Plan
Achalapura	1	77.05	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Achalapura	29	4.39	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Chandragiri	2	17.56	KGHbB2g1	LMU-3	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Pear millet+Paddy+Dyke (Mz+Pm+Pd+Dy)	Not Available	IIes	TCB
Chandragiri	3	4.95	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Chandragiri	4	4.8	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Chandragiri	5	5.48	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Chandragiri	6	21.65	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Chandragiri	7	7.1	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Chandragiri	8	14.73	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke+Current Fallow Land (Dy+CFL)	Not Available	Ro	Ro
Kumara Ramanakunta	4	0.24	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Kumara Ramanakunta	5	0.01	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Kumara Ramanakunta	6	5.21	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Kumara Ramanakunta	7	1.42	BSRbB2g1	LMU-1	Moderately deep (75-100 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IIes	TCB
Kumara Ramanakunta	8	0.49	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Kumara Ramanakunta	9	1.99	BGThB2g1	LMU-5	Very shallow (<25 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVes	TCB
Kumara Ramanakunta	10	2.23	BGThB2g1	LMU-5	Very shallow (<25 cm)	Sandy clay loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVes	TCB
Kumara Ramanakunta	12	0.69	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke (Dy)	Not Available	Ro	Ro
Kumara Ramanakunta	16	293.93	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Dyke+Maize+Pearl millet (Dy+Mz+Pm)	6 Open well,1 Check Dam	Ro	Ro
NA	NA	42.14	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Not Available (NA)	Not Available	Ro	Ro
Nageshanahalli	12	1.18	KGHbB2g1	LMU-3	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Dyke+Eucalyptus+Maize (Dy+Eu+Mz)	Not Available	IIes	TCB

Appendix II

Chandrageri1 (9F2a) Microwatershed

Soil Fertility Information

Village	Survey NO	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Achalapura	1	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Achalapura	29	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	2	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Chandragiri	3	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	4	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	5	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	6	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	7	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	8	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	4	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	5	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	6	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	7	Moderately alkaline (pH 7.8 – 8.4)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kumara Ramanakunta	8	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	9	Moderately alkaline (pH 7.8 – 8.4)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kumara Ramanakunta	10	Moderately alkaline (pH 7.8 – 8.4)	Non saline (<2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kumara Ramanakunta	12	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	16	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
NA	NA	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Nageshanahalli	12	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Appendix III

Chandrageri1 (9F2a) Microwatershed

Soil Suitability Information

Village	Survey NO	Mango	Maize	Sapota	Sorgham	Guava	Cotton	Tamarind	Lime	Bengalgram	Sunflower	Redgram	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Jasmine	Crossandra	Drumstick	Mulberry
Achalapura	1	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Achalapura	29	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	2	N1r	S2r	S3r	S2r	S3r	S2r	N1r	S3r	S2rt	S3r	S3r	S2r	S3r	S2r	S3r	S3r	S3r	S2r	S2r	S2r	S2r	S2r	S3r	S2r	S2r	S2r	S3r	S3r
Chandragiri	3	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	4	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	5	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	6	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	7	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Chandragiri	8	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	4	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	5	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	6	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	7	S3r	S2tg	S2rg	S2g	S2rt	S2rg	S3r	S2rg	S2gt	S2r	S2gt	S2t	S2rg	S1	S2rt	S2rg	S2rg	S2t	S2t	S2t	S2tg	S2tg	S2rg	S2t	S2tg	S2gt	S2r	S2r
Kumara Ramanakunta	8	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	9	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
Kumara Ramanakunta	10	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
Kumara Ramanakunta	12	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Kumara Ramanakunta	16	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
NA	NA	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro	Ro
Nageshanahalli	12	N1r	S2r	S3r	S2r	S3r	S2r	N1r	S3r	S2rt	S3r	S3r	S2r	S3r	S2r	S3r	S3r	S3r	S2r	S2r	S2r	S2r	S2r	S3r	S2r	S2r	S2r	S3r	S3r

Ro-Rock outcrops

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

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Chapter 1

SALIENT FINDINGS OF THE STUDY

- *Results indicated that 35 farmers were sampled in Chandrageri-1micro watershed among them 6 (17.14%) were marginal farmers, 19 (54.29%) were small farmers, 4 (11.43%) were semi medium farmers, 1 (2.86 %) were medium farmers and 5 (14.29 %) landless farmers were also interviewed for the survey.*
- *The data indicated that there were 196 population households were there in the studied micro watershed. Among them 113 (57.65%) men and 83 (42.35%) were women. The average family size of landless was 7, marginal farmers and small farmers were 5, semi medium farmer was 8 and medium farmers were 4. On an average the family size was 6.*
- *The data indicated that 49 (25%) people were in 0-15 years of age, 83 (42.35 %) were in 16-35 years of age, 44 (22.45 %) were in 36-60 years of age and 20 (10.20%) were above 61 years of age.*
- *The results indicated that the Chandrageri-1 had 25 per cent illiterates, 41.84 per cent of them had primary school education, 8.16 per cent of them had both middle schools, 11.22 per cent of them had high school education, 4.59 per cent of them had PUC education, 1.53 per cent them had ITI education and 0.51 per cent them had degree education.*
- *The results indicated that, 68.57 per cent of households practicing agriculture, 2.86 per cent of the household heads were agricultural labour and in private service respectively. 11.43 per cent of the household heads were general labour.*
- *The results indicated that agriculture was the major occupation for 56.12 per cent of the household members, 5.61 per cent were agricultural labourers,6.12 per cent were general labours, 0.51 per cent of them were in private sector, 20.92 per cent of them were students, 7.14 per cent of them were children and 3.57 per cent were doing other jobs. In case of landless households 33.33 per cent were agricultural labour, 36.36 per cent were general labourers and 27.27 per cent were students. In case of marginal farmers 72.41 per cent were agriculturist, 10.34 per cent were students and 13.79 per cent were children. In case of small farmers 68.69 per cent of them were agriculturist and 21.21 per cent of them were students. In case of semi medium farmers 61.29 per cent of the family members were agriculturist and 25.81 per cent of them were students. In case of medium farmers 50 per cent of the family members were agriculturist and 50 per cent of them were children.*
- *The results showed that 1.53 per cent of them participated in self help groups and 98.47 per cent of them have not participated in any local institutions. Only land less and marginal farmers have participated in one or other institutions. Small, semi medium and medium farmers have not participated in any local institutions.*

- *The results indicated that 85.71 per cent of the households possess Katcha house, 14.29 per cent of the households possess Pucca house and 2.86 per cent of them possess Thatched house.*
- *The results showed that, 74.29 per cent of the households possess TV, 60 per cent of the households possess Mixer grinder, 40 per cent of the households possess bicycle, 45.71 per cent of the households possess motor cycle, 2.86 per cent of the households possess landline phone and 97.14 per cent of the households possess mobile phones.*
- *The results showed that the average value of television was Rs. 2250, mixer grinder was Rs.1119, bicycle was Rs.964, motor cycle was Rs.37187, land line phone was Rs. 2000 and mobile phone was Rs.1254.*
- *About 5.71 per cent of the households possess bullock cart, 17.14 per cent of them possess plough, 2.86 per cent of the households possess power tiller, 5.71 per cent of the households possess tractor, 22.86 per cent of the households possess sprayer, 74.29 per cent of the households possess weeder and 28.57 per cent of the households possess chaff cutter.*
- *The results showed that the average value of bullock cart was Rs.12500; the average value of plough was Rs. 562, the average value of power tiller was Rs. 5000, the average value of tractor was Rs. 200000, the average value of sprayer was Rs. 1611, the average value of weeder was Rs. 27 and the average value of chaff cutter was Rs. 716.*
- *The results indicated that, 25.71 per cent of the households possess bullocks, 20 per cent of the households possess local cow, 11.43 per cent of the households possess sheep, 5.71 per cent of the households possess goat and 8.57 per cent of the households possess poultry birds. 20 per cent of the landless farmers possess bullocks.*
- *In case of marginal farmers, 33.33 per cent of the households possess bullock and 16.67 per cent of the households possess poultry birds. In case of small farmers, 26.32 per cent of households possess bullock, 5.26 per cent possess local cow and 10.53 per cent of the households possess sheep and poultry birds respectively. In case of semi medium farmers, 50 per cent of the households possess bullock, sheep and goat correspondingly, 75 per cent of the households possess local cow.*
- *The results indicated that, average own labour men available in the micro watershed was 2.03, average own labour (women) available was 1.37, average hired labour (men) available was 7.60 and average hired labour (women) available was 8.07.*
- *In case of marginal farmers, average own labour men available was 1.18, average own labour (women) was also 1.17, average hired labour (men) was 7.17 and average hired labour (women) available was 7.83. In case of small*

farmers, average own labour men available was 2.16, average own labour (women) was 1.37, average hired labour (men) was 8.32 and average hired labour (women) available was 8.79. In case of semi medium farmers, average own labour men available was 1.75, average own labour (women) was 1.75, average hired labour (men) was 5.50 and average hired labour (women) available was 5.75. In medium farmers average own labour men available was 1, average own labour (women) was 1, average hired labour (men) was 5 and average hired labour (women) available was 5.

- *The results indicated that, 85.71 per cent of the household opined that hired labour was adequate.*
- *The results indicated that, households of the Chandrageri-1 micro watershed possess 32.25 ha (80.75 %) of dry land and 7.69 ha (19.25%) of irrigated land. Marginal farmers possess 4.61 ha (100 %) of dry land. Small farmers possess 25.29 ha (95.42 %) of dry land and 1.21 ha (4.58 %) of irrigated land. Semi medium farmers possess 2.35 ha (34.52 %) of dry land and 4.45 ha (65.48 %) of irrigated land. Medium farmers possess 2.02 ha (100%) of irrigated land.*
- *The results indicated that, the average value of dry land was Rs. 241,731.49 and average value of irrigated was Rs. 533,000. In case of marginal famers, the average land value was Rs. 433,333.33 for dry land. In case of small famers, the average land value was Rs. 209,456 for dry land Rs. 1,070,333.33 for irrigated land. In case of semi medium famers, the average land value was Rs. 212,931.03 for dry land and Rs. 471,545.45 for irrigated land. In case of medium famers, the average land value was Rs. 345,800.00 for irrigated land.*
- *The results indicated that, there were 1 functioning bore wells in the micro watershed.*
- *The results indicated that, bore well was the major irrigation source for 2.86 per cent of the farmers.*
- *The results indicated that on an average the depth of the bore well was 2.26 meters.*
- *The results indicated that, in case of small farmers there was 0.40 ha of irrigated land.*
- *The results indicated that, farmers have grown bajra (11.74 ha), Bengal gram (1.42 ha), groundnut (5.34 ha), maize (14.17 ha), marigold (1.62 ha), paddy (3.24 ha) and sunflower (2.02 ha) in kharif season and also grown bajra (0.81 ha), maize (2.83 ha) and paddy (0.40 ha) in Rabi season. Marginal farmers had grown bajra, groundnut and maize. Small farmers had grown bajra, Bengal gram, groundnut, maize, marigold, paddy and sunflower. Semi medium farmers had grown groundnut, maize and paddy. Medium farmers had grown bajra and maize.*

- *The results indicated that, the cropping intensity in Chandrageri-1 micro watershed was found to be 85 per cent. In case of marginal farmers it was 100 per cent, in small farmers it was 90.48, in semi medium farmers it was 77.99 and in medium farmers it was 50 per cent.*
- *The results indicated that, 94.29 per cent of the households have bank account including 80 per cent of the landless, 100 per cent of the marginal, semi medium, medium farmers and 94.74 per cent of the small farmers respectively.*
- *The results indicated that, 60 per cent of the landless, 83.33 per cent of marginal, 63.16 per cent of small, 50 per cent of the semi medium and 100 per cent of medium farmers have borrowed credit from different sources.*
- *The results indicated that, 26.09 per cent have availed loan from friends/ relatives, 13.04 per cent have availed loan from Grameena bank, 4.35 per cent have availed loan from money lender and 27.74 per cent have availed loan from SHGs/CBOs.*
- *The results indicated that, landless, marginal, small and semi medium have availed Rs.200000, Rs. 56000, Rs. 52916.67 and Rs. 100000 respectively. Overall average credit amount availed by households in the micro watershed is 74565.22.*
- *The results indicated that, 100 per cent of the households have borrowed loan for agriculture production.*
- *The results indicated that, about 50 percent of loan was taken for agriculture production and 25 per cent of the loan was taken for household consumption and social functions like marriage respectively.*
- *Results indicated that 100 per cent of the households have unpaid their institutional credit.*
- *Results indicated that 66.67 per cent of the households have repaid their private credit partially and 33.33 percent of the households have unpaid their loan.*
- *The results indicated that, the total cost of cultivation for bajra was Rs. 24146.04. The gross income realized by the farmers was Rs. 39356.18. The net income from bajra cultivation was Rs. 15210.14, thus the benefit cost ratio was found to be 1:1.63.*
- *The results indicated that, the total cost of cultivation for maize was Rs. 32651.11. The gross income realized by the farmers was Rs. 54099.73. The net income from maize cultivation was Rs. 21448.62. Thus the benefit cost ratio was found to be 1:1.66.*
- *The results indicated that, the total cost of cultivation for paddy was Rs. 40611.14. The gross income realized by the farmers was Rs. 95195.63. The net income from paddy cultivation was Rs. 54584.49. Thus the benefit cost ratio was found to be 1:2.34.*
- *The results indicated that, the total cost of cultivation for groundnut was Rs. 44527.28. The gross income realized by the farmers was Rs. 45562.07. The net*

income from groundnut cultivation was Rs. 1034.79. Thus the benefit cost ratio was found to be 1:1.02.

- *The results indicated that, the total cost of cultivation for Sunflower was Rs. 23037.56. The gross income realized by the farmers was Rs. 34518.25. The net income from Sunflower cultivation was Rs.11480.69. Thus the benefit cost ratio was found to be 1:1.5.*
- *The results indicated that, the total cost of cultivation for Bengal gram was Rs. 36881.18. The gross income realized by the farmers was Rs. 43577.86. The net income from Bengal gram cultivation was Rs. 6696.68. Thus the benefit cost ratio was found to be 1:1.18.*
- *The results indicated that, 28.57 per cent of the households opined that dry fodder was adequate.*
- *The table indicated that, in landless farmers, the average income from wage was Rs. 87000. In case of marginal farmers, the average income from wage was Rs.23333.33 and agriculture was Rs.63166.67. In small farmers the average income from service/salary was Rs. 4736.84, wage was Rs.23421.05, agriculture was Rs.102578.95, dairy farm was Rs.263.16 and goat farming was Rs.526.32. In semi medium farmers, the average income from wage, dairy farming and goat farming was Rs.25000 respectively and agriculture was Rs.225000. In case of medium farmers the average income from agriculture was Rs.300000.*
- *The results indicated that, in case of landless farmers, the annual average expenditure from wage was Rs. 20000. In marginal farmers the annual average expenditure from agriculture was Rs.33000. In small farmers, the annual average expenditure from wage was Rs. 1538.46, agriculture was Rs.48789.47, dairy farm Was Rs.2000 and Goat farming was Rs.1000. In semi medium farmers, the annual average expenditure from wage was Rs. 50000, agriculture was Rs.100000, dairy farm Was Rs.50000 and Goat farming was Rs.20000. In case of medium farmers, the annual average expenditure from agriculture was Rs.150000.*
- *The results indicated that, sampled households have grown 55coconut trees and 13 mango tree in their field and also planted 6 coconut trees in their backyard.*
- *The results indicated that, households have planted 3 Eucalyptus tree, 18 teak trees, 200 neem trees, 1tamarind tress and 1 pongamia trees in their field and also grown 4 Neem tree in the backyard.*
- *The results indicated that, groundnut, paddy and sunflower crops were sold to the extent of 100 per cent. Bajra, Bengal gram and maize crops were sold to the extent of 93.39 per cent, 92.31 per cent and 91.13per cent respectively.*
- *The results indicated that, 85.71 percent of the households have sold their produce local/village merchant and 22.86 percent of the households sold their produce in regulated markets.*

- *The results indicated that 91.43 per cent of the households have used tractor as a mode of transport and 17.14 per cent have used truck.*
- *The results indicated that, 40 per cent of the households have experienced the soil and water erosion problems i.e. 50 percent of marginal farmers, 47.37 per cent of small farmers and 50 per cent of semi medium farmers.*
- *The results indicated that, 85.71 per cent of the households have shown interest in soil testing.*
- *The results indicated that, 65.71 percent used fire wood as a source of fuel and 34.29 percent of the households used LPG as a source of fuel.*
- *The results indicated that, piped supply was the source of drinking water for 71.43 per cent and 31.43 per cent of them were using bore well for drinking water.*
- *The results indicated that, electricity was the major source of light for 100 per cent of the households.*
- *The results indicated that, 80 per cent of the households possess sanitary toilet i.e. 20 per cent of landless, 100 per cent of marginal, small and medium farmers and 25 per cent of the semi medium farmers had sanitary toilet facility.*
- *The results indicated that, 97.14 per cent of the sampled households possessed BPL card and 2.86 per cent of the sampled households have not possessed BPL card.*
- *The results indicated that, 42.86 per cent of the households participated in NREGA programme which included 100 per cent of the landless, marginal and medium farmers and 25 per cent of the semi medium farmers.*
- *The results indicated that, cereals, pulses, oilseeds, vegetables, fruits , milk, egg and meat were adequate for 100 per cent, 97.14 per cent, 34.29 per cent, 17.14 per cent, 2.86 per cent, 88.57 per cent, 57.14 per cent and 2.86 per cent respectively.*
- *The results indicated that, oilseed, vegetables, fruits, milk, egg and meat were inadequate for 45.71 per cent, 48.57 per cent, 60 per cent, 8.57 per cent, 42.86 per cent and 68.57 per cent of the households.*
- *The results indicated that, Lower fertility status of the soil was the constraint experienced by 60 per cent of the households, wild animal menace on farm field (71.43%), frequent incidence of pest and diseases (71.43%), inadequacy of irrigation water (25.71%), high cost of Fertilizers and plant protection chemicals (82.86%), high rate of interest on credit (25.71%), low price for the agricultural commodities (60%), lack of marketing facilities in the area (60%), inadequate extension services (25.71%), lack of transport for safe transport of the agricultural produce to the market (77.14%) and less rainfall (17.14%).*

Chapter 2

INTRODUCTION

Soil and water are the two precious natural resources which are essential for crop production and existence of life on earth. Rainfed agriculture is under severe stress due to various constraints related to agriculture like uneven and erratic distribution of rainfall, indiscriminate use of fertilizers, chemicals and pesticides, adoption of improper land management practices, soil erosion, decline in soil fertility, decline in ground water resources leading to low crop productivity. The area under rainfed agriculture has to be managed effectively using the best available practices to enhance the production of food, fodder and fuel. This is possible if the land resources are characterized at each parcel of land through detailed land resource inventory using the best available techniques of remote sensing, GPS and GIS. The watershed development programs are aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a watershed boundary.

World Bank funded KWDP II, SUJALA III project was implemented in with Broad objective of demonstrating more effective watershed management through greater integration of programmes related to rain-fed agriculture, innovative and science based approaches and strengthen institutional capacities and If successful, it is expected that the systems and tools could be mainstreamed into the overall IWMP in the State of Karnataka and in time, throughout other IWMP operations in India. With this background the socio-economic survey has been carried out with following specific objectives:

1. To understand the demographic features of the households in the micro-watershed
2. To understand the extent of family labour available and additional employment opportunities available within the village.
3. To know the status of assets of households in the micro-watershed for suggesting possible improvements.
4. To study the cropping pattern, cropped area and productivity levels of different households in micro-watershed.
5. To determine the type and extent of livestock owned by different categories of HHs
6. Availability of fodder and level of livestock management.

Scope and importance of survey

Survey helps in identification of different socio-economic and resource use-patterns of farmers at the Micro watershed. Household survey provides demographic features, labour force, and levels of education; land ownership and asset position (including livestock and other household assets) of surveyed households; and cropping patterns, input intensities, and average crop yields from farmers' fields. It also discusses crop utilization and the degree of commercialization of production in the areas; farmers' access to and utilization of credit from formal and informal sources; and the level of adoption and use of soil, water,and pest management technologies.

Chapter 3

METHODOLOGY

The description of the methods, components selected for the survey and procedures followed in conducting the baseline survey are furnished under the following heads.

Description of the study area

Koppal district is an administrative district in the state of Karnataka in India. In the past Koppal was referred to as 'Kopana Nagara'. Koppal, now a district headquarters is ancient Kopana a major holy place of the Jains. The district occupies an area of 7,190 km² and has a population of 1,196,089, which 16.58% were urban as of 2001. The Koppal district was formed after split of Raichur district. It consists of four taluks namely Koppal, Gangavathi, Kushtagi and Yelburga. The undulating topography with black cotton soil shrips, cut across by numerous nalas or streams is the major characteristic feature of the study region. The Koppal district is having partly red sandy and black soil suitable for agriculture and horticulture crops. Majority of Gangavathi taluk is having black soil. The taluk is also having very few hills with xerophilous vegetation. The partly red sandy soil and black soil of mixed geographical origin are found in the Yelburga taluk.

Three physiographic divisions have made considering the local conditions of landforms and crops grown in the district. On the basis of physiographic, Koppal district can be divided into three major divisions. They are (a) Koppal & Yelburga plateau, (b) Maidan division, (c) Tungabhadra valley. The district is part of Krishna basin the main streams draining the area are Maskinala, Ilkal-nadi and Hirenala. These are Ephemeral in nature, these come under Tungabhadra sub-basin. The drainage exhibit dendritic to subdendritic with drainage density varies from 1.4 to7.0kms/sq.km. According to the 2011 census Koppal district has a population of 1,391,292, roughly equal to the nation of Swaziland or the US state of Hawaii. This gives it a ranking of 350th in India (out of a total of 640). The district has a population density of 250 inhabitants per square kilometre (650/sq mi). Its population growth rate over the decade 2001-2011 was 16.32%. Koppal has a sex ratio of 983 females for every 1000 males, and a literacy rate of 67.28%.

Description of the micro-watershed

Chandrageri-1 micro-watershed (Shivpur sub-watershed, Koppal Taluk and District) is located at North latitude $15^0$23’45.481’’ to 15^0 22’0.397” and East longitude 76^0 22’27.677’’ to $76^0$21’16.253’’ E covering an area of 507.35 ha and spread across Chandragiri, KumaraRamanakunta, Achalapura and Bandiharlapura villages.

Methodology followed in assessing socio-economic status of households

In order to assess the socio-economic condition of the farmers in the watershed a comprehensive questionnaire was prepared. Major components such as demographic conditions, migration details, food consumption and family expenditure pattern, material possession, land holding, land use management, cropping pattern, cost of cultivation of crops, livestock management. The statistical components such as frequency and percentage were used to analyze the data. About 35 households located in the micro-watershed were interviewed for the survey.

SALIENT FEATURES OF THE SURVEY

Households sampled for socio-economic survey: The data on households sampled for socio economic survey in Chandrageri-1 micro watershed is presented in Table 1 and it indicated that 35 farmers were sampled in Chandrageri-1 micro watershed among them 6 (17.14%) were marginal farmers, 19 (54.29%) were small farmers, 4 (11.43%) were semi medium farmers, 1 (2.86 %) were medium farmers and 5 (14.29 %) landless farmers were also interviewed for the survey.

Table 1: Households sampled for socio economic survey in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Farmers	5	14.29	6	17.14	19	54.29	4	11.43	1	2.86	35	100

Population characteristics: The population characteristics of households sampled for socio-economic survey in Chandrageri-1 micro watershed is presented in Table 2. The data indicated that there were 196 population households were there in the studied micro watershed. Among them 113 (57.65%) men and 83 (42.35%) were women. The average family size of landless was 7, marginal farmers and small farmers were 5, semi medium farmer was 8 and medium farmers were 4. On an average the family size was 6.

Table 2: Population characteristics of Chandrageri-1 micro-watershed

Sl. No.	Particulars	LL (33)		MF (29)		SF (99)		SMF (31)		MDF (4)		All (196)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Male	20	60.61	18	62.07	55	55.56	18	58.06	2	50	113	57.65
2	Female	13	39.39	11	37.93	44	44.44	13	41.94	2	50	83	42.35
Total		33	100	29	100	99	100	31	100	4	100	196	100
Average		7		5		5		8		4		6	

Age wise classification of population: The age wise classification of household members in Chandrageri-1 micro watershed is presented in Table 3. The data indicated that 49 (25%) people were in 0-15 years of age, 83 (42.35 %) were in 16-35 years of age, 44 (22.45 %) were in 36-60 years of age and 20 (10.20%) were above 61 years of age.

Table 3: Age wise classification of household members in Chandrageri-1 micro watershed

S. N.	Particulars	LL (33)		MF (29)		SF (99)		SMF (31)		MDF (4)		All (196)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	0-15 years	11	33.33	4	13.79	20	20.20	12	38.71	2	50	49	25
2	16-35 years	12	36.36	12	41.38	44	44.44	13	41.94	2	50	83	42.35
3	36-60 years	6	18.18	11	37.93	24	24.24	3	9.68	0	0	44	22.45
4	> 61 years	4	12.12	2	6.90	11	11.11	3	9.68	0	0	20	10.20
Total		33	100	29	100	99	100	31	100	4	100	196	100

Education level of household members: Education level of household members in Chandrageri-1 micro watershed is presented in Table 4. The results indicated that the

Chandrageri-1 had 25 per cent illiterates, 41.84 per cent of them had primary school education, 8.16 per cent of them had both middle schools, 11.22 per cent of them had high school education, 4.59 per cent of them had PUC education, 1.53 per cent them had ITI education and 0.51 per cent them had degree education.

Table 4: Education level of household members in Chandrageri-1 micro watershed

S.N.	Particulars	LL (33)		MF (29)		SF (99)		SMF (31)		MDF (4)		All (196)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Illiterate	6	18.18	7	24.14	30	30.30	5	16.13	1	25.00	49	25.00
2	Primary School	24	72.73	4	13.79	35	35.35	18	58.06	1	25.00	82	41.84
3	Middle School	2	6.06	2	6.90	9	9.09	3	9.68	0	0.00	16	8.16
4	High School	0	0.00	6	20.69	15	15.15	1	3.23	0	0.00	22	11.22
5	PUC	0	0.00	4	13.79	5	5.05	0	0.00	0	0.00	9	4.59
6	ITI	0	0.00	1	3.45	2	2.02	0	0.00	0	0.00	3	1.53
7	Degree	0	0.00	1	3.45	0	0.00	0	0.00	0	0.00	1	0.51
Total		33	100.00	29	100.00	99	100.00	31	100.00	4	100.00	196	100.00

Occupation of household heads: The data regarding the occupation of the household heads in Chandrageri-1 micro watershed is presented in Table 5. The results indicated that, 68.57 per cent of households practicing agriculture, 2.86 per cent of the household heads were agricultural labour and in private service respectively. 11.43 per cent of the household heads were general labour.

Table 5: Occupation of household heads in Chandrageri-1 micro watershed

S. N.	Particulars	LL (5)		MF (6)		SF (19)		SMF(4)		MDF(1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Agriculture	0	0	5	83.33	14	73.68	4	100	1	100	24	68.57
2	Agricultural Labour	1	20	0	0	0	0	0	0	0	0	1	2.86
3	General Labour	4	80	0	0	0	0	0	0	0	0	4	11.43
4	Private Service	0	0	0	0	1	5.26	0	0	0	0	1	2.86
5	Others	0	0	1	16.67	3	15.79	0	0	0	0	4	11.43
Total		5	100	6	100	18	100	4	100	1	100	34	100

Occupation of the household members: The data regarding the occupation of the household members in Chandrageri-1 micro watershed is presented in Table 6. The results indicated that agriculture was the major occupation for 56.12 per cent of the household members, 5.61 per cent were agricultural labourers,6.12 per cent were general labours, 0.51 per cent of them were in private sector, 20.92 per cent of them were students, 7.14 per cent of them were children and 3.57 per cent were doing other jobs.

In case of landless households 33.33 per cent were agricultural labour, 36.36 per cent were general labourers and 27.27 per cent were students. In case of marginal farmers 72.41 per cent were agriculturist, 10.34 per cent were students and 13.79 per cent were children. In case of small farmers 68.69 per cent of them were agriculturist and 21.21 per cent of them were students. In case of semi medium farmers 61.29 per cent of the family members were agriculturist and 25.81 per cent of them were students. In case of medium

farmers 50 per cent of the family members were agriculturist and 50 per cent of them were children.

Table 6: Occupation of family members in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (33)		MF (29)		SF (99)		SMF (31)		MDF(4)		All (196)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Agriculture	0	0	21	72.41	68	68.69	19	61.29	2	50	110	56.12
2	Agricultural Labour	11	33.33	0	0	0	0	0	0	0	0	11	5.61
3	General Labour	12	36.36	0	0	0	0	0	0	0	0	12	6.12
4	Private Service	0	0	0	0	1	1.01	0	0	0	0	1	0.51
5	Student	9	27.27	3	10.34	21	21.21	8	25.81	0	0	41	20.92
6	Others	0	0.00	1	3.45	6	6.06	0	0.00	0	0	7	3.57
7	Children	1	3.03	4	13.79	3	3.03	4	12.90	2	50	14	7.14
Total		33	100	29	100	99	100	31	100	4	100	196	100

Institutional participation of the household members: The data regarding the institutional participation of the household members in Chandrageri-1 micro-watershed is presented in Table 7. The results showed that 1.53 per cent of them participated in self help groups and 98.47 per cent of them have not participated in any local institutions. Only land less and marginal farmers have participated in one or other institutions. Small, semi medium and medium farmers have not participated in any local institutions.

Table 7: Institutional Participation of household members in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (33)		MF (29)		SF (99)		SMF(31)		MDF(4)		All (196)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Self Help Group	2	6.06	1	3.45	0	0	0	0	0	0	3	1.53
2	No Participation	31	93.94	28	96.55	99	100	31	100	4	100	193	98.47
Total		33	100	29	100	99	100	31	100	4	100	196	100

Type of house owned: The data regarding the type of house owned by the households in Chandrageri-1 micro watershed is presented in Table 8. The results indicated that 85.71 per cent of the households possess Katcha house, 14.29 per cent of the households possess Pucca house and 2.86 per cent of them possess Thatched house.

Table 8: Type of house owned by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Thatched	0	0	0		0	0	1	25	0	0	1	2.86
2	Katcha	4	80	4	66.67	19	100	2	50	1	100	30	85.71
3	Pucca/RCC	2	40	2	33.33	0	0	1	25	0	0	5	14.29
Total		6	100	6	100	19	100	4	100	1	100	35	100

Durable Assets owned by the households: The data regarding the Durable Assets owned by the households in Chandrageri-1 micro watershed is presented in Table 9. The results showed that, 74.29 per cent of the households possess TV, 60 per cent of the households possess Mixer grinder, 40 per cent of the households possess bicycle, 45.71

per cent of the households possess motor cycle, 2.86 per cent of the households possess landline phone and 97.14 per cent of the households possess mobile phones.

Table 9: Durable Assets owned by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Television	5	100.00	6	100.00	13	68.42	2	50.00	26	74.29
2	Mixer/Grinder	4	80.00	6	100.00	10	52.63	1	25.00	21	60.00
3	Bicycle	2	40.00	3	50.00	9	47.37	0	0.00	14	40.00
4	Motor Cycle	1	20.00	4	66.67	8	42.11	3	75.00	16	45.71
5	Landline Phone	1	20.00	0	0.00	0	0.00	0	0.00	1	2.86
6	Mobile Phone	4	80.00	6	100.00	19	100.00	4	100.00	34	97.14

Average value of durable assets: The data regarding the average value of durable assets owned by the households in Chandrageri-1 micro watershed is presented in Table 10. The results showed that the average value of television was Rs. 2250, mixer grinder was Rs.1119, bicycle was Rs.964, motor cycle was Rs.37187, land line phone was Rs. 2000 and mobile phone was Rs.1254.

Table 10: Average value (Rs) of durable assets owned by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)	MF (6)	SF (19)	SMF (4)	All (35)
1	Television	2,000.00	2,750.00	2,000.00	3,000.00	2,250.00
2	Mixer/Grinder	1,000.00	1,333.00	1,050.00	1,000.00	1,119.00
3	Bicycle	1,000.00	1,000.00	944.00	0.00	964.00
4	Motor Cycle	20,000.00	30,000.00	40,625.00	43,333.00	37,187.00
5	Landline Phone	2,000.00	0.00	0.00	0.00	2,000.00
6	Mobile Phone	820.00	1,700.00	1,117.00	1,357.00	1,254.00

Farm Implements owned: The data regarding the farm implements owned by the households in Chandrageri-1 micro watershed is presented in Table 11. About 5.71 per cent of the households possess bullock cart, 17.14 per cent of them possess plough, 2.86 per cent of the households possess power tiller, 5.71 per cent of the households possess tractor, 22.86 per cent of the households possess sprayer, 74.29 per cent of the households possess weeder and 28.57 per cent of the households possess chaff cutter.

Table 11: Farm Implements owned by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Bullock Cart	0	0.00	0	0.00	1	5.26	1	25.00	2	5.71
2	Plough	1	20.00	1	16.67	2	10.53	2	50.00	6	17.14
3	Power Tiller	0	0.00	0	0.00	1	5.26	0	0.00	1	2.86
4	Tractor	1	20.00	1	16.67	0	0.00	0	0.00	2	5.71
5	Sprayer	1	20.00	2	33.33	4	21.05	1	25.00	8	22.86
6	Weeder	4	80.00	6	100.00	14	73.68	2	50.00	26	74.29
7	Chaff Cutter	1	20.00	3	50.00	5	26.32	1	25.00	10	28.57

Average value of farm implements: The data regarding the average value of farm Implements owned by the households in Chandrageri-1 micro watershed is presented in Table 12. The results showed that the average value of bullock cart was Rs.12500; the average value of plough was Rs. 562, the average value of power tiller was Rs. 5000, the average value of tractor was Rs. 200000, the average value of sprayer was Rs. 1611, the average value of weeder was Rs. 27 and the average value of chaff cutter was Rs. 716.

Table 12: Average value (Rs) of farm implements owned by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)	MF (6)	SF (19)	SMF (4)	All (35)
1	Bullock Cart	0	0	20000	5000	12500
2	Plough	333	500	666	625	562
3	Power Tiller	0	0	500	0	500
4	Tractor	200000	200000	0	0	200000
5	Sprayer	1500	1000	2500	500	1611
6	Weeder	22	25	29	27	27
7	Chaff Cutter	500	500	1220	166	716

Livestock possession by the households: The data regarding the Livestock possession by the households in Chandrageri-1 micro watershed is presented in Table 13. The results indicated that, 25.71 per cent of the households possess bullocks, 20 per cent of the households possess local cow, 11.43 per cent of the households possess sheep, 5.71 per cent of the households possess goat and 8.57 per cent of the households possess poultry birds. 20 per cent of the landless farmers possess bullocks.

In case of marginal farmers, 33.33 per cent of the households possess bullock and 16.67 per cent of the households possess poultry birds. In case of small farmers, 26.32 per cent of households possess bullock, 5.26 per cent possess local cow and 10.53 per cent of the households possess sheep and poultry birds respectively. In case of semi medium farmers, 50 per cent of the households possess bullock, sheep and goat correspondingly, 75 per cent of the households possess local cow.

Table 13: Livestock possession by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Bullock	1	20.00	0	0.00	5	26.32	2	50.00	9	25.71
2	Local cow	0	0.00	2	33.33	1	5.26	3	75.00	7	20.00
3	Sheep	0	0.00	0	0.00	2	10.53	2	50.00	4	11.43
4	Goat	0	0.00	0	0.00	0	0.00	2	50.00	2	5.71
5	Poultry birds	0	0.00	1	16.67	2	10.53	0	0.00	3	8.57

Average Labour availability: The data regarding the average labour availability in Chandrageri-1 micro watershed is presented in Table 14. The results indicated that, average own labour men available in the micro watershed was 2.03, average own labour (women) available was 1.37, average hired labour (men) available was 7.60 and average hired labour (women) available was 8.07.

In case of marginal farmers, average own labour men available was 1.18, average own labour (women) was also 1.17, average hired labour (men) was 7.17 and average hired labour (women) available was 7.83. In case of small farmers, average own labour men available was 2.16, average own labour (women) was 1.37, average hired labour (men) was 8.32 and average hired labour (women) available was 8.79. In case of semi medium farmers, average own labour men available was 1.75, average own labour (women) was 1.75, average hired labour (men) was 5.50 and average hired labour (women) available was 5.75. In medium farmers average own labour men available was 1, average own labour (women) was 1, average hired labour (men) was 5 and average hired labour (women) available was 5.

Table 14: Average Labour availability in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)	SF (19)	SMF (4)	MDF (1)	All (35)
		N	N	N	N	N
1	Own labour Male	2.00	2.16	1.75	1.00	2.03
2	Own Labour Female	1.17	1.37	1.75	1.00	1.37
3	Hired labour Male	7.17	8.32	5.50	5.00	7.60
4	Hired labour Female	7.83	8.79	5.75	5.00	8.07

Adequacy of Hired Labour: The data regarding the adequacy of hired labour in Chandrageri-1 micro watershed is presented in Table 15. The results indicated that, 85.71 per cent of the household opined that hired labour was adequate.

Table 15: Adequacy of Hired Labour in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Adequate	6	100.00	19	100.00	4	100.00	1	100.00	30	85.71

Distribution of land (ha): The data regarding the distribution of land (ha) in Chandrageri-1 micro watershed is presented in Table 16. The results indicated that, households of the Chandrageri-1 micro watershed possess 32.25 ha (80.75 %) of dry land and 7.69 ha (19.25%) of irrigated land. Marginal farmers possess 4.61 ha (100 %) of dry land. Small farmers possess 25.29 ha (95.42 %) of dry land and 1.21 ha (4.58 %) of irrigated land. Semi medium farmers possess 2.35 ha (34.52 %) of dry land and 4.45 ha (65.48 %) of irrigated land. Medium farmers possess 2.02 ha (100%) of irrigated land.

Table 16: Distribution of land (Ha) in Chandrageri-1 micro watershed

Sl. No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		ha	%	ha	%	ha	%	ha	%	ha	%
1	Dry	4.61	100	25.29	95.42	2.35	34.52	0	0	32.25	80.75
2	Irrigated	0	0	1.21	4.58	4.45	65.48	2.02	100	7.69	19.25
Total		4.61	100	26.51	100	6.80	100	2.02	100	39.94	100.00

Average land value (Rs./ha): The data regarding the average land value (Rs./ha) in Chandrageri-1 micro watershed is presented in Table 17. The results indicated that, the average value of dry land was Rs. 241,731.49 and average value of irrigated was Rs.

533,000. In case of marginal famers, the average land value was Rs. 433,333.33 for dry land. In case of small famers, the average land value was Rs. 209,456 for dry land Rs. 1,070,333.33 for irrigated land. In case of semi medium famers, the average land value was Rs. 212,931.03 for dry land and Rs. 471,545.45 for irrigated land. In case of medium famers, the average land value was Rs. 345,800.00 for irrigated land.

Table 17: Average land value (Rs. /ha) in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)	SF (19)	SMF (4)	MDF (1)	All (35)
		N	N	N	N	N
1	Dry	433,333.33	209,456.00	212,931.03	0.00	241,731.49
2	Irrigated	0.00	1,070,333.33	471,545.45	345,800.00	533,000.00

Status of bore wells: The data regarding the status of bore wells in Chandrageri-1 micro watershed is presented in Table 18. The results indicated that, there were 1 functioning bore wells in the micro watershed.

Table 18: Status of bore wells in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)	MF (6)	SF (19)	All (35)
		N	N	N	N
1	Functioning	0	0	1	1

Source of irrigation: The data regarding the source of irrigation in Chandrageri-1 micro watershed is presented in Table 19. The results indicated that, bore well was the major irrigation source for 2.86 per cent of the farmers.

Table 19: Source of irrigation in Chandrageri-1 micro watershed

Sl.No.	Particulars	SF (19)		All (35)	
		N	%	N	%
1	Bore Well	1	5.26	1	2.86

Depth of water: The data regarding the depth of water in Chandrageri-1 micro watershed is presented in Table 20.The results indicated that on an average the depth of the bore well was 2.26 meters.

Table 20: Depth of water in Chandrageri-1 micro watershed

Sl.No.	Particulars	SF (19)	SMF (4)	All (35)
		N	N	N
1	Bore Well	4.17	0.00	2.26

Irrigated Area (ha): The data regarding the irrigated area (ha) in Chandrageri-1 micro watershed is presented in Table 21. The results indicated that, in case of small farmers there was 0.40 ha of irrigated land.

Table 21: Irrigated Area (ha) in Chandrageri-1 micro watershed

Sl.No.	Particulars	SF (19)	All (35)
1	Kharif	0.40	0.40

Cropping pattern: The data regarding the cropping pattern in Chandrageri-1 micro watershed is presented in Table 22. The results indicated that, farmers have grown bajra

(11.74 ha), Bengal gram (1.42 ha), groundnut (5.34 ha), maize (14.17 ha), marigold (1.62 ha), paddy (3.24 ha) and sunflower (2.02 ha) in kharif season and also grown bajra (0.81 ha), maize (2.83 ha) and paddy (0.40 ha) in Rabi season. Marginal farmers had grown bajra, groundnut and maize. Small farmers had grown bajra, Bengal gram, groundnut, maize, marigold, paddy and sunflower. Semi medium farmers had grown groundnut, maize and paddy. Medium farmers had grown bajra and maize.

Table 22: Cropping pattern in Chandrageri-1 micro watershed Area (ha)

Sl.No.	Particulars	MF (6)	SF (19)	SMF (4)	MDF (1)	All (35)
1	Kharif - Bajra	0.81	10.53	0.00	0.40	11.74
2	Kharif - Bengal gram	0.00	1.42	0.00	0.00	1.42
3	Kharif - Groundnut	0.89	3.64	0.81	0.00	5.34
4	Kharif - Maize	2.91	6.48	3.16	1.62	14.17
5	Kharif - Marigold	0.00	1.62	0.00	0.00	1.62
6	Kharif - Paddy	0.00	0.40	2.83	0.00	3.24
7	Kharif - Sunflower	0.00	2.02	0.00	0.00	2.02
8	Rabi - Bajra	0.00	0.81	0.00	0.00	0.81
9	Rabi - Maize	0.00	0.00	2.83	0.00	2.83
10	Rabi - Paddy	0.00	0.00	0.40	0.00	0.40
Total		4.62	26.92	10.04	2.02	43.60

Cropping intensity: The data regarding the cropping intensity in Chandrageri-1 micro watershed is presented in Table 23. The results indicated that, the cropping intensity in Chandrageri-1 micro watershed was found to be 85 per cent. In case of marginal farmers it was 100 per cent, in small farmers it was 90.48, in semi medium farmers it was 77.99 and in medium farmers it was 50 per cent.

Table 23: Cropping intensity (%) in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)	SF (19)	SMF (4)	MDF (1)	All (35)
1	Cropping Intensity	100.00	90.48	77.99	50.00	85.00

Possession of Bank account: The data regarding the possession of Bank account and savings in Chandrageri-1 micro watershed is presented in Table 24. The results indicated that, 94.29 per cent of the households have bank account including 80 per cent of the landless, 100 per cent of the marginal, semi medium, medium farmers and 94.74 per cent of the small farmers respectively.

Table 24: Possession of Bank account and savings in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Account	4	80.00	6	100	18	94.74	4	100	1	100	33	94.29

Borrowing status: The data regarding the possession of borrowing status in Chandrageri-1 micro watershed is presented in Table 25. The results indicated that, 60 per cent of the landless, 83.33 per cent of marginal, 63.16 per cent of small, 50 per cent of the semi

medium and 100 per cent of medium farmers have borrowed credit from different sources.

Table 25: Borrowing status in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Credit Availed	3	60	5	83.33	12	63.16	2	50.00	1	100	23	65.71

Source of credit: The data regarding the source of credit availed by households in Chandrageri-1 micro watershed is presented in Table 26. The results indicated that, 26.09 per cent have availed loan from friends/ relatives, 13.04 per cent have availed loan from Grameena bank, 4.35 per cent have availed loan from money lender and 27.74 per cent have availed loan from SHGs/CBOs.

Table 26: Source of credit availed by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (3)		MF (5)		SF (12)		SMF (2)		All (23)	
		N	%	N	%	N	%	N	%	N	%
1	Friends/Relatives	0	0.00	2	40.00	3	25.00	1	50.00	6	26.09
2	Grameena Bank	0	0.00	1	20.00	2	16.67	0	0.00	3	13.04
3	Money Lender	1	33.33	0	0.00	0	0.00	0	0.00	1	4.35
4	SHGs/CBOs	0	0.00	1	20.00	4	33.33	0	0.00	5	21.74

Average credit amount: The data regarding the average credit amount availed by households in Chandrageri-1 micro watershed is presented in Table 27. The results indicated that, landless, marginal, small and semi medium have availed Rs.200000, Rs. 56000, Rs. 52916.67 and Rs. 100000 respectively. Overall average credit amount availed by households in the micro watershed is 74565.22.

Table 27: Average Credit amount availed by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (3)	MF (5)	SF (12)	SMF (2)	All (23)
		N	N	N	N	N
1	Average Credit	200,000.00	56,000.00	52,916.67	100,000.00	74,565.22

Purpose of credit borrowed (institutional Source): The data regarding the purpose of credit borrowed from institutional sources by households in Chandrageri-1 micro watershed is presented in Table 28. The results indicated that, 100 per cent of the households have borrowed loan for agriculture production.

Table 28: Purpose of credit borrowed (institutional Source) by households in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (5)		SF (12)		All (23)	
		N	%	N	%	N	%
1	Agriculture production	1	100.00	2	100.00	3	100.00

Purpose of credit borrowed (Private Credit): The data regarding the purpose of credit borrowed from private sources by households in Chandrageri-1 micro watershed is presented in Table 29. The results indicated that, about 50 percent of loan was taken for

agriculture production and 25 per cent of the loan was taken for household consumption and social functions like marriage respectively.

Table 29: Purpose of credit borrowed (Private Credit) by households in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (0)		MF (1)		SF (2)		SMF (0)		All (3)	
		N	%	N	%	N	%	N	%	N	%
1	Agriculture production	0	0	2	66.67	3	42.86	1	100	6	50
2	Household consumption	1	100	0	0.00	2	28.57	0	0	3	25
3	Social functions like marriage	0	0	1	33.33	2	28.57	0	0	3	25

Repayment status of households (Institutional): The data regarding the repayment status of credit borrowed from institutional sources by households in Chandrageri-1 micro watershed is presented in Table 30. Results indicated that 100 per cent of the households have unpaid their institutional credit.

Table 30: Repayment status of households (Institutional) in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (1)		SF (2)		All (3)	
		N	%	N	%	N	%
1	Un paid	1	100.00	2	100.00	3	100.00

Repayment status of households (Private): The data regarding the repayment status of credit borrowed from private sources by households in Chandrageri-1 micro watershed is presented in Table 31. Results indicated that 66.67 per cent of the households have repaid their private credit partially and 33.33 percent of the households have unpaid their loan.

Table 31: Repayment status of households (Private) in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (0)		MF (1)		SF (2)		SMF (0)		All (3)	
		N	%	N	%	N	%	N	%	N	%
1	Partially paid	1	100.00	1	33.33	5	71.43	1	100.00	8	66.67
2	Un paid	0	0.00	2	66.67	2	28.57	0	0.00	4	33.33

Cost of Cultivation of Bajra: The data regarding the cost of cultivation of bajra in Chandrageri-1 micro watershed is presented in Table 32. The results indicated that, the total cost of cultivation for bajra was Rs. 24146.04. The gross income realized by the farmers was Rs. 39356.18. The net income from bajra cultivation was Rs. 15210.14, thus the benefit cost ratio was found to be 1:1.63.

Table 32: Cost of Cultivation of Bajra in Chandrageri-1 micro watershed

Sl. No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	30.31	5309.94	21.99
2	Bullock		Pairs/day	0.06	33.68	0.14
3	Tractor		Hours	3.26	2155.64	8.93
4	Machinery		Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	13.87	1663.88	6.89
6	FYM		Quintal	25.94	3112.20	12.89
7	Fertilizer + micronutrients		Quintal	3.03	2583.40	10.70
8	Pesticides (PPC)		Kgs / liters	1.24	1235.00	5.11
9	Irrigation		Number	2.47	0.00	0.00
10	Depreciation charges			0.00	480.65	1.99
11	Land revenue and Taxes			0.00	5.01	0.02
II	**Cost B1**					
12	Interest on working capital				1031.34	4.27
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**				17610.74	72.93
III	**Cost B2**					
14	Rental Value of Land				400.00	1.66
15	**Cost B2 = (Cost B1 + Rental value)**				18010.74	74.59
IV	**Cost C1**					
16	Family Human Labour			18.97	3940.21	16.32
17	**Cost C1 = (Cost B2 + Family Labour)**				21950.95	90.91
V	**Cost C2**					
18	Risk Premium				0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**				21950.95	90.91
VI	**Cost C3**					
20	Managerial Cost				2195.09	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**				24146.04	100.00
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		33.35	39256.16	
		b) Main Crop Sales Price (Rs.)			1177.27	
	By Product	e) Main Product (q)		7.86	100.02	
		f) Main Crop Sales Price (Rs.)			12.73	
b.	Gross Income (Rs.)				39356.18	
c.	Net Income (Rs.)				15210.14	
d.	Cost per Quintal (Rs./q.)				724.13	
e.	Benefit Cost Ratio (BC Ratio)				1:1.63	

Cost of Cultivation of Maize: The data regarding the cost of cultivation of maize in Chandrageri-1 micro watershed is presented in Table 33. The results indicated that, the total cost of cultivation for maize was Rs. 32651.11. The gross income realized by the farmers was Rs. 54099.73. The net income from maize cultivation was Rs. 21448.62. Thus the benefit cost ratio was found to be 1:1.66.

Table 33: Cost of Cultivation of Maize in Chandrageri-1 micro watershed

Sl. No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	30.06	5264.03	16.12
2	Bullock		Pairs/day	0.33	193.48	0.59
3	Tractor		Hours	3.51	2376.64	7.28
4	Machinery		Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	30.92	5332.69	16.33
6	FYM		Quintal	21.05	6354.96	19.46
7	Fertilizer + micronutrients		Quintal	2.98	2381.61	7.29
8	Pesticides (PPC)		Kgs / liters	0.83	873.02	2.67
9	Irrigation		Number	1.54	0.00	0.00
10	Depreciation charges			0.00	30.50	0.09
11	Land revenue and Taxes			0.00	4.72	0.01
II	**Cost B1**					
12	Interest on working capital				1793.07	5.49
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**				24604.73	75.36
III	**Cost B2**					
14	Rental Value of Land				453.33	1.39
15	**Cost B2 = (Cost B1 + Rental value)**				25058.06	76.74
IV	**Cost C1**					
16	Family Human Labour			22.27	4624.77	14.16
17	**Cost C1 = (Cost B2 + Family Labour)**				29682.83	90.91
V	**Cost C2**					
18	Risk Premium				0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**				29682.83	90.91
VI	**Cost C3**					
20	Managerial Cost				2968.28	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**				32651.11	100.00
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		41.34	51955.17	
		b) Main Crop Sales Price (Rs.)			1256.67	
	By Product	e) Main Product (q)		29.51	2144.56	
		f) Main Crop Sales Price (Rs.)			72.67	
b.	Gross Income (Rs.)				54099.73	
c.	Net Income (Rs.)				21448.62	
d.	Cost per Quintal (Rs./q.)				789.75	
e.	Benefit Cost Ratio (BC Ratio)				1:1.66	

Cost of Cultivation of Paddy: The data regarding the cost of cultivation of paddy in Chandrageri-1 micro watershed is presented in Table 34. The results indicated that, the total cost of cultivation for paddy was Rs. 40611.14. The gross income realized by the farmers was Rs. 95195.63. The net income from paddy cultivation was Rs. 54584.49. Thus the benefit cost ratio was found to be 1:2.34.

Table 34: Cost of Cultivation of Paddy in Chandrageri-1 micro watershed

Sl. No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	44.32	7986.33	19.67
2	Bullock		Pairs/day	0.00	0.00	0.00
3	Tractor		Hours	5.76	3705.00	9.12
4	Machinery		Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	98.80	10703.33	26.36
6	FYM		Quintal	20.58	2470.00	6.08
7	Fertilizer + micronutrients		Quintal	3.02	2380.81	5.86
8	Pesticides (PPC)		Kgs /liters	1.58	1660.39	4.09
9	Irrigation		Number	3.98	0.00	0.00
10	Depreciation charges			0.00	98.81	0.24
11	Land revenue and Taxes			0.00	4.67	0.01
II	**Cost B1**					
12	Interest on working capital				2065.74	5.09
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**				31075.08	76.52
III	**Cost B2**					
14	Rental Value of Land				444.44	1.09
15	**Cost B2 = (Cost B1 + Rental value)**				31519.52	77.61
IV	**Cost C1**					
16	Family Human Labour			26.35	5399.69	13.30
17	**Cost C1 = (Cost B2 + Family Labour)**				36919.21	90.91
V	**Cost C2**					
18	Risk Premium				0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**				36919.21	90.91
VI	**Cost C3**					
20	Managerial Cost				3691.92	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**				40611.14	100.00
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		63.81	93585.56	
		b) Main Crop Sales Price (Rs.)			1466.67	
	By Product	e) Main Product (q)		30.19	1610.07	
		f) Main Crop Sales Price (Rs.)			53.33	
b.	Gross Income (Rs.)				95195.63	
c.	Net Income (Rs.)				54584.49	
d.	Cost per Quintal (Rs./q.)				636.46	
e.	Benefit Cost Ratio (BC Ratio)				1:2.34	

Cost of Cultivation of Ground nut: The data regarding the cost of cultivation of groundnut in Chandrageri-1 micro watershed is presented in Table 35. The results indicated that, the total cost of cultivation for groundnut was Rs. 44527.28. The gross income realized by the farmers was Rs. 45562.07. The net income from groundnut cultivation was Rs. 1034.79. Thus the benefit cost ratio was found to be 1:1.02.

Table 35: Cost of Cultivation of Groundnut in Chandrageri-1 micro watershed

Sl. No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	31.63	5295.75	11.89
2	Bullock		Pairs/day	0.41	230.53	0.52
3	Tractor		Hours	3.47	2189.17	4.92
4	Machinery		Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	119.61	16847.65	37.84
6	FYM		Quintal	24.70	2964.00	6.66
7	Fertilizer + micronutrients		Quintal	3.64	3045.73	6.84
8	Pesticides (PPC)		Kgs/liters	0.90	898.18	2.02
9	Irrigation		Number	0.00	0.00	0.00
10	Depreciation charges			0.00	39.23	0.09
11	Land revenue and Taxes			0.00	4.45	0.01
II	**Cost B1**					
12	Interest on working capital				2850.67	6.40
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**				34365.36	77.18
III	**Cost B2**					
14	Rental Value of Land				560.00	1.26
15	**Cost B2 = (Cost B1 + Rental value)**				34925.36	78.44
IV	**Cost C1**					
16	Family Human Labour			24.91	5553.98	12.47
17	**Cost C1 = (Cost B2 + Family Labour)**				40479.34	90.91
V	**Cost C2**					
18	Risk Premium				0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**				40479.34	90.91
VI	**Cost C3**					
20	Managerial Cost				4047.93	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**				44527.28	100.00
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		9.97	45562.07	
		b) Main Crop Sales Price (Rs.)			4570.00	
b.	Gross Income (Rs.)				45562.07	
c.	Net Income (Rs.)				1034.79	
d.	Cost per Quintal (Rs./q.)				4466.21	
e.	Benefit Cost Ratio (BC Ratio)				1:1.02	

Cost of Cultivation of Sunflower: The data regarding the cost of cultivation of Sunflower in Chandrageri-1 micro watershed is presented in Table 36. The results indicated that, the total cost of cultivation for Sunflower was Rs. 23037.56. The gross income realized by the farmers was Rs. 34518.25. The net income from Sunflower cultivation was Rs.11480.69. Thus the benefit cost ratio was found to be 1:1.5.

Table 36: Cost of Cultivation of Sunflower in Chandrageri-1 micro watershed

Sl. No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	32.11	5166.42	22.43
2	Bullock		Pairs/day	1.03	617.50	2.68
3	Tractor		Hours	3.91	2428.83	10.54
4	Machinery		Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	6.18	2852.85	12.38
6	FYM		Quintal	0.00	0.00	0.00
7	Fertilizer + micronutrients		Quintal	3.50	2819.92	12.24
8	Pesticides (PPC)		Kgs / liters	1.03	1029.17	4.47
9	Irrigation		Number	0.00	0.00	0.00
10	Depreciation charges			0.00	2.06	0.01
11	Land revenue and Taxes			0.00	5.76	0.03
II	**Cost B1**					
12	Interest on working capital				804.23	3.49
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**				15726.74	68.27
III	**Cost B2**					
14	Rental Value of Land				400.00	1.74
15	**Cost B2 = (Cost B1 + Rental value)**				16126.74	70.00
IV	**Cost C1**					
16	Family Human Labour			22.64	4816.50	20.91
17	**Cost C1 = (Cost B2 + Family Labour)**				20943.24	90.91
V	**Cost C2**					
18	Risk Premium				0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**				20943.24	90.91
VI	**Cost C3**					
20	Managerial Cost				2094.32	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**				23037.56	100.00
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		8.03	34518.25	
		b) Main Crop Sales Price (Rs.)			4300.00	
b.	Gross Income (Rs.)				34518.25	
c.	Net Income (Rs.)				11480.69	
d.	Cost per Quintal (Rs./q.)				2869.83	
e.	Benefit Cost Ratio (BC Ratio)				1:1.5	

Cost of Cultivation of Bengal gram: The data regarding the cost of cultivation of Bengal gram in Chandrageri-1 micro watershed is presented in Table 37. The results indicated that, the total cost of cultivation for Bengal gram was Rs. 36881.18. The gross income realized by the farmers was Rs. 43577.86. The net income from Bengal gram cultivation was Rs. 6696.68. Thus the benefit cost ratio was found to be 1:1.18.

Table 37: Cost of Cultivation of Bengal gram in Chandrageri-1 micro watershed

Sl. No	Particulars	Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**				
1	Hired Human Labour	Man days	21.88	3909.66	10.60
2	Bullock	Pairs/day	0.00	0.00	0.00
3	Tractor	Hours	8.47	5928.00	16.07
4	Machinery	Hours	0.00	0.00	0.00
5	Seed Main Crop (Establishment and Maintenance)	Kgs (Rs.)	84.69	10162.29	27.55
6	FYM	Quintal	14.11	1693.71	4.59
7	Fertilizer + micronutrients	Quintal	2.12	2223.00	6.03
8	Pesticides (PPC)	Kgs / liters	0.71	705.71	1.91
9	Irrigation	Number	0.00	0.00	0.00
10	Depreciation charges		0.00	340.15	0.92
11	Land revenue and Taxes		0.00	4.94	0.01
II	**Cost B1**				
12	Interest on working capital			1774.17	4.81
13	**Cost B1 = (Cost A1 + sum of 15 and 16)**			26741.63	72.51
III	**Cost B2**				
14	Rental Value of Land			400.00	1.08
15	**Cost B2 = (Cost B1 + Rental value)**			27141.63	73.59
IV	**Cost C1**				
16	Family Human Labour		28.23	6386.71	17.32
17	**Cost C1 = (Cost B2 + Family Labour)**			33528.35	90.91
V	**Cost C2**				
18	Risk Premium			0.00	0.00
19	**Cost C2 = (Cost C1 + Risk Premium)**			33528.35	90.91
VI	**Cost C3**				
20	Managerial Cost			3352.83	9.09
21	**Cost C3 = (Cost C2 + Managerial Cost)**			36881.18	100.00
VII	**Economics of the Crop**				
a.	Main Product	a) Main Product (q)	9.17	43577.86	
		b) Main Crop Sales Price (Rs.)		4750.00	
b.	Gross Income (Rs.)			43577.86	
c.	Net Income (Rs.)			6696.68	
d.	Cost per Quintal (Rs./q.)			4020.06	
e.	Benefit Cost Ratio (BC Ratio)			1:1.18	

Adequacy of fodder: The data regarding the adequacy of fodder in Chandrageri-1 micro watershed is presented in Table 38. The results indicated that, 28.57 per cent of the households opined that dry fodder was adequate.

Table 38: Adequacy of fodder in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)		SF (19)		SMF (4)		All (35)	
		N	%	N	%	N	%	N	%
1	Adequate-Dry Fodder	1	16.67	6	31.58	3	75.00	10	28.57

Average Annual gross income of households: The results of the overall average annual gross income of the household in Chandrageri-1 is presented in table 39. The table indicated that, in landless farmers, the average income from wage was Rs. 87000. In case of marginal farmers, the average income from wage was Rs.23333.33 and agriculture was Rs.63166.67. In small farmers the average income from service/salary was Rs. 4736.84, wage was Rs.23421.05, agriculture was Rs.102578.95, dairy farm was Rs.263.16 and goat farming was Rs.526.32. In semi medium farmers, the average income from wage, dairy farming and goat farming was Rs.25000 respectively and agriculture was Rs.225000. In case of medium farmers the average income from agriculture was Rs.300000.

Table 39: Average Annual gross income (Rs.) of households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL(5)	MF (6)	SF (19)	SMF(4)	MDF (1)	All (35)
1	Service/salary	0	0	4,736.84	0	0	2,571.43
2	Wage	87000	23,333.33	23,421.05	25000	0	32,000.00
3	Agriculture	0	63,166.67	102,578.95	225000	300,000.00	100,800
4	Dairy Farm	0	0	263.16	25000	0	3,000
5	Goat Farming	0	0	526.32	25000	0	3,142.86
Income(Rs.)		87000	86500	131,526.32	300000	300,000.00	141,514.29

Table 40: Average Annual expenditure of households in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)	MF (6)	SF (19)	SMF (4)	MDF (1)	All (35)
1	Wage	20,000.00	0.00	1,538.46	50,000	0	4,857.14
2	Agriculture	0	33,000	48,789.47	100,000	150,000	47,857.14
3	Dairy Farm	0	0	2,000	50,000	0	1,485.71
4	Goat Farming	0	0	1,000	20,000	0	600.00
Total		20,000	33,000	53,327.94	220,000	150,000	476,327.94
Average		4,000	5,500	2,806.73	55,000	150,000	13,609.37

Average Annual expenditure of households: The results of the overall average annual expenditure of the household in Chandrageri-1 were presented in Table 40. The results indicated that, in case of landless farmers, the annual average expenditure from wage was Rs. 20000. In marginal farmers the annual average expenditure from agriculture was Rs.33000. In small farmers, the annual average expenditure from wage was Rs. 1538.46, agriculture was Rs.48789.47, dairy farm Was Rs.2000 and Goat farming was Rs.1000. In

semi medium farmers, the annual average expenditure from wage was Rs. 50000, agriculture was Rs.100000, dairy farm Was Rs.50000 and Goat farming was Rs.20000. In case of medium farmers, the annual average expenditure from agriculture was Rs.150000.

Horticulture species grown: The data regarding horticulture species grown in Chandrageri-1 micro watershed is presented in Table 41. The results indicated that, sampled households have grown 55coconut trees and 13 mango tree in their field and also planted 6 coconut trees in their backyard.

Table 41: Horticulture species grown in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		F	B	F	B	F	B	F	B	F	B
1	Coconut	6	3	13	1	16	2	20	0	55	6
2	Mango	1	0	0	0	7	0	5	0	13	0

Forest species grown: The data regarding forest species grown in Chandrageri-1 micro watershed is presented in Table 42. The results indicated that, households have planted 3 Eucalyptus tree, 18 teak trees, 200 neem trees, 1tamarind tress and 1 pongamia trees in their field and also grown 4 Neem tree in the backyard.

Table 42: Forest species grown in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		F	B	F	B	F	B	F	B	F	B
1	Eucalyptus	0	0	3	0	0	0	0	0	3	0
2	Teak	2	0	16	0	0	0	0	0	18	0
3	Neem	12	1	77	1	52	0	60	1	200	4
4	Tamarind	0	0	1	0	0	0	0	0	1	0
5	Pongamia	0	0	1	0	0	0	0	0	1	0

Marketing of the agricultural produce: The data regarding marketing of the agricultural produce in Chandrageri-1 micro watershed is presented in Table 43. The results indicated that, groundnut, paddy and sunflower crops were sold to the extent of 100 per cent. Bajra, Bengal gram and maize crops were sold to the extent of 93.39 per cent, 92.31 per cent and 91.13per cent respectively.

Table 43: Marketing of the agricultural produce in Chandrageri-1 micro watershed

Sl.No	Crops	Output obtained(q)	Output retained(q)	Output sold (q)	Output sold (%)	Avg. Price obtained (Rs/q)
1	Bajra	378.0	25.0	353.0	93.39	1177.27
2	Bengalgram	13.0	1.0	12.0	92.31	4750.0
3	Groundnut	50.0	0.0	50.0	100.0	4570.0
4	Maize	733.0	65.0	668.0	91.13	1278.13
5	Paddy	190.0	0.0	190.0	100.0	1466.67
6	Sunflower	16.0	0.0	16.0	100.0	4300.0

Marketing Channels used for sale of agricultural produce: The data regarding marketing channels used for sale of agricultural produce in Chandrageri-1 micro

watershed is presented in Table 44. The results indicated that, 85.71 percent of the households have sold their produce local/village merchant and 22.86 percent of the households sold their produce in regulated markets.

Table 44: Marketing Channels used for sale of agricultural produce in Chandrageri-1 micro watershed

S.N.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Local/village Merchant	6	100	19	100	2	50	1	100	30	85.71
2	Regulated Market	0	0	3	15.79	2	50	0	0	8	22.86

Mode of transport of agricultural produce: The data regarding mode of transport of agricultural produce in Chandrageri-1 micro watershed is presented in Table 45. The results indicated that 91.43 per cent of the households have used tractor as a mode of transport and 17.14 per cent have used truck.

Table 45: Mode of transport of agricultural produce in Chandrageri-1 micro watershed

Sl. No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Tractor	4	66.67	20	105.26	4	75	1	100	32	91.43
2	Truck	2	33.33	3	15.79	1	25	0	0	6	17.14

Incidence of soil and water erosion problems: The data regarding incidence of soil and water erosion problems in Chandrageri-1 microwatershed is presented in Table 46. The results indicated that, 40 per cent of the households have experienced the soil and water erosion problems i.e. 50 percent of marginal farmers, 47.37 per cent of small farmers and 50 per cent of semi medium farmers.

Table 46: Incidence of soil and water erosion problems in Chandrageri-1 microwatershed

Sl. No.	Particulars	MF (6)		SF (19)		SMF (4)		All (35)	
		N	%	N	%	N	%	N	%
1	Soil and water erosion problems in the farm	3	50	9	47.37	2	50	14	40

Interest towards soil testing: The data regarding interest shown towards soil testing in Chandrageri-1 micro watershed is presented in Table 47. The results indicated that, 85.71 per cent of the households have shown interest in soil testing.

Table 47: Interest shown towards soil testing in Chandrageri-1 micro watershed

Sl.No.	Particulars	MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Interest in soil test	6	100	19	100	4	100	1	100	30	85.71

Usage pattern of fuel for domestic use: The data regarding usage pattern of fuel for domestic use in Chandrageri-1 micro watershed is presented in Table 48. The results

indicated that, 65.71 percent used fire wood as a source of fuel and 34.29 percent of the households used LPG as a source of fuel.

Table 48: Usage pattern of fuel for domestic use in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Fire Wood	4	80	2	33.33	12	63.16	4	100	1	100	23	65.71
2	LPG	1	20	4	66.67	7	36.84	0	0	0	0	12	34.29

Source of drinking water: The data regarding source of drinking water in Chandrageri-1 micro watershed is presented in Table 49. The results indicated that, piped supply was the source of drinking water for 71.43 for per cent and 31.43 per cent of them were using bore well for drinking water.

Table 49: Source of drinking water in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Piped supply	5	100	4	66.67	12	63.16	3	75	1	100	25	71.43
2	Bore Well	0	0	2	33.33	8	42.11	1	25	0	0	11	31.43

Source of light: The data regarding source of light in Chandrageri-1 micro watershed is presented in Table 50. The results indicated that, electricity was the major source of light for 100 per cent of the households.

Table 50: Source of light in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Electricity	5	100	6	100	19	100	4	100	1	100	35	100

Existence of Sanitary toilet facility: The data regarding existence of sanitary toilet facilit**y** in Chandrageri-1 micro watershed is presented in Table 51. The results indicated that, 80 per cent of the households possess sanitary toilet i.e. 20 per cent of landless, 100 per cent of marginal, small and medium farmers and 25 per cent of the semi medium farmers had sanitary toilet facility.

Table 51: Existence of Sanitary toilet facility in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Sanitary toilet facility	1	20	6	100	19	100	1	25	1	100	28	80

Table 52: Possession of PDS card in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	BPL	5	100	6	100	19	100	3	75.00	1	100.	34	97.14
2	Not Possessed	0	0	0	0	0	0	1	25	0	0	1	2.86

Possession of PDS card: The data regarding possession of PDS card in Chandrageri-1 micro watershed is presented in Table 52. The results indicated that, 97.14 per cent of the

sampled households possessed BPL card and 2.86 per cent of the sampled households have not possessed BPL card.

Participation in NREGA programme: The data regarding participation in NREGA programme in Chandrageri-1 micro watershed is presented in Table 53. The results indicated that, 42.86 per cent of the households participated in NREGA programme which included 100 per cent of the landless, marginal and medium farmers and 25 per cent of the semi medium farmers.

Table 53: Participation in NREGA programme in Chandrageri-1 micro watershed

Sl. No.	Particulars	LL (5)		MF (6)		SF (19)		SMF(4)		MDF(1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Participation in NREGA programme	5	100	6	100	2	10.53	1	25	1	100	15	42.86

Adequacy of food items: The data regarding adequacy of food items in Chandrageri-1 micro watershed is presented in Table 54. The results indicated that, cereals, pulses, oilseeds, vegetables, fruits , milk, egg and meat were adequate for 100 per cent, 97.14 per cent, 34.29 per cent, 17.14 per cent, 2.86 per cent, 88.57 per cent, 57.14 per cent and 2.86 per cent respectively.

Table 54: Adequacy of food items in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Cereals	5	100	6	100	19	100	4	100	1	100	35	100
2	Pulses	5	100	6	100	18	94.74	4	100	1	100	34	97.14
3	Oilseed	1	20	2	33.33	7	36.84	2	50	0	0	12	34.29
4	Vegetables	1	20	0	0	4	21.05	0	0	1	100	6	17.14
5	Fruits	0	0	0	0	1	5.26	0	0	0	0	1	2.86
6	Milk	5	100	6	100	17	89.47	2	50	1	100	31	88.57
7	Egg	3	60	4	66.67	11	57.89	2	50	0	0	20	57.14
8	Meat	0	0	0	0	1	5.26	0	0	0	0	1	2.86

Response on Inadequacy of food items: The data regarding inadequacy of food items in Chandrageri-1 micro watershed is presented in Table 55. The results indicated that, oilseed, vegetables, fruits, milk, egg and meat were inadequate for 45.71 per cent, 48.57 per cent, 60 per cent, 8.57 per cent, 42.86 per cent and 68.57 per cent of the households.

Table 55: Response on Inadequacy of food items in Chandrageri-1 micro watershed

Sl.No.	Particulars	LL (5)		MF (6)		SF (19)		SMF (4)		MDF (1)		All (35)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Oilseed	3	60	4	66.67	7	36.84	2	50	0	0	16	45.71
2	Vegetables	2	40	5	83.33	7	36.84	3	75	0	0	17	48.57
3	Fruits	3	60	5	83.33	10	52.63	2	50	1	100	21	60.00
4	Milk	0	0	0	0	2	10.53	1	25	0	0	3	8.57
5	Egg	2	40	2	33.33	8	42.11	2	50	1	100	15	42.86
6	Meat	3	60	4	66.67	13	68.42	3	75	1	100	24	68.57

Farming constraints: The data regarding farming constraints experienced by households in Chandrageri-1 micro watershed is presented in Table 56. The results indicated that, Lower fertility status of the soil was the constraint experienced by 60 per cent of the households, wild animal menace on farm field (71.43%), frequent incidence of pest and diseases (71.43%), inadequacy of irrigation water (25.71%), high cost of Fertilizers and plant protection chemicals (82.86%), high rate of interest on credit (25.71%), low price for the agricultural commodities (60%), lack of marketing facilities in the area (60%), inadequate extension services (25.71%), lack of transport for safe transport of the agricultural produce to the market (77.14%) and less rainfall (17.14%).

Table 56: Farming constraints Experienced in Chandrageri-1 micro watershed

Sl. No.	Particulars	MF (6)		SF (19)		SMF(4)		MDF(1)		All (35)	
		N	%	N	%	N	%	N	%	N	%
1	Lower fertility status of the soil	4	66.67	15	78.95	2	50	0	0	21	60.00
2	Wild animal menace on farm field	5	83.33	16	84.21	3	75	1	100	25	71.43
3	Frequent incidence of pest and diseases	5	83.33	15	78.95	4	100	1	100	25	71.43
4	Inadequacy of irrigation water	1	16.67	6	31.58	2	50	0	0	9	25.71
5	High cost of Fertilizers and plant protection chemicals	6	100.00	18	94.74	4	100	1	100	29	82.86
6	High rate of interest on credit	0	0	7	36.84	2	50	0	0	9	25.71
7	Low price for the agricultural commodities	5	83.33	13	68.42	2	50	1	100	21	60.00
8	Lack of marketing facilities in the area	5	83.33	13	68.42	2	50	1	100	21	60.00
9	Inadequate extension services	1	16.67	7	36.84	1	25	0	0	9	25.71
10	Lack of transport for safe transport of the Agril produce to the market.	6	100	17	89.47	3	75	1	100	27	77.14
11	Less rainfall	2	33.33	3	15.79	1	25	0	0	6	17.14

Chapter 5

SUMMARY

In order to assess the socio-economic condition of the farmers in the watershed a comprehensive questionnaire was prepared. Major components such as demographic conditions, migration details, food consumption and family expenditure pattern, material possession, land holding, land use management, cropping pattern, cost of cultivation of crops, livestock management. The statistical components such as frequency and percentage were used to analyze the data. About 35 households located in the micro watershed were interviewed for the survey.

Results indicated that 35 farmers were sampled in Chandrageri-1 micro watershed among them 6 (17.14%) were marginal farmers, 19 (54.29%) were small farmers, 4 (11.43%) were semi medium farmers, 1 (2.86 %) were medium farmers and 5 (14.29 %) landless farmers were also interviewed for the survey. The data indicated that there were 196 population households were there in the studied micro watershed. Among them 113 (57.65%) men and 83 (42.35%) were women. The average family size of landless was 7, marginal farmers and small farmers were 5, semi medium farmer was 8 and medium farmers were 4. On an average the family size was 6. The data indicated that 49 (25%) people were in 0-15 years of age, 83 (42.35 %) were in 16-35 years of age, 44 (22.45 %) were in 36-60 years of age and 20 (10.20%) were above 61 years of age.

The results indicated that the Chandrageri-1 had 25 per cent illiterates, 41.84 per cent of them had primary school education, 8.16 per cent of them had both middle schools, 11.22 per cent of them had high school education, 4.59 per cent of them had PUC education, 1.53 per cent them had ITI education and 0.51 per cent them had degree education. The results indicated that, 68.57 per cent of households practicing agriculture, 2.86 per cent of the household heads were agricultural labour and in private service respectively. 11.43 per cent of the household heads were general labour.

The results indicated that agriculture was the major occupation for 56.12 per cent of the household members, 5.61 per cent were agricultural labourers,6.12 per cent were general labours, 0.51 per cent of them were in private sector, 20.92 per cent of them were students, 7.14 per cent of them were children and 3.57 per cent were doing other jobs. In case of landless households 33.33 per cent were agricultural labour, 36.36 per cent were general labourers and 27.27 per cent were students. In case of marginal farmers 72.41 per cent were agriculturist, 10.34 per cent were students and 13.79 per cent were children. In case of small farmers 68.69 per cent of them were agriculturist and 21.21 per cent of them were students. In case of semi medium farmers 61.29 per cent of the family members were agriculturist and 25.81 per cent of them were students. In case of medium farmers 50 per cent of the family members were agriculturist and 50 per cent of them were children.

The results showed that 1.53 per cent of them participated in self help groups and 98.47 per cent of them have not participated in any local institutions. Only land less and marginal farmers have participated in one or other institutions. Small, semi medium and medium farmers have not participated in any local institutions. The results indicated that 85.71 per cent of the households possess Katcha house, 14.29 per cent of the households possess Pucca house and 2.86 per cent of them possess Thatched house.

The results showed that, 74.29 per cent of the households possess TV, 60 per cent of the households possess Mixer grinder, 40 per cent of the households possess bicycle, 45.71 per cent of the households possess motor cycle, 2.86 per cent of the households possess landline phone and 97.14 per cent of the households possess mobile phones. The results showed that the average value of television was Rs. 2250, mixer grinder was Rs.1119, bicycle was Rs.964, motor cycle was Rs.37187, land line phone was Rs. 2000 and mobile phone was Rs.1254.

About 5.71 per cent of the households possess bullock cart, 17.14 per cent of them possess plough, 2.86 per cent of the households possess power tiller, 5.71 per cent of the households possess tractor, 22.86 per cent of the households possess sprayer, 74.29 per cent of the households possess weeder and 28.57 per cent of the households possess chaff cutter. The results showed that the average value of bullock cart was Rs.12500; the average value of plough was Rs. 562, the average value of power tiller was Rs. 5000, the average value of tractor was Rs. 200000, the average value of sprayer was Rs. 1611, the average value of weeder was Rs. 27 and the average value of chaff cutter was Rs. 716.

The results indicated that, 25.71 per cent of the households possess bullocks, 20 per cent of the households possess local cow, 11.43 per cent of the households possess sheep, 5.71 per cent of the households possess goat and 8.57 per cent of the households possess poultry birds. 20 per cent of the landless farmers possess bullocks. In case of marginal farmers, 33.33 per cent of the households possess bullock and 16.67 per cent of the households possess poultry birds. In case of small farmers, 26.32 per cent of households possess bullock, 5.26 per cent possess local cow and 10.53 per cent of the households possess sheep and poultry birds respectively. In case of semi medium farmers, 50 per cent of the households possess bullock, sheep and goat correspondingly, 75 per cent of the households possess local cow.

The results indicated that, average own labour men available in the micro watershed was 2.03, average own labour (women) available was 1.37, average hired labour (men) available was 7.60 and average hired labour (women) available was 8.07. In case of marginal farmers, average own labour men available was 1.18, average own labour (women) was also 1.17, average hired labour (men) was 7.17 and average hired labour (women) available was 7.83. In case of small farmers, average own labour men available was 2.16, average own labour (women) was 1.37, average hired labour (men)

was 8.32 and average hired labour (women) available was 8.79. In case of semi medium farmers, average own labour men available was 1.75, average own labour (women) was 1.75, average hired labour (men) was 5.50 and average hired labour (women) available was 5.75. In medium farmers average own labour men available was 1, average own labour (women) was 1, average hired labour (men) was 5 and average hired labour (women) available was 5. The results indicated that, 85.71 per cent of the household opined that hired labour was adequate.

The results indicated that, households of the Chandrageri-1 micro watershed possess 32.25 ha (80.75 %) of dry land and 7.69 ha (19.25%) of irrigated land. Marginal farmers possess 4.61 ha (100 %) of dry land. Small farmers possess 25.29 ha (95.42 %) of dry land and 1.21 ha (4.58 %) of irrigated land. Semi medium farmers possess 2.35 ha (34.52 %) of dry land and 4.45 ha (65.48 %) of irrigated land. Medium farmers possess 2.02 ha (100%) of irrigated land. The results indicated that, the average value of dry land was Rs. 241,731.49 and average value of irrigated was Rs. 533,000. In case of marginal famers, the average land value was Rs. 433,333.33 for dry land. In case of small famers, the average land value was Rs. 209,456 for dry land Rs. 1,070,333.33 for irrigated land. In case of semi medium famers, the average land value was Rs. 212,931.03 for dry land and Rs. 471,545.45 for irrigated land. In case of medium famers, the average land value was Rs. 345,800.00 for irrigated land.

The results indicated that, there were 1 functioning bore wells in the micro watershed. The results indicated that, bore well was the major irrigation source for 2.86 per cent of the farmers. The results indicated that on an average the depth of the bore well was 2.26 meters. The results indicated that, in case of small farmers there was 0.40 ha of irrigated land. The results indicated that, farmers have grown bajra (11.74 ha), Bengal gram (1.42 ha), groundnut (5.34 ha), maize (14.17 ha), marigold (1.62 ha), paddy (3.24 ha) and sunflower (2.02 ha) in kharif season and also grown bajra (0.81 ha), maize (2.83 ha) and paddy (0.40 ha) in Rabi season. Marginal farmers had grown bajra, groundnut and maize. Small farmers had grown bajra, Bengal gram, groundnut, maize, marigold, paddy and sunflower. Semi medium farmers had grown groundnut, maize and paddy. Medium farmers had grown bajra and maize. The results indicated that, the cropping intensity in Chandrageri-1 micro watershed was found to be 85 per cent. In case of marginal farmers it was 100 per cent, in small farmers it was 90.48, in semi medium farmers it was 77.99 and in medium farmers it was 50 per cent.

The results indicated that, 94.29 per cent of the households have bank account including 80 per cent of the landless, 100 per cent of the marginal, semi medium, medium farmers and 94.74 per cent of the small farmers respectively. The results indicated that, 60 per cent of the landless, 83.33 per cent of marginal, 63.16 per cent of small, 50 per cent of the semi medium and 100 per cent of medium farmers have borrowed credit from

different sources. The results indicated that, 26.09 per cent have availed loan from friends/ relatives, 13.04 per cent have availed loan from Grameena bank, 4.35 per cent have availed loan from money lender and 27.74 per cent have availed loan from SHGs/CBOs. The results indicated that, landless, marginal, small and semi medium have availed Rs.200000, Rs. 56000, Rs. 52916.67 and Rs. 100000 respectively. Overall average credit amount availed by households in the micro watershed is 74565.22. The results indicated that, 100 per cent of the households have borrowed loan for agriculture production. The results indicated that, about 50 percent of loan was taken for agriculture production and 25 per cent of the loan was taken for household consumption and social functions like marriage respectively. Results indicated that 100 per cent of the households have unpaid their institutional credit. Results indicated that 66.67 per cent of the households have repaid their private credit partially and 33.33 percent of the households have unpaid their loan.

The results indicated that, the total cost of cultivation for bajra was Rs. 24146.04. The gross income realized by the farmers was Rs. 39356.18. The net income from bajra cultivation was Rs. 15210.14, thus the benefit cost ratio was found to be 1:1.63. The results indicated that, the total cost of cultivation for maize was Rs. 32651.11. The gross income realized by the farmers was Rs. 54099.73. The net income from maize cultivation was Rs. 21448.62. Thus the benefit cost ratio was found to be 1:1.66. The results indicated that, the total cost of cultivation for paddy was Rs. 40611.14. The gross income realized by the farmers was Rs. 95195.63. The net income from paddy cultivation was Rs. 54584.49. Thus the benefit cost ratio was found to be 1:2.34.

The results indicated that, the total cost of cultivation for groundnut was Rs. 44527.28. The gross income realized by the farmers was Rs. 45562.07. The net income from groundnut cultivation was Rs. 1034.79. Thus the benefit cost ratio was found to be 1:1.02. The results indicated that, the total cost of cultivation for Sunflower was Rs. 23037.56. The gross income realized by the farmers was Rs. 34518.25. The net income from Sunflower cultivation was Rs.11480.69. Thus the benefit cost ratio was found to be 1:1.5. The results indicated that, the total cost of cultivation for Bengal gram was Rs. 36881.18. The gross income realized by the farmers was Rs. 43577.86. The net income from Bengal gram cultivation was Rs. 6696.68. Thus the benefit cost ratio was found to be 1:1.18. The results indicated that, 28.57 per cent of the households opined that dry fodder was adequate.

The table indicated that, in landless farmers, the average income from wage was Rs. 87000. In case of marginal farmers, the average income from wage was Rs.23333.33 and agriculture was Rs.63166.67. In small farmers the average income from service/salary was Rs. 4736.84, wage was Rs.23421.05, agriculture was Rs.102578.95, dairy farm was Rs.263.16 and goat farming was Rs.526.32. In semi medium farmers, the

average income from wage, dairy farming and goat farming was Rs.25000 respectively and agriculture was Rs.225000. In case of medium farmers the average income from agriculture was Rs.300000.

The results indicated that, in case of landless farmers, the annual average expenditure from wage was Rs. 20000. In marginal farmers the annual average expenditure from agriculture was Rs.33000. In small farmers, the annual average expenditure from wage was Rs. 1538.46, agriculture was Rs.48789.47, dairy farm Was Rs.2000 and Goat farming was Rs.1000. In semi medium farmers, the annual average expenditure from wage was Rs. 50000, agriculture was Rs.100000, dairy farm Was Rs.50000 and Goat farming was Rs.20000. In case of medium farmers, the annual average expenditure from agriculture was Rs.150000.

The results indicated that, sampled households have grown 55coconut trees and 13 mango tree in their field and also planted 6 coconut trees in their backyard. The results indicated that, households have planted 3 Eucalyptus tree, 18 teak trees, 200 neem trees, 1tamarind tress and 1 pongamia trees in their field and also grown 4 Neem tree in the backyard. The results indicated that, groundnut, paddy and sunflower crops were sold to the extent of 100 per cent. Bajra, Bengal gram and maize crops were sold to the extent of 93.39 per cent, 92.31 per cent and 91.13per cent respectively. The results indicated that, 85.71 percent of the households have sold their produce local/village merchant and 22.86 percent of the households sold their produce in regulated markets. The results indicated that 91.43 per cent of the households have used tractor as a mode of transport and 17.14 per cent have used truck.

The results indicated that, 40 per cent of the households have experienced the soil and water erosion problems i.e. 50 percent of marginal farmers, 47.37 per cent of small farmers and 50 per cent of semi medium farmers. The results indicated that, 85.71 per cent of the households have shown interest in soil testing. The results indicated that, 65.71 percent used fire wood as a source of fuel and 34.29 percent of the households used LPG as a source of fuel. The results indicated that, piped supply was the source of drinking water for 71.43 per cent and 31.43 per cent of them were using bore well for drinking water. The results indicated that, electricity was the major source of light for 100 per cent of the households. The results indicated that, 80 per cent of the households possess sanitary toilet i.e. 20 per cent of landless, 100 per cent of marginal, small and medium farmers and 25 per cent of the semi medium farmers had sanitary toilet facility. The results indicated that, 97.14 per cent of the sampled households possessed BPL card and 2.86 per cent of the sampled households have not possessed BPL card. The results indicated that, 42.86 per cent of the households participated in NREGA programme which included 100 per cent of the landless, marginal and medium farmers and 25 per cent of the semi medium farmers.

The results indicated that, cereals, pulses, oilseeds, vegetables, fruits , milk, egg and meat were adequate for 100 per cent, 97.14 per cent, 34.29 per cent, 17.14 per cent, 2.86 per cent, 88.57 per cent, 57.14 per cent and 2.86 per cent respectively. The results indicated that, oilseed, vegetables, fruits, milk, egg and meat were inadequate for 45.71 per cent, 48.57 per cent, 60 per cent, 8.57 per cent, 42.86 per cent and 68.57 per cent of the households.

The results indicated that, Lower fertility status of the soil was the constraint experienced by 60 per cent of the households, wild animal menace on farm field (71.43%), frequent incidence of pest and diseases (71.43%), inadequacy of irrigation water (25.71%), high cost of Fertilizers and plant protection chemicals (82.86%), high rate of interest on credit (25.71%), low price for the agricultural commodities (60%), lack of marketing facilities in the area (60%), inadequate extension services (25.71%), lack of transport for safe transport of the agricultural produce to the market (77.14%) and less rainfall (17.14%).