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

CHIK HANGARGI-2 (4D5A3Q2c) MICROWATERSHED

Jewargi Taluk, Gulbarga District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

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

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

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PREFACE

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

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

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

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

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of Chik Hangargi-2 Microwatershed, Jewargi Taluk, Gulbarga District, Karnataka" for integrated development was taken up in collaboration with then 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

Date:03.01.2018

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The land resource inventory of Chik Hangargi-2 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, behaviour and use potentials of the soils in the microwartershed.

The present study covers an area of 711ha in Chik Hangargi-2 microwatershed in Jewargi taluk of Gulbarga district, Karnataka. The climate is semiarid and categorized as drought-prone with an average annual rainfall of 751 mm, of which about 538 mm is received during south–west monsoon, 138 mm during north-east and the remaining 75 mm during the rest of the year. 98 per cent area is covered by soils and 2 per cent is by habitation and waterbodies. The salient findings from the land resource inventory are summarized briefly below.

❖ The soils belong to 4 soil series and 8 soil phases (management units) and 3 land use classes.

❖ The length of crop growing period is about 150 days starting from the 1st week of June to 1st week of October.

❖ From the master soil map, several interpretative and thematic maps like land capability, soil depth, surface soil texture, soil gravelliness, available water capacity, soil slope and soil erosion were generated.

❖ Soil fertility status maps for macro and micronutrients were generated based on the surface soil samples collected at every 250 m grid interval.

❖ Land suitability for growing 19 major agricultural and horticultural crops were assessed and maps showing the degree of suitability along with the constraints were generated.

❖ Entire area is suitable for agriculture.

❖ About 2 per cent of the soils are very deep (>150 cm) and 24 per cent is deep (100-150 cm), 33 per cent is shallow (25-50 cm) and 39 per cent are very shallow (<25cm) soils.

❖ Entire area in the microwatershed has clayey soils at the surface.

❖ Entire area has non-gravelly (<15%) soils.

❖ About 2 per cent of the area has soils that are very high (>200mm/m) and 24 per cent is medium (101-150 mm/m) in available water capacity. About 33 per cent low (50-100 mm/m) and very low (<50 mm/m) in 39 per cent area.

❖ Major area has very gently sloping (1-3%) lands and 3 per cent gently sloping (3-5%).

❖ An area of about 31 per cent has soils that are slightly eroded (e1), 62 per cent moderately eroded (e2) and 5 per cent severely eroded (e3) soils.

❖ An area of about 80 per cent has soils that are strongly alkaline soils (pH 8.4-9.0) and 18 per cent very strongly alkaline (>9.0).

❖ The Electrical Conductivity (EC) of the soils are dominantly <2 dS m^{-1}indicating that the soils are non-saline.

❖ About 475 ha (67%) area is low (<0.5%) in organic carbon, medium (0.5-0.75%) in about 217 ha (30%) and high (>0.75%) in 6 ha (1%) in organic carbon.

- ❖ *Major area of 94 per cent has soils that are low (<23 kg/ha), 3 per cent medium (23-57 kg/ha) and >1 per cent high (>57 kg/ha) in available phosphorus.*
- ❖ *About 76 per cent high (>337 kg/ha) and 22 per cent medium (145-337 kg/ha) in available potassium.*
- ❖ *Available sulphur is medium (10-20 ppm) in 71 per cent, 15 per cent high (>20 ppm) and 12 per cent low (<10) in available sulphur.*
- ❖ *Available boron is low (<0.5 ppm) in about 13 per cent area, medium (0.5-1.0 ppm) in about 84 per cent area and high (>1.0 ppm) in about 1%.*
- ❖ *Major area is sufficient (>4.5 ppm) and 4 per cent is deficient (<4.5ppm) in available iron.*
- ❖ *Available manganese and copper are sufficient in all the soils.*
- ❖ *About 76 per cent area has soils that are deficient (<0.6 ppm) in available zinc and 22 per cent sufficient (>0.6 ppm).*
- ❖ *The land suitability for 19 major crops grown in the microwatershed were assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, 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	186 (26)	-	Guava	-	14 (2)
Maize	-	-	Jackfruit	-	-
Red gram	-	186 (26)	Jamun	-	186 (26)
Soybean	14 (2)	172 (24)	Musambi	186 (26)	-
Bengalgram	186 (26)	235 (33)	Lime	186 (26)	-
Sunflower	186 (26)	-	Cashew	-	-
Cotton	186 (26)	-	Custard apple	186 (26)	-
Sugarcane	-	-	Amla	186 (26)	-
Mango	-	-	Tamarind	-	186 (26)
Sapota	-	14 (2)			

    Apart from the individual crop suitability, a proposed crop plan has been prepared for the 3 identified LUCs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fodder fibre and horticulture crops that helps in maintaining the productivity and ecological balance in the microwatershed.

- ❖ *Maintaining soil-health is vital to crop production and conserve soil and land resource base for maintaining ecological balance and to mitigate climate change. For this, several ameliorative measures have been suggested to these problematic soils like saline/alkali, highly eroded, sandy soils etc.*
- ❖ *Soil and water conservation treatment plan has been prepared that would help in identifying the sites to be treated and also the type of structures required.*

❖ *As part of the greening programme, several tree species have been suggested to be planted in marginal and submarginal lands, field bunds and also in the hillocks, mounds and ridges that would help in supplementing the farm income, provide fodder and fuel and generate lots of biomass. This would help in maintaining ecological balance and contribute to mitigating the climate change.*

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 geographical 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 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 an 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.,* soil, 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 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 Chik Hangargi-2 micro-watershed, Chik Hangargi sub-watershed in Jewargi taluk, Kalaburagi 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 Chik Hangargi-2 microwatershed (Chik Hangargi sub-watershed) is located in the northern part of Karnataka in Jewargi Taluk, Kalaburagi District, Karnataka State (Fig. 2.1). It comprises parts of Sumbada and Yedrami villages. It lies between $16^0 45'$ and $16^0 51'$ North latitudes and $76^0 32'$ and $76^0 35'$ East longitudes and covers an area of 711.06 ha. It is about 80 km south of Kalaburagi and is surrounded by Yedrami village on the north and Sumbada village on the southeast and western part of the microwatershed.
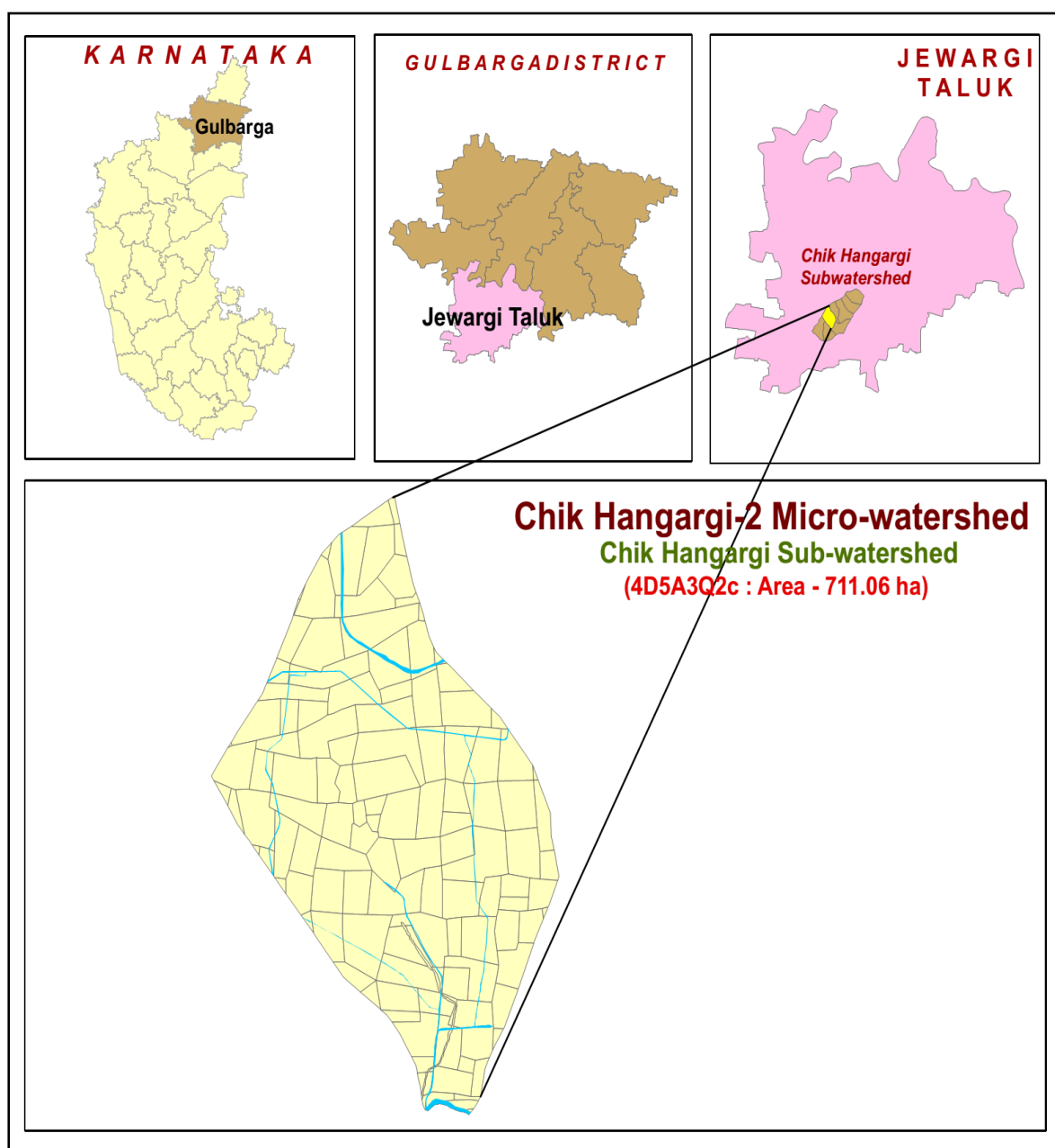
Fig. 2.1 Location map of Chik Hangargi-2 Microwatershed

2.2 Geology

Major rock formation observed in the microwatershed is Basalt or Deccan trap (Fig.2.2). The Deccan Traps cover the whole of Bidar, parts of Kalaburgi, Bijapur and Belgaum districts. In all, eight lava flows have been identified in Karnataka horizontally overlying the older formations. The thickness of the individual flows averages about five meters. It is relatively uniform in petrographic character. The most common type is augite basalt. Dominant colour is grayish green and texture ranges from cryptocrystalline to glassy. The rock is often vesicular and scoriaceous filled up with secondary minerals like coloured agate, quartz, calcite and a large variety of zeolites. The Deccan Traps form an excellent building material and also used as road-metal and railway ballast.

Fig. 2.2 Basalt rock

2.3 Physiography

Physiographically, the area has been identified as basalt landscape based on geology. Based on slope and its relief features, the area has been further subdivided into four landforms, viz; mounds/ridges, summits, side slopes and very gently sloping uplands. The elevation ranges from 458 to 490 m. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

The area is drained by several small parallel streams that join Monia nala which further joins Awarja river along its course. Though, it is not a perennial one, during rainy season it carries large quantities of rain water. The microwatershed has only few small

tanks which are not capable of storing the water that flows during the rainy season. Due to this, the ground water recharge is very much affected. This is reflected in the failure of many bore wells in the villages. If the available rain water is properly harnessed by constructing new tanks and recharge structures at appropriate places in the villages, then the drinking and irrigation needs of the area can be easily met. The drainage network is parallel to sub parallel and dendritic.

2.5 Climate

The district falls under semiarid tract and is categorized as drought-prone with average annual rainfall of 751 mm (Table 2.1). Of the total rainfall, a maximum of 538 mm is received during south-west monsoon period from June to September, north-east monsoon from October to early December contributes about 138 mm and the remaining 75 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 42° C and in December and January, the temperatures will go down to 16° C. Rainfall distribution is shown in Figure 2.3. The average Potential Evapo-transpiration (PET) is 159 mm and varies from a low of 115 mm in December to 232 mm in the month of May. The PET is always higher than precipitation in all the months except in September. Generally, the Length of crop Growing Period (LGP) is 150 days and starts from 1st week of June to 1st week of October.

Table 2.1 Mean Monthly Rainfall, PET, 1/2 PET in Jewargi Taluk, Kalaburagi District

Sl. no.	Months	Rainfall	PET	1/2 PET
1	JAN	3.40	126.80	63.40
2	FEB	2.00	143.90	71.95
3	MAR	12.70	189.90	94.95
4	APR	21.90	209.80	104.90
5	MAY	34.60	232.20	116.10
6	JUN	109.20	186.40	93.20
7	JUL	128.20	152.80	76.40
8	AUG	141.30	147.60	73.80
9	SEP	159.00	131.70	65.85
10	OCT	104.90	145.50	72.75
11	NOV	28.60	129.80	64.90
12	DEC	4.90	114.80	57.40
Total		**750.70**		
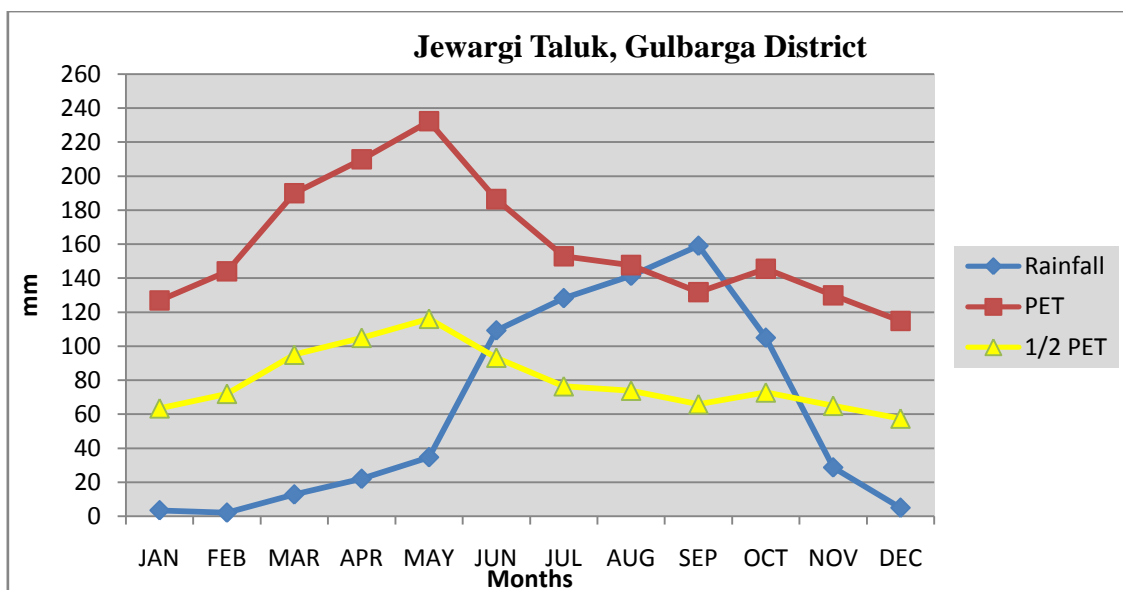
Fig 2.3 Rainfall distribution in Jewargi Taluk, Kalaburagi District

2.6 Natural Vegetation

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

Fig. 2.4. Natural Vegetation of Chik Hangargi-2 Microwatershed

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2.7 Land Utilization

About 84 per cent area (Table 2.2) in Jewargi taluk is cultivated at present. An area of about 4 per cent is permanently under pasture, one per cent each under non agricultural land and currently barren. Forests occupy an area of about less than one per cent and the tree cover is in a very poor state. Most of the mounds, ridges and bouldery areas have very poor vegetative cover. Major crops grown in the area are Sorghum, Maize, Soybean, Cotton, Redgram and Sapota. The cropping intensity in the taluk is 106 per cent. 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 generated. The current land use map generated 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 Chik Hangargi-2 microwatershed is presented in Figure 2.5. Simultaneously, enumeration of wells (bore wells and open wells) existing conservation structures in the microwatershed are made and their location in different survey numbers is located on the cadastral map. No wells are existing in the microwatershed. Map showing the conservation structures and other water bodies in Chik Hangargi-2 microwatershed is given in Figure 2.6.
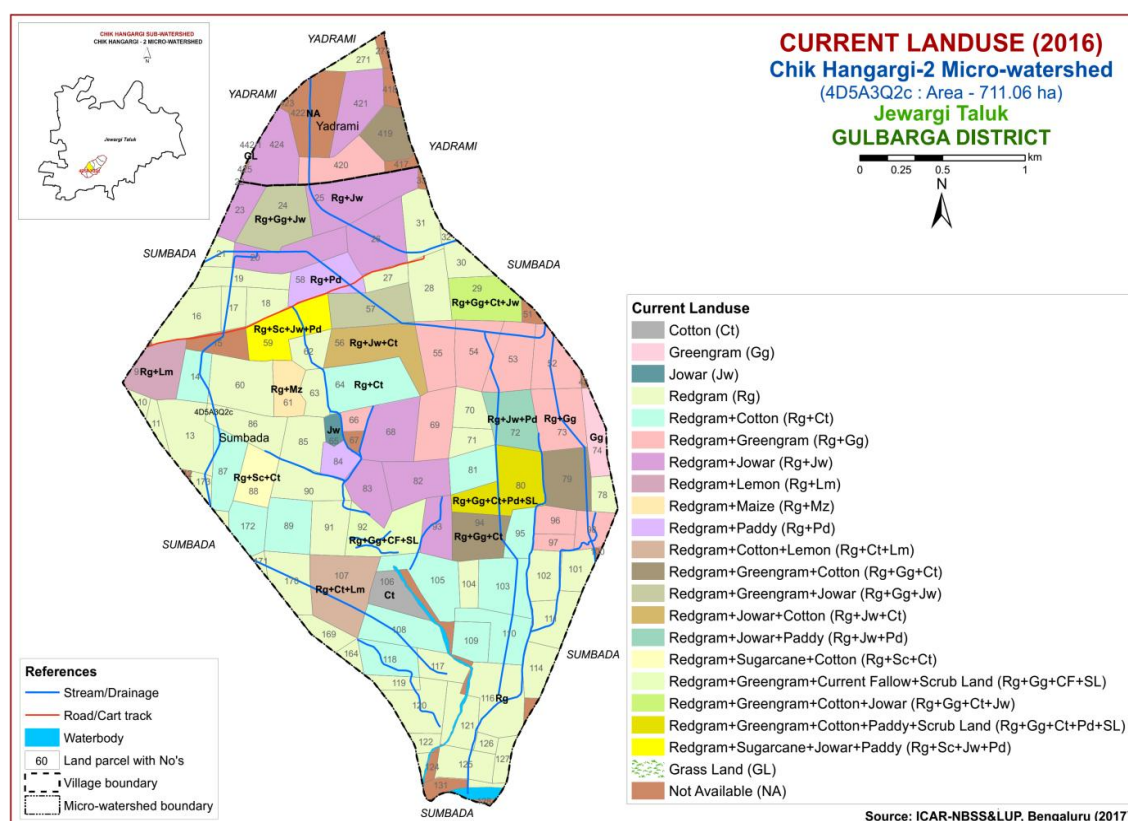
Fig.2.5 Current Land Use - Chik Hangargi-2 Microwatershed

Table 2.2 Land Utilization in Jewargi Taluk

Sl. No.	Agricultural land use	Area (ha)	Per cent
1.	Total geographical area	182313	-
2.	Total cultivated area	153142	83.99
3.	Area sown more than once	8695	-
4.	Cropping intensity	-	105.67
5.	Trees and grooves	62	0.034
6.	Forest	310	0.17
7.	Cultivable wasteland	294	0.16
8.	Permanent Pasture land	6486	3.55
9.	Barren land	1838	1.00
10.	Non- Agriculture land	5317	2.91
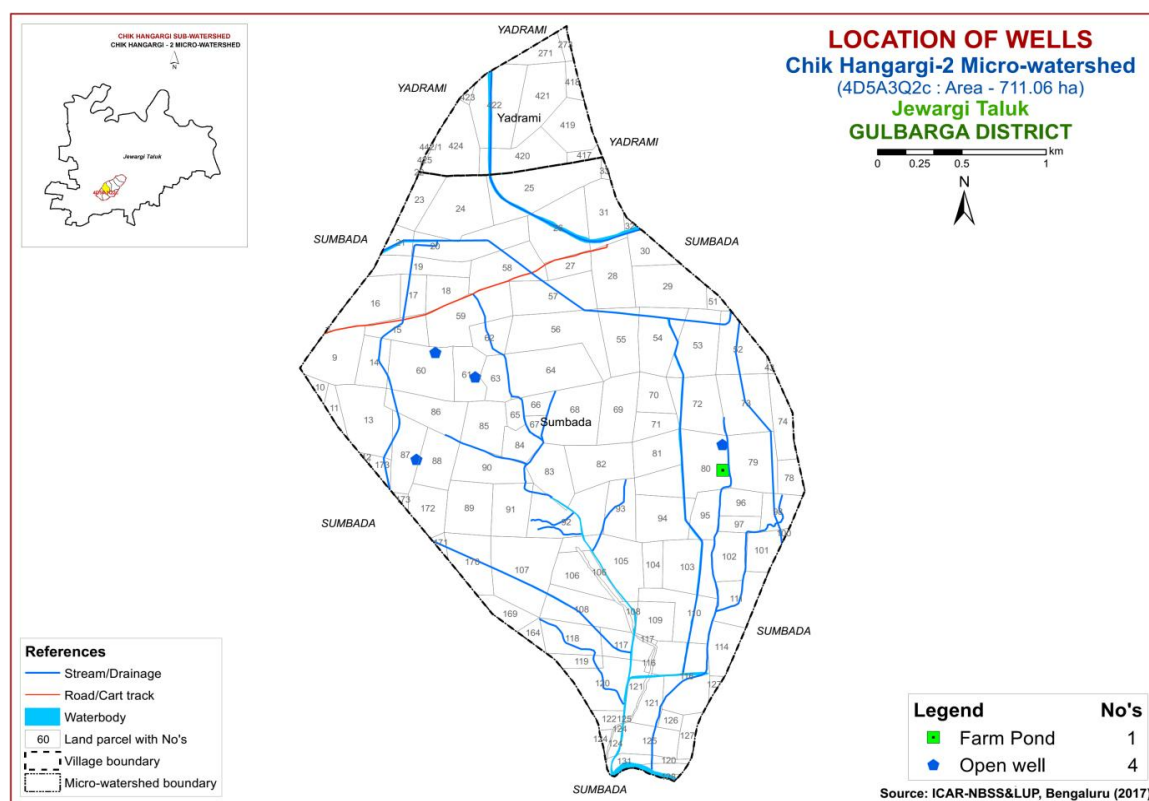
Fig. 2.6. Location of conservation structures and wells in Chik Hangargi-2 Microwatershed.

SURVEY METHODOLOGY

The purpose of land resource inventory is to delineate similar areas (soil series and phases), which respond or expected to respond similarly to a given level of management. This was achieved in Chik Hangargi-2 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 characteristics (slope of the land, erosion, drainage, occurrence of rock fragments etc.) and followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units, and showing their extent and geographic distribution on the microwatershed cadastral map. The detailed survey at 1:7920 scale was carried out in an area of 711 ha. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.,* 2015) which is briefly described below.

3.1 Base Maps

The detailed survey of the land resources occurring in the microwatershed was carried out by using digitized cadastral map as a base. The cadastral map shows field boundaries with their survey numbers, location of tanks, streams and other permanent features of the area (Fig. 3.1). Apart from the cadastral map, remote sensing data products from Cartosat-1 and LISS IV merged at the scale of 1:7920 were used in conjunction with the cadastral map to identify the 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 also used for initial traversing, identification of geology and landforms, drainage features, present land use and also for selection of transects in the microwatershed.

3.2 Image Interpretation for Physiography

False Colour Composites (FCCs) of Cartosat-I and LISS-IV merged satellite data covering the microwatershed area was visually interpreted using image interpretation elements along with the geology map 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 basalt landscape and is divided into landforms such as ridges, mounds and uplands based on slope and other relief features. They were further subdivided into physiographic/ image interpretation units based on image characteristics.
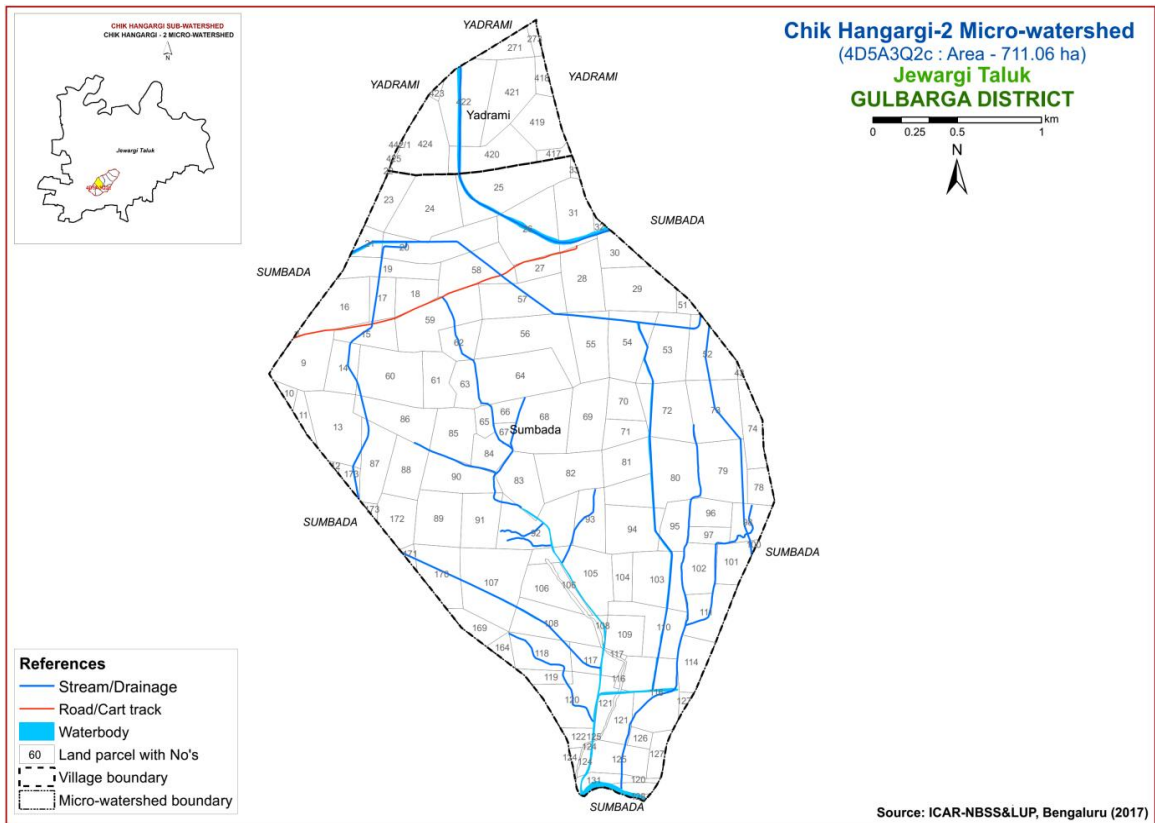
Fig 3.1 Scanned and Digitized Cadastral map of Chik Hangargi-2 Microwatershed
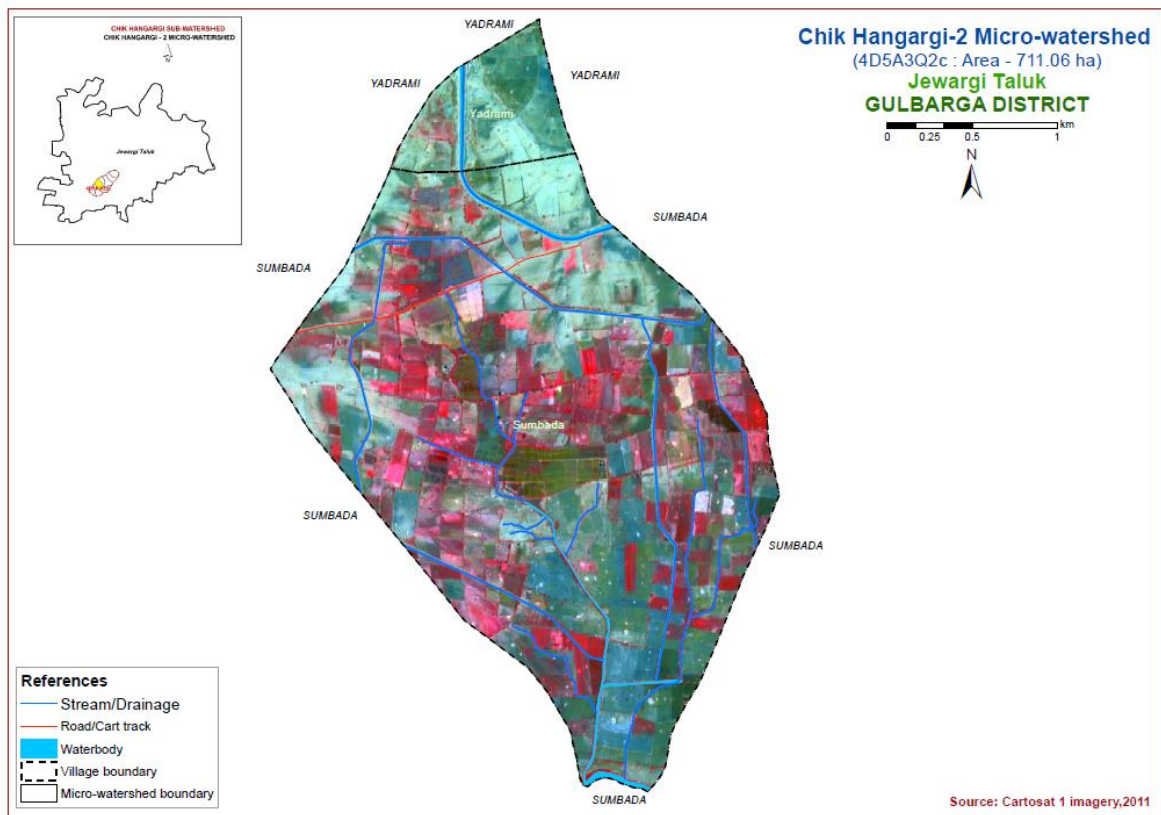
Fig.3.2 Satellite Image of Chik Hangargi-2 Microwatershed
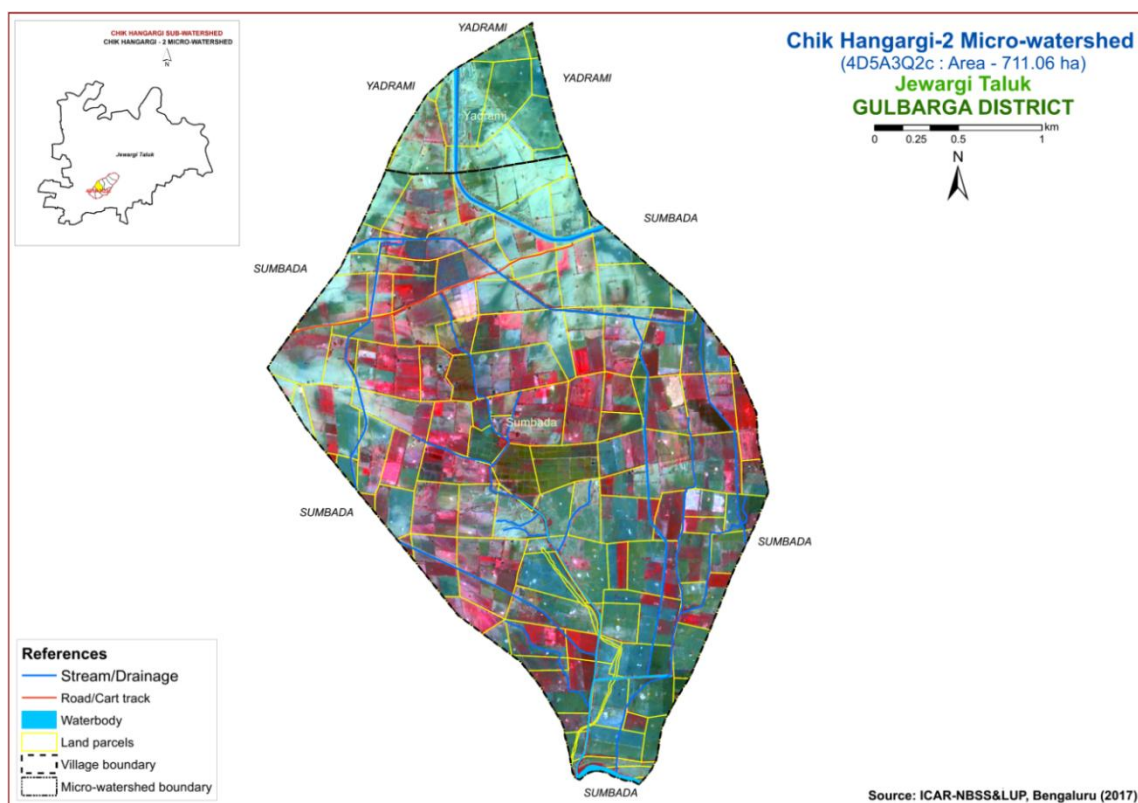
Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Chik Hangargi-2 Microwatershed

3.3 Field Investigation

The field boundaries and survey numbers given on the cadastral sheet were located on the ground by following permanent features like roads, cart tracks, nallas, streams, tanks etc., and wherever changes were noticed, they were incorporated on the microwatershed cadastral map. Preliminary traverse of the microwatershed was carried out with the help of cadastral map, imagery and toposheets. While traversing, landforms and physiographic units identified were checked and preliminary soil legend was prepared by studying soils at few selected places. Then, intensive traversing of each physiographic unit like hills, ridges and uplands was carried out. Based on the variability observed on the surface, transects (Fig. 3.4) were selected across the slope covering all the landform units in the microwatershed (Natarajan and Dipak Sarkar, 2010).
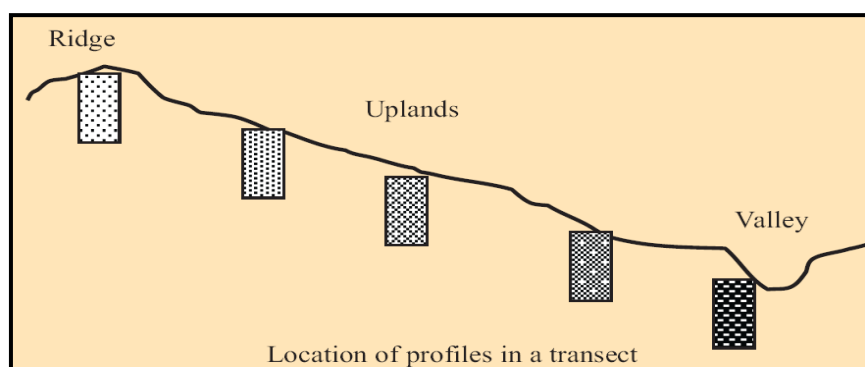
Fig: 3.4. Location of profiles in a transect

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 up to 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all the profile sites on a standard proforma as per the guidelines given in USDA Soil Survey Manual (Soil Survey Staff, 2012). Apart from the transect study, profiles were also studied at random, almost like in a grid pattern, outside the transect areas.

Based on the soil 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, calcareouness 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, 4 soil series were identified in the Chik Hangargi-2 microwatershed.

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

Sl No.	Series	Depth (cm)	Colour (moist)	Texture	Gravel (%)	Horizon sequence	Effer vesence
	Soils of Basalt Landscape						
1.	Margutti MG(MGT)	<25	10YR3/3,4/3,5/4 7.5YR4/3	c	15-35	-	Ap-R/cr
2.	Novinihala NH(NHA)	25-50	10YR3/2,3/1,4/2 7.5YR3/4	**c**	<15	-	Ap-Bw-cr/R
3.	Dimal (DIM)	100-150	10YR3/2,3/1 4/2,4/3,4/4	**c**	<15	**e-es**	Ap-B--Bss-cr
4.	Mannur (MAR)	>150	10YR3/2,3/1,4/3	**c**	<15	**e-es**	Ap-BA-Bss

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 about 19 profile pits, few minipits 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 minipits, road cuts, terrace cuts etc., were studied to validate the soil boundaries on the soil map.

The soil map shows the geographic distribution of 8 mapping units representing 4 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 8 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one phase will have similar management needs and have to be treated accordingly.

The 8 soil phases identified and mapped in the microwatershed were grouped into 3 Land Use class (LUC'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 Use class (LUC's) based on the management needs. One or more than one soil site characteristic having influence on the management have been choosen for identification and delineation of LUCs. For Chik Hangargi-2 microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The land use classes are expected to behave similarly for a given level of management.

3.5 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected from farmer's fields (113 samples) for fertility status (major and micronutrients) at 250 m grid interval were analyzed in the laboratory (Katyal and Rattan, 2003). By linking the soil fertility data to the survey numbers through GIS, soil fertility maps were generated by using kriging method for the microwatershed.

Table 3.2 Soil map unit description of Chik Hangargi-2 Microwatershed

Sl. map unit no.	Soil series	Soil phase	Mapping unit Description	Area in ha (%)
	MGT		Marguti soils are very shallow (<25 cm), well drained, have very dark grayish brown to dark brown clayey soils occuring on very gently sloping to moderately sloping uplands	**277 (38.93)**
1		MGTmB2	Clay surface, 1-3% slope, moderate erosion	258 (36.26)
2		MGTmC1	Clay surface, 3-5% slope, slight erosion	19 (2.67)
	NHA		Novinihala soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark brown clayey soils occurring on very gently sloping to moderately sloping uplands	**235 (33.09)**
3		NHAmB1	Clay surface, 1-3% slope, slight erosion	45 (6.28)
4		NHAmB2	Clay surface, 1-3% slope, moderate erosion	158 (22.26)
5		NHAmB3	Clay surface, 1-3% slope, severe erosion	32 (4.55)
	DIM		Dimal soils are deep (100-150 cm), moderately well drained, have very dark grayish brown to very dark gray calcareous cracking clay soils occurring on nearly level to very gently sloping and moderately sloping uplands	**172 (24.15)**
6		DIMmB1	Clay surface, 1-3% slope, slight erosion	146 (20.5)
7		DIMmB2	Clay surface, 1-3% slope, moderate erosion	26 (3.65)
	MAR		Mannur soils are very deep (>150 cm), moderately well drained, have very dark gray to brown calcareous cracking clay soils occurring on nearly level to very gently sloping uplands	**14 (2.0)**
8		MARmB1	Clay surface, 1-3% slope, slight erosion	14 (2.0)
9		Others	Habitation & waterbody	13 (1.83)

YADRAMI
YADRAMI
YADRAMI
Yadrami
SUMBADA
SUMBADA
SUMBADA
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SUMBADA
SUMBADA

SOILS
Chik Hangargi-2 Micro-watershed
(4D5A3Q2c : Area - 711.06 ha)
Jewargi Taluk
GULBARGA DISTRICT

km
0   0.25   0.5   1

N

Texture

MGT m B 2

Soil
Series   Slope   Erosion

Soil Phase	Area in ha (%)
1, MGTmB2	258 (36.26)
2, MGTmC1	19 (2.67)
3, NHAmB1	45 (6.28)
4, NHAmB2	158 (22.26)
5, NHAmB3	32 (4.55)
6, DIMmB1	146 (20.5)
7, DIMmB2	26 (3.65)
8, MARmB1	14 (2.0)
9, Others*	13 (1.83)

* - Habitation & Waterbody

KEY
TEXTURE
m – Clay

SLOPE
B – Very gently sloping (1-3%)
C - Gently sloping (3-5%)

EROSION
1 – Slight
2 – Moderate
3 – Severe

DEPTH
MGT - Very shallow (<25 cm)
NHA - Shallow (25-50 cm)
DIM - Deep (100-150 cm)
MAR - Very deep (>150 cm)

References
———— Stream/Drainage
———— Road/Cart track
Waterbody
60   Land parcel with No's
Village boundary
Micro-watershed boundary

Source: ICAR-NBSS&LUP, Bengaluru (2017)

Fig 3.5 Soil Phase or Management Units - Chik Hangargi-2 Microwatershed

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THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Chik Hangargi-2 microwatershed is provided in this chapter. The microwatershed area has been identified as basalt landscape based on geology. In all, 4 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. Soil formation in the basalt landscape is dominantly influenced by the parent material, climate and relief.

A brief description of each of the 4 soil series identified followed by 8 soil phases (management units) mapped under each series are furnished below. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site 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 Basalt landscape

In this landscape, 4 soil series are identified and mapped. Brief description of each series and their phases identified are given below. Of these, Marguti (MGT) series occupies major area of 277 ha (39%), Novinihala (NHA) 235 ha (33%), Dimal (DIM) 172 ha (24%) and Mannur (MAR) series 14 ha (2%) area in the microwatershed.

4.1.1 Margutti (MGT) Series: Marguti soils are very shallow (<25cm), well drained, have very dark grayish brown to dark brown clayey soils. They have developed from basalt and occur on very gently sloping to moderately sloping uplands.

Landscape and Soil Profile characteristics of Margutti (MGT) Series

The total depth of the soil ranges from 10 to 23 cm. The thickness of A horizon ranges from 7 to 24 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 to 4 and chroma 2 to 4. The texture is clay with 15 to 35 per cent gravel. The available water capacity is very low (<50 mm/m). Two phases were identified and mapped.

4.1.2 Novinihala (NHA) Series: Novinihala soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark brown clayey soils. They have developed from basalt and occur on very gently sloping to moderately sloping uplands.

The thickness of the solum ranges from 27 to 48 cm. The thickness of A horizon ranges from 12 to 20 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 to 4 and chroma 2 to 4. The texture varies from sandy clay to clay with 10 to 20 per cent gravel. The thickness of B horizon ranges from 22 to 37 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 to 4 and chroma 2 to 4. Its texture is clay with gravel content of 10-15 per cent. The available water capacity is low (51-100 mm/m). Two phases were identified and mapped.

Landscape and Soil Profile characteristics of Novinihala (NHA) Series

4.1.3 Dimal (DIM) Series: Dimal soils are deep (100-150 cm), moderately well drained, have very dark grayish brown to very dark gray calcareous cracking clay soils. They have developed from basalt and occur on nearly level to very gently sloping and moderately sloping uplands.

The thickness of the solum ranges from 125 to 140 cm. The thickness of A horizon ranges from 14 to 23 cm. Its colour is in 10 YR hue with value 3 and chroma 1. The texture is clay with 5 to 10 per cent gravel. The thickness of B horizon ranges from 85 to 130 cm. Its colour is in 10 YR hue with value 3 and chroma 1 to 2. Its texture is clay with gravel content of less than 15 per cent and are calcareous. The available water capacity is very high (>200 mm/m). Two phases were identified and mapped.

Landscape and Soil Profile characteristics of Dimal (DIM) Series

4.1.4 Mannur (MAR) Series: Mannur soils are deep (>150 cm), moderately well drained, have very dark grayish brown to gray calcareous cracking clay soils. They have developed from basalt and occur on very gently sloping to moderately sloping uplands.

The thickness of the solum is more than 150 cm. The thickness of A horizon ranges from 18 to 25 cm. Its colour is in 10 YR hue with value 3 and chroma 2 to 1. The texture is clay with less than 10 per cent gravel. The thickness of B horizon ranges from 128 to 175 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 3. Its texture is clay with gravel content of less than 15 per cent and are calcareous. The available water capacity is very high (>200 mm/m). Only one phase was identified and mapped.

Landscape and Soil Profile Characteristics of Mannur (MAR) Series

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

The most important soil and site characteristics that affect the land use and conservation needs of an area are land capability, soil depth, soil texture, coarse fragments, available water capacity, soil slope, soil erosion, soil reaction etc. These are interpreted from the data base 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: Depth, texture, gravelliness, calcareousness.

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

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

The 8 soil map units identified in the Chik Hangargi-2 microwatershed are grouped under 2 land capability classes and 4 subclasses each. An entire area in the microwatershed is suitable for agriculture (Fig. 5.1).
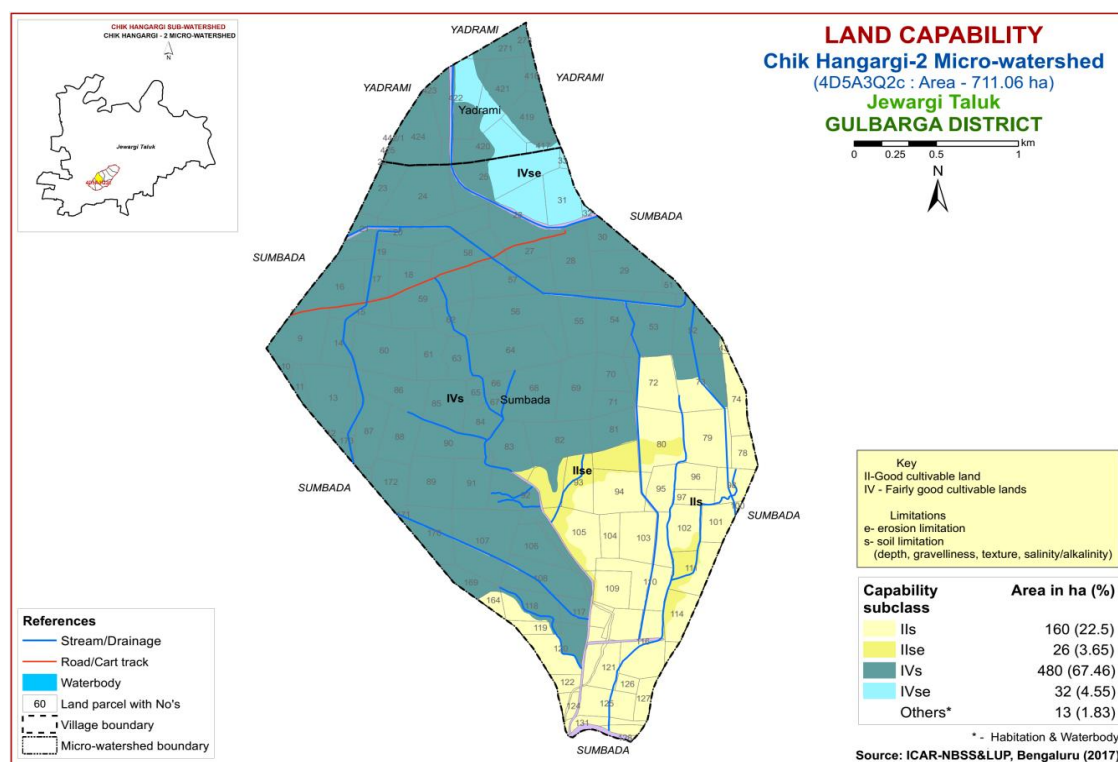
Fig. 5.1 Land Capability map of Chik Hangargi-2 Microwatershed

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Good cultivable lands (Class II) cover an area of about 26 per cent and are distributed in southern and southeastern part of the micowatershed with minor problems of soil and erosion. The fairly good cultivable lands (Class IV) cover a large area of about 72 per cent. They have severe limitations of soil and erosion and are distributed in the southern part of the microwatershed.

5.2 Soil Depth

Soil depth refers to the depth of the soil occurring above the parent material or hard rock. The depth of the soil determines the effective rooting depth for plants and in accordance with soil texture, mineralogy and gravel content, the capacity of the soil column to hold water and nutrient availability. Soil depth is one of the most important soil characteristic that is used in differentiating soils into different soil series. The soil depth classes used in identifying soils in the field are very shallow (<25 cm), shallow (25-50 cm), moderately shallow (50-75 cm), moderately deep (75-100 cm), deep (100-150 cm) and very deep (>150 cm). They were used to classify the soils into different depth classes and a soil depth map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.2.
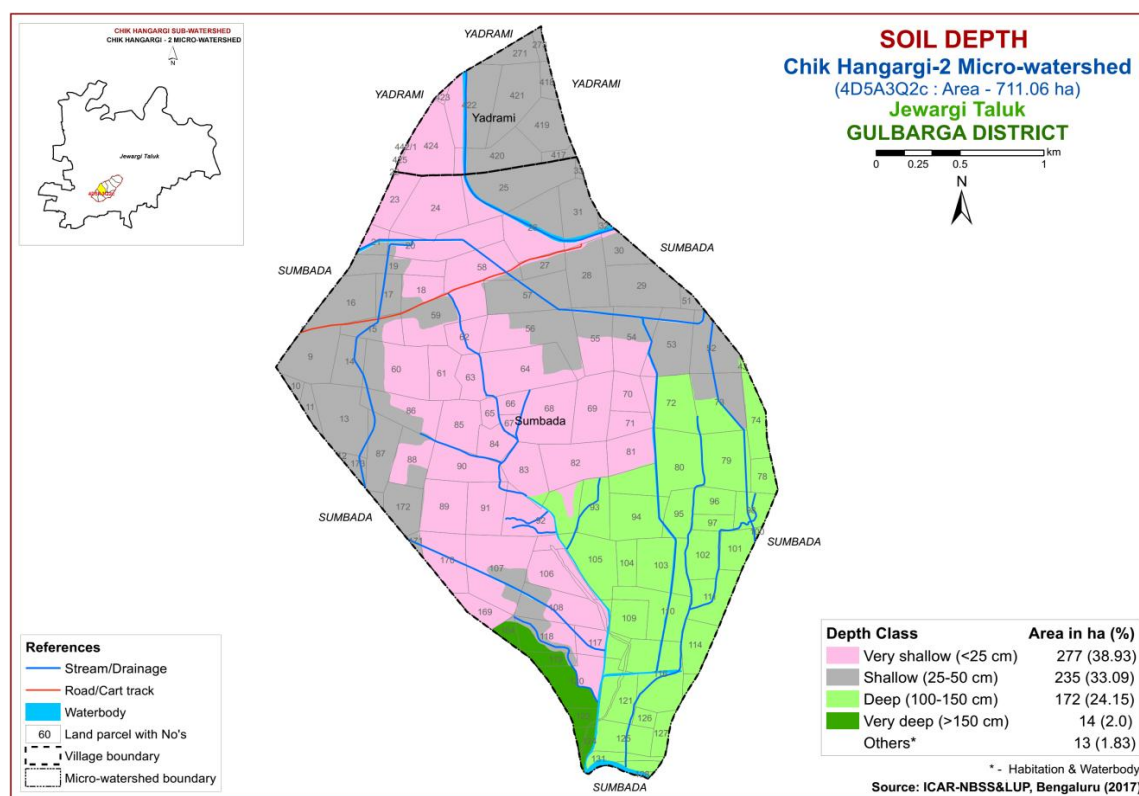
Fig. 5.2 Soil Depth map of Chik Hangargi-2 Microwatershed

An area of about 277 ha (39%) are very shallow (<25 cm) and occur in central and northwestern part of the microwatershed. Shallow (25-50 cm) soils occupy an area of about 235 ha (33%) and are distributed in western, souther, northern and northeastern part of the microwatershed. Deep soils (100-150 cm) cover an area of about 172 ha (24%) and are distributed in the southeastern part of the microwatershed. Very deep (>150 cm) soils

cover a minor area of 14 ha (2%) and are distributed in the southwestern part of the microwatershed. The most productive lands 186 ha (26%) with respect to soil rooting depth where all climatically adapted annual and perennial crops can be grown are very deep (>150 cm) and deep (100-150 cm) occurring in the major part of the microwatershed.

The most problem lands with an area of about 235 ha (33%) having shallow (25-50 cm) rooting depth occur in the northern, northeastern, western and 277 ha (39%). The very shallow (<25 cm) soils occur in the northwestern, central and southwestern part of the microwatershed. They are not suitable for growing agricultural crops but well suited for pasture, forestry or other recreational purposes. Occasionally, short duration crops may be grown if rainfall is normal.

5.3 Surface Soil Texture

Texture is an expression to indicate the coarseness or fineness of the soil as determined by the relative proportion of primary particles of sand, silt and clay. It has a direct bearing on the structure, porosity, adhesion and consistence. The surface layer of a soil to a depth of about 25 cm is the layer that is most used by crops and plants. The surface soil textural class provides a guide to understanding soil-water retention and availability, nutrient holding capacity, infiltration, workability, drainage, physical and chemical behaviour, microbial activity and crop suitability. The textural classes used for LRI were used to classify the soils and a surface soil texture map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.3. The entire area in the microwatershed is clayey at the surface.
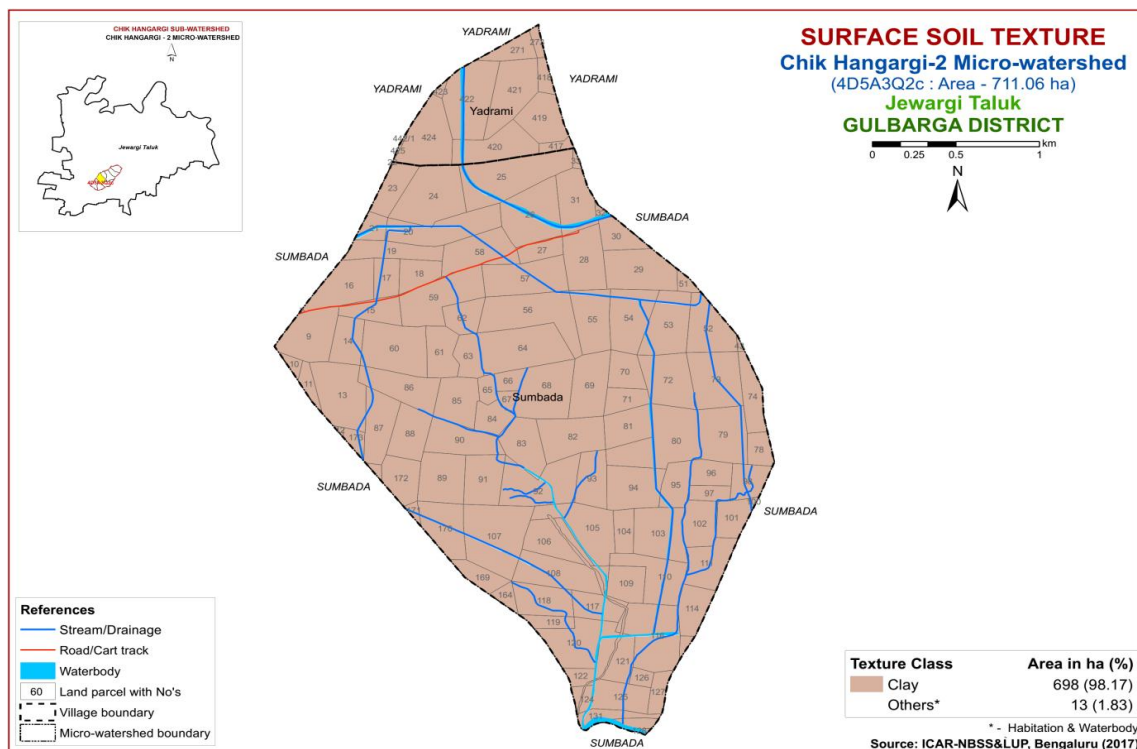
Fig. 5.3 Surface Soil Texture map of Chik Hangargi-2 Microwatershed

Entire area has most productive lands (98%) with respect to surface soil texture where are they clayey that have high potential for soil-water retention and availability, and nutrient retention and availability, but have problems of drainage, infiltration, workability and other physical problems.

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 Figure 5.4. The entire area in the microwatershed is non gravelly.

The entire area in the microwatershed is non gravelly (Fig. 5.4). They are most productive lands with respect to soil gravelliness. They are nongravelly (<15% gravel) and have high potential for growing both annual and perennial crops.
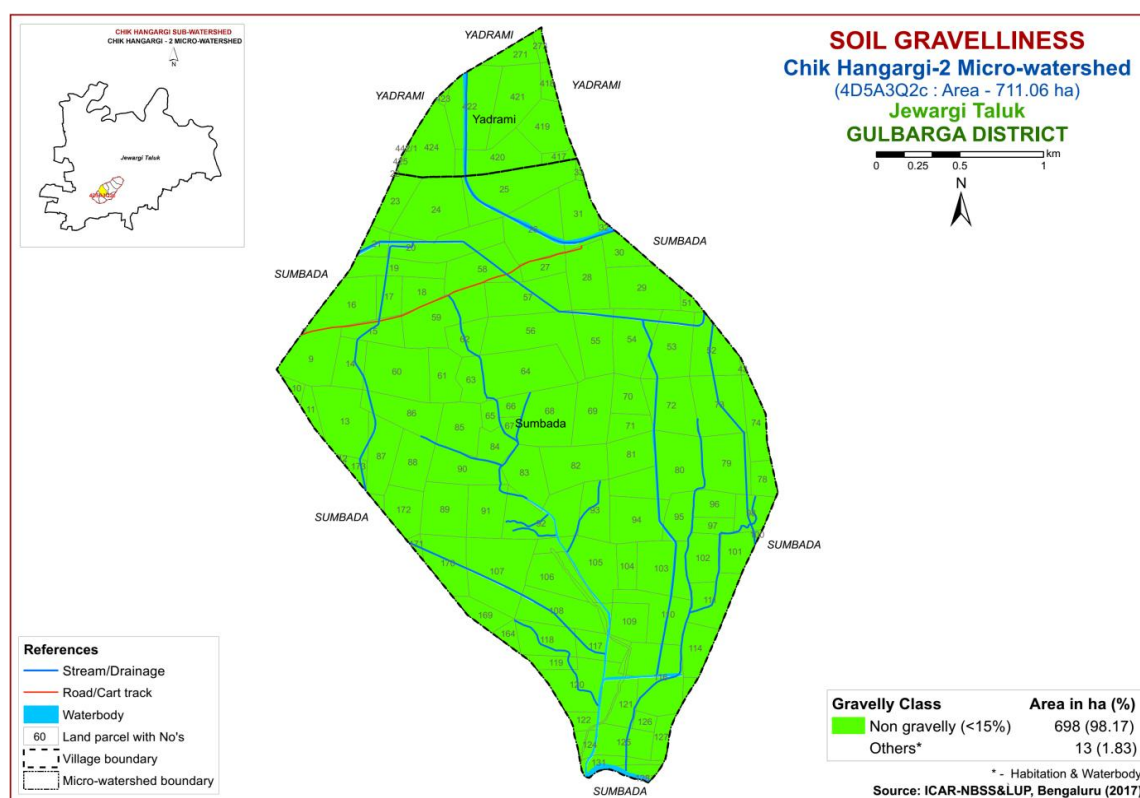
Fig. 5.4 Soil Gravelliness map of Chik Hangargi-2 Microwatershed

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 (51-100 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 given in Figure 5.5.

Maximum area of about 235 ha (33%) has soils that are low (51-100 mm/m) in available water capacity and are distributed in the northeastern and western part of the microwatershed. Very low (<50 mm/m) available water capacity occupy an area of 277 ha (39%) and are distributed in the central and northwestern part of the microwatershed. About 172 ha (24%) area is medium in available water capacity and are distributed in the southestern part of the microwatershed. An area of about 14 ha (2%) is very high (>200 mm/m) in available water capacity and are distributed in the southwestern part of the microwateshed.

Major area about 512 ha (72%) area in the microwatershed has soils that are problematic with regard to available water capacity. Here, only short or medium duration crops can be grown and the probability of crop failure is very high. These areas are best put to other alternative uses. An area of about 14 ha (2%) has soils that have high potential (>200 mm/m) with regard to available water capacity where all climatically adapted long duration crops can be grown successfully.
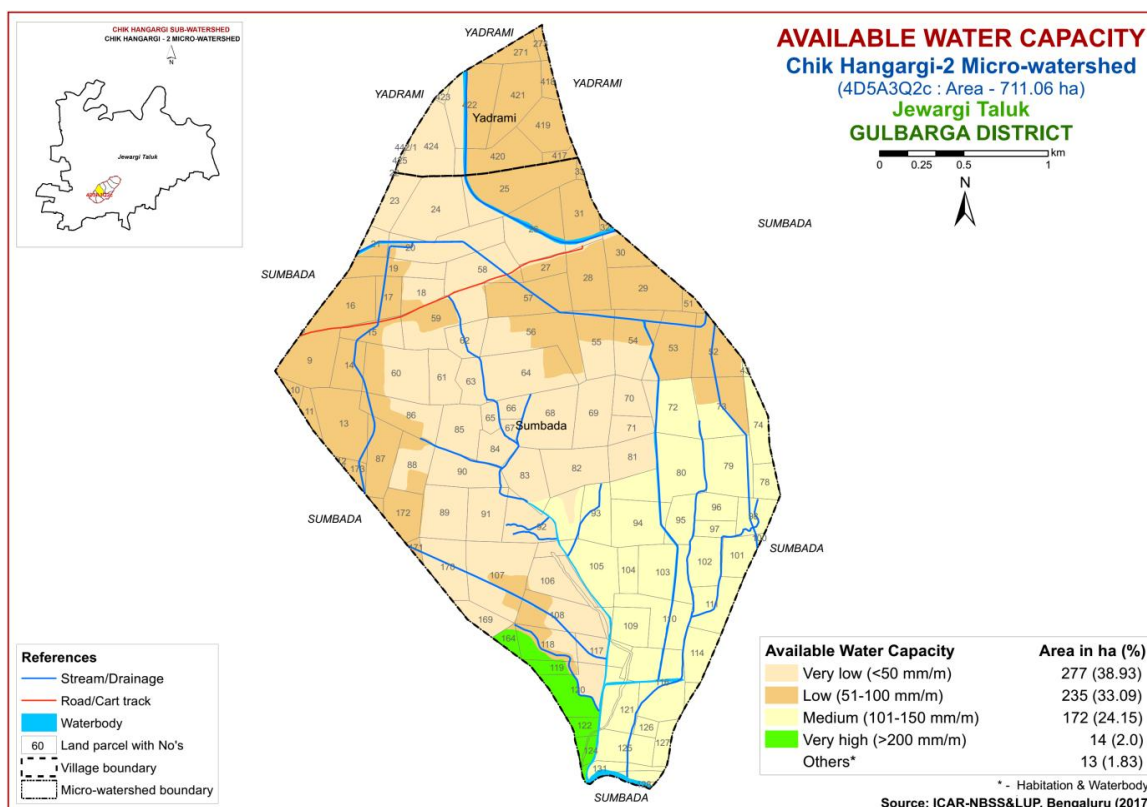
Fig. 5.5 Soil Available Water Capacity map of Chik Hangargi-2 Microwatershed

5.6 Soil Slope

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

Entire area of 679 ha (95%) falls under very gently sloping (1-3% slope) lands. All are most productive lands with respect to soil slopes where all climatically adapted annual and perennial crops can be grown without much soil and water conservation, and other land development measures.
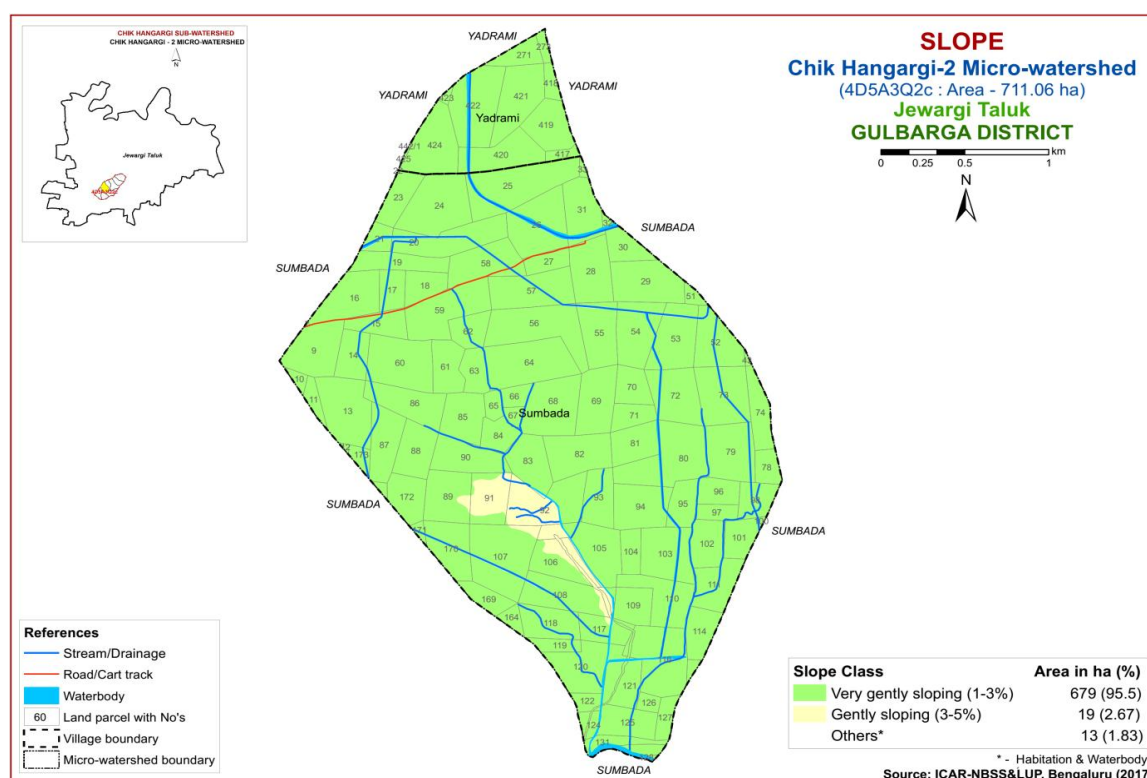
Fig. 5.6 Soil Slope map of Chik Hangargi-2 Microwatershed

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

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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.

Soils that are moderately eroded (e2 class) cover an area of about 442 ha (62%) in the microwatershed. They are distributed in the northwestern, western, central, small patches in the northestern and southwestern part of the microwatershed. Slightly eroded (e1 class) soils cover a maximum area of about 224 ha (31%) and are distributed in the southern, southeastern and small patch in the southwestern part of the microwatershed. An area of about 32 ha (5%) is under severe erosion and are distributed in northern part of the microwaterhsed.

An area of about 32 ha (4%) in the microwatershed is the problematic because of severe erosion following moderately eroded areas (62%). To these areas taking up soil and water conservation and other land development measures are required for restoring the soil health.
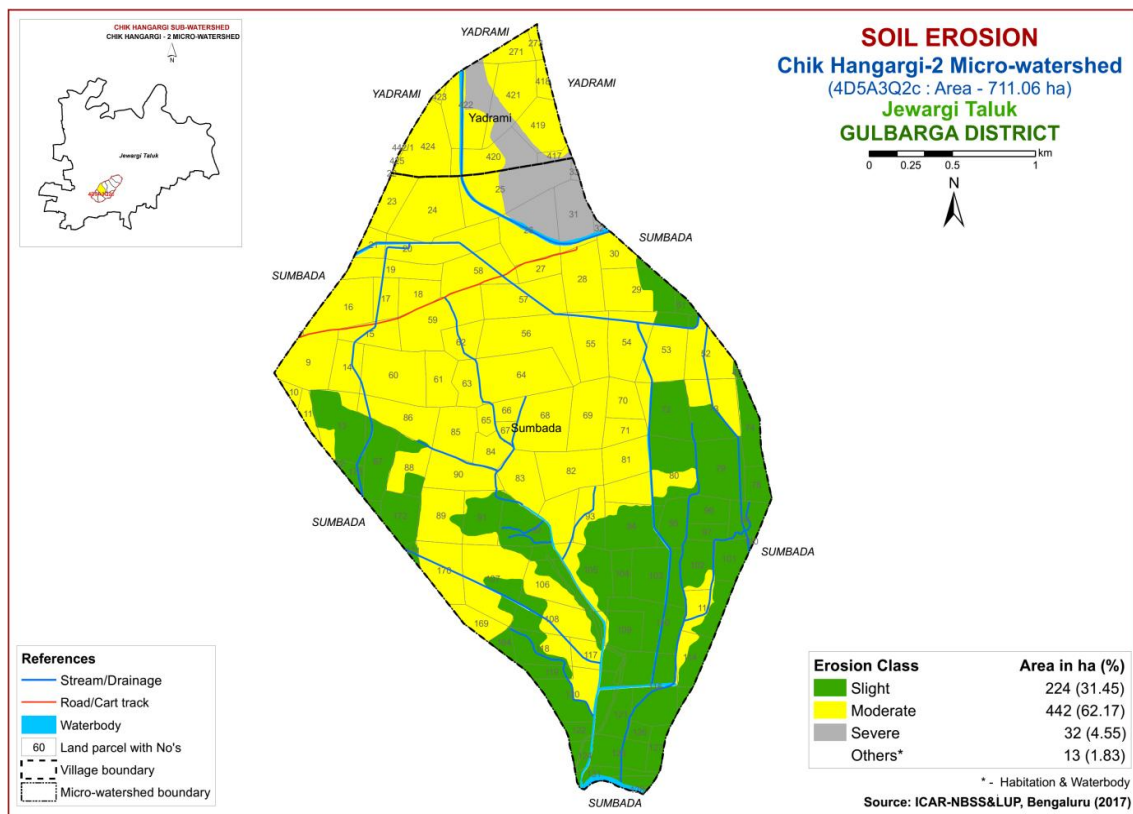
Fig. 5.7 Soil Erosion map of Chik Hangargi-2 Microwatershed

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status as these areas are characterised by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected (89 samples) from the grid points (one soil sample at every 250 m interval) all over the microwatershed through land resource inventory in the year 2016 were analysed for pH, EC, organic carbon, available phosphorus and potassium, and for micronutrients like zinc, boron, copper, iron and manganese, and secondary nutrient sulphur.

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

6.1 Soil Reaction (pH)

The soil analysis of the Chik Hangargi-2 microwatershed for soil reaction (pH) showed that an area of about 567 ha (80%) is strongly alkaline (pH 8.4-9.0) and occur in all parts of the microwatershed. Very strongly alkaline (pH >9.0) soils cover an area of 131 ha (18%) and are distributed in the central and southwestern part of the microwatershed (Fig. 6.1).

6.2 Electrical Conductivity (EC)

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

6.3 Organic Carbon

The soil organic carbon content (an index of available Nitrogen) in the soils of the microwatershed is high (>0.75%) in a small area of about 6 ha (1%) and is distributed in small areas in the northeastern part of the microwatershed. Major area of 217 ha (30%) is under medium (0.5-0.75%) in organic carbon content and are distributed in the southern, southeastern, eastern, small patches in the western and central part of the microwatershed. Organic carbon content is low (<0.5%) in major area of 475 ha (67%) and are distributed in all parts of the microwatershed (Fig. 6.3).

6.4 Available Phosphorus

Available phosphorus content is low (<23 kg/ha) in maximum area of about 670 ha (94%) and is distributed in major part of the microwatershed. An area of about 25 ha (3%) is medium (23-57 kg/ha) in available phosphorus and high (>57 kg/ha) in about 3 ha (0.45%) area and are distributed in the northeastern part of the microwatershed (Fig 6.4).
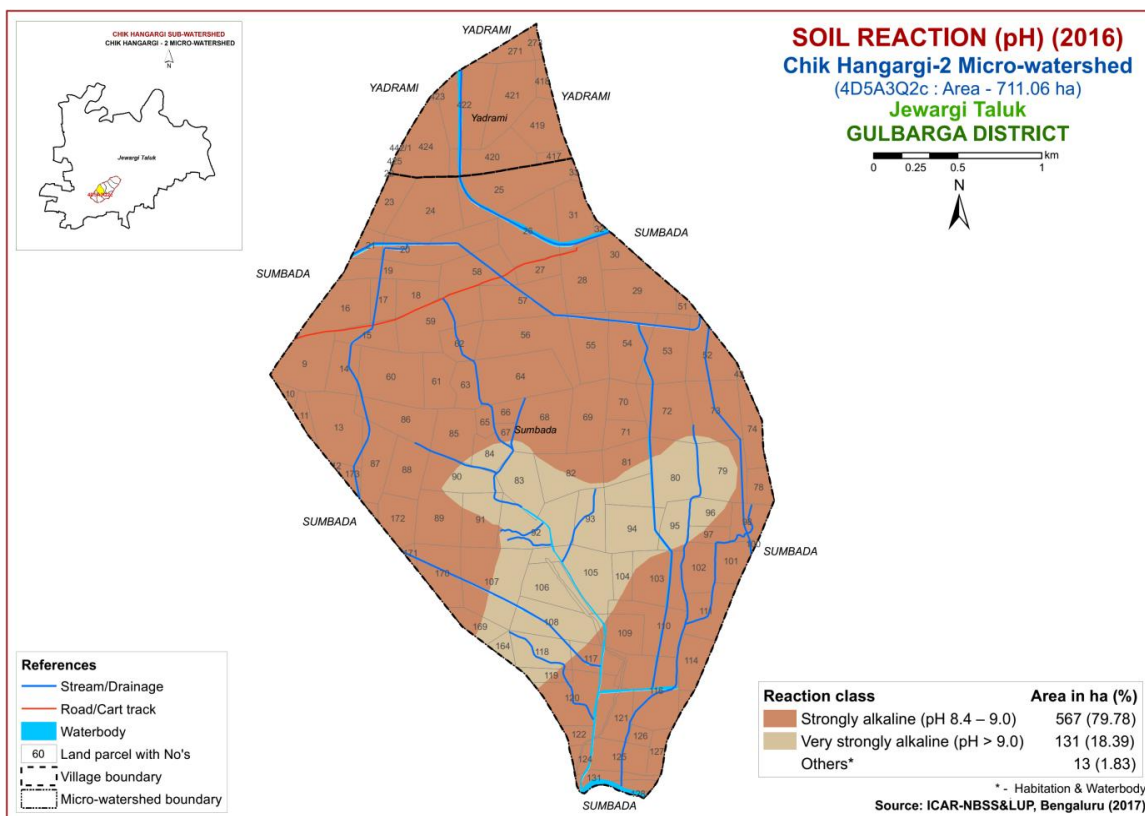
Fig.6.1 Soil Reaction (pH) map of Chik Hangargi-2 Microwatershed
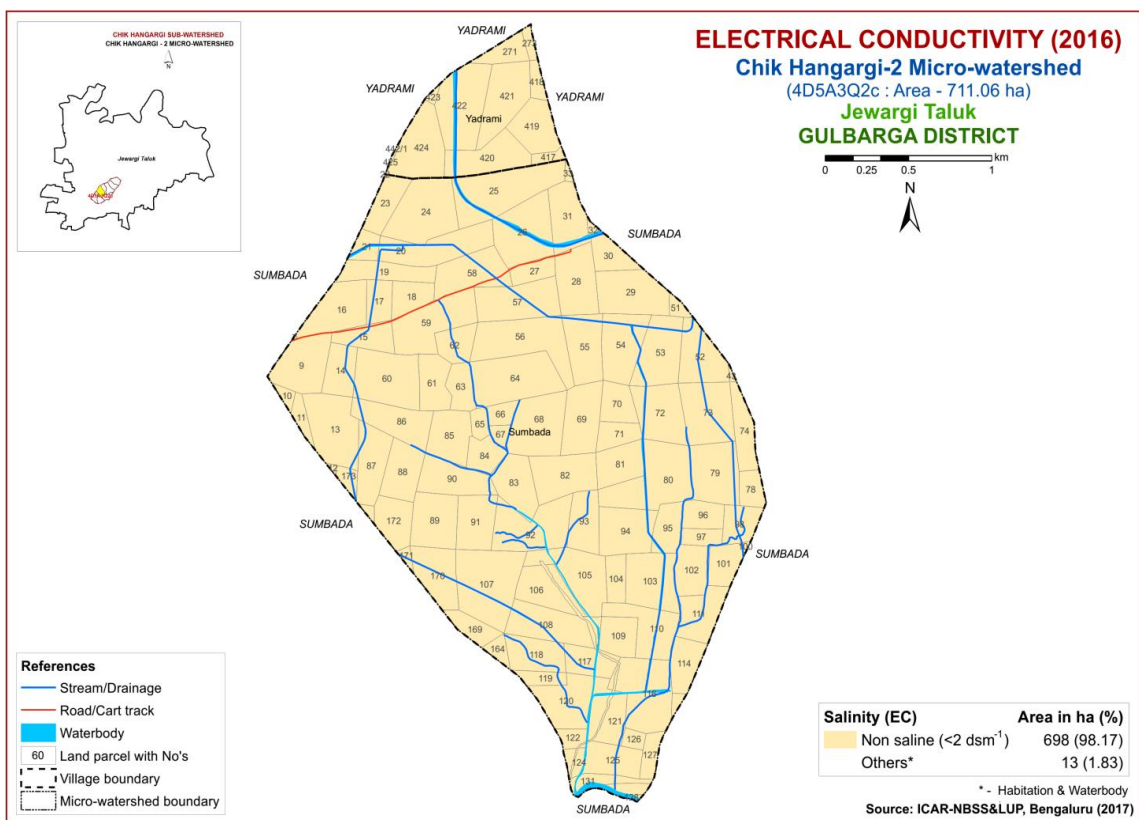
Fig.6.2 Electrical Conductivity (EC) map of Chik Hangargi-2 Microwatershed

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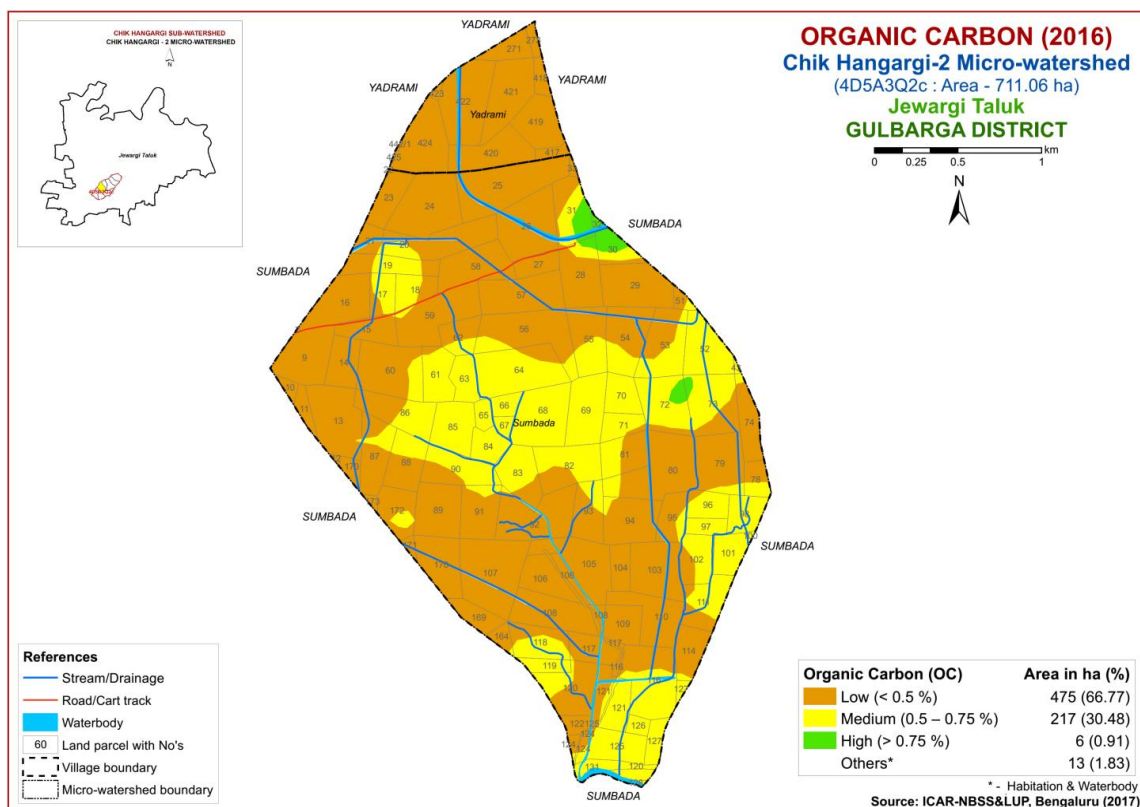
Fig.6.3 Soil Organic Carbon map of Chik Hangargi-2 Microwatershed
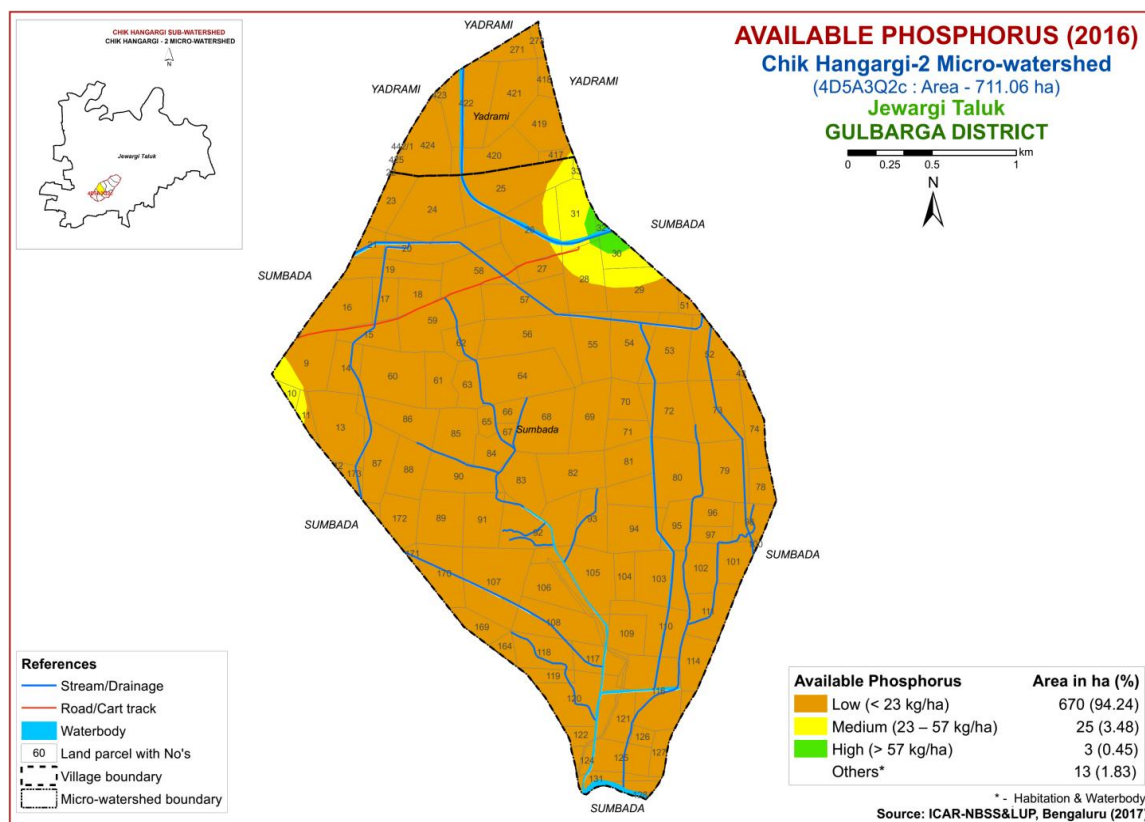
Fig.6.4 Soil Available Phosphorus map of Chik Hangargi-2 Microwatershed

6.5 Available Potassium

It is high in available potassium (>337 kg/ ha) in maximum area of 539 ha (76%) and is distributed in all parts of the microwatershed and medium (145-337 kg/ha) in about 159 ha (22%) area and occur in the northern, northwestern and a small area of southwestern part of the microwatershed (Fig. 6.5).

6.6 Available Sulphur

Available sulphur content is medium (10-20 ppm) in an area of about 502 ha (70%) and are distributed in the major part of the microwatershed. An area of about 108 ha (15%) is high (>20 ppm) in available sulphur and are distributed in the eastern, central, southwestern and nothrthwestern part of the microwatershed. An area of 88 ha (12%) is low (<10 ppm) in available sulphur (Fig. 6.6) and is distributed in the south, west and northern part of the microwatershed.

6.7 Available Boron

Available boron content is medium (0.5-1.0 ppm) in maximum area of 596 ha (84%) in the microwatershed and is distributed in the major part of the microwatershed. An area of about 94 ha (13%) is low (<0.5 ppm) in available boron and are distributed in the southwestern and northern part of the microwatershed (Fig. 6.7).

6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in major area and is distributed in the all parts of the microwatershed. An area of about 25 ha (4%) is deficient (<4.5 ppm) and distributed in the northwest part of the microwaterhsed (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).

6.11 Available Zinc

Available zinc content is deficient (<0.6 ppm) in 540 ha (76%) and are distributed in all parts of the microwaterhsed and about 158 ha (22%) is sufficient (>0.6 ppm) in available zinc and are distributed in the central, weststern and eastern part of the microwaterhsed (Fig 6.11).
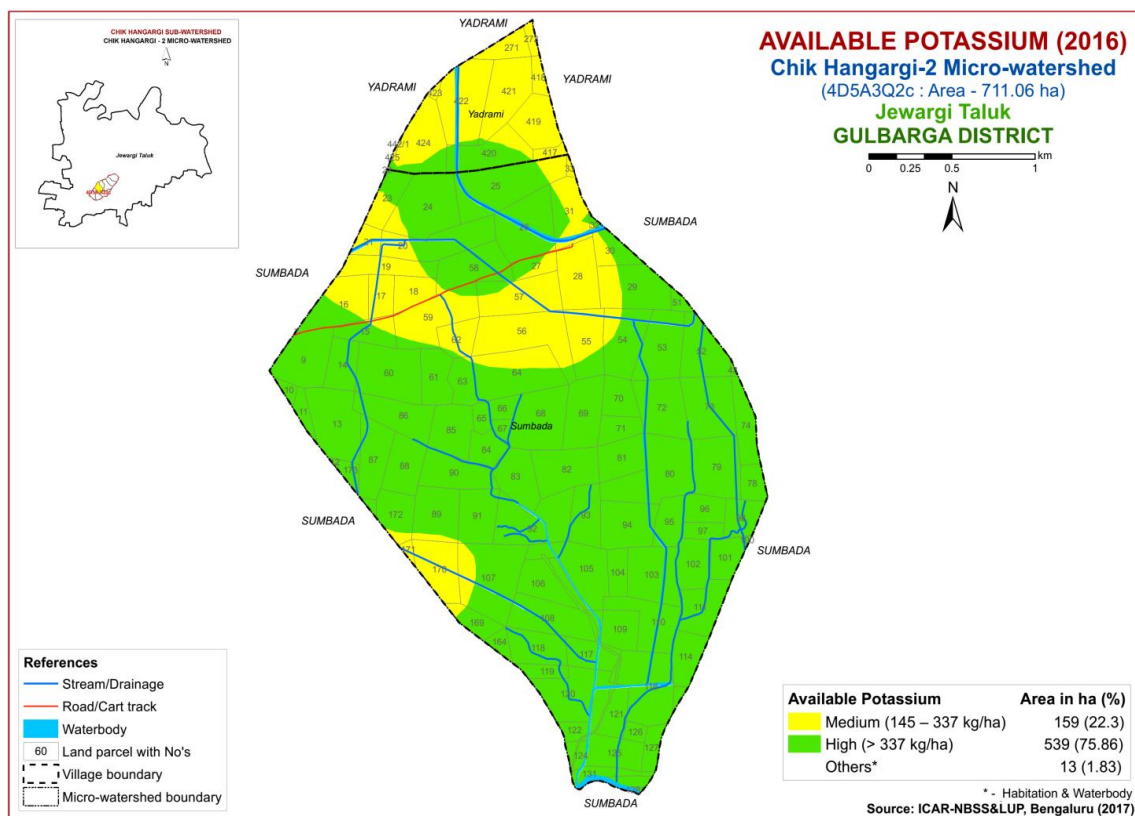
Fig.6.5 Soil Available Potassium map of Chik Hangargi-2 Microwatershed
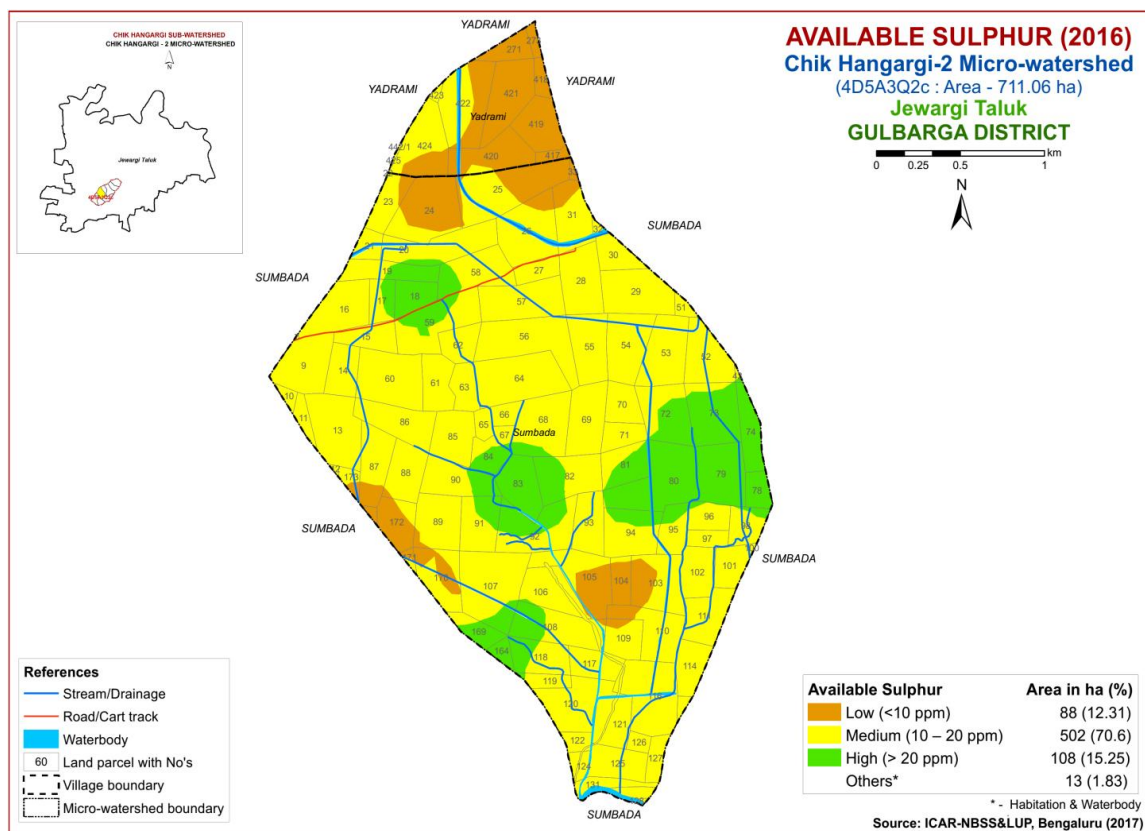
Fig.6.6 Soil Available Sulphur map of Chik Hangargi-2 Microwatershed
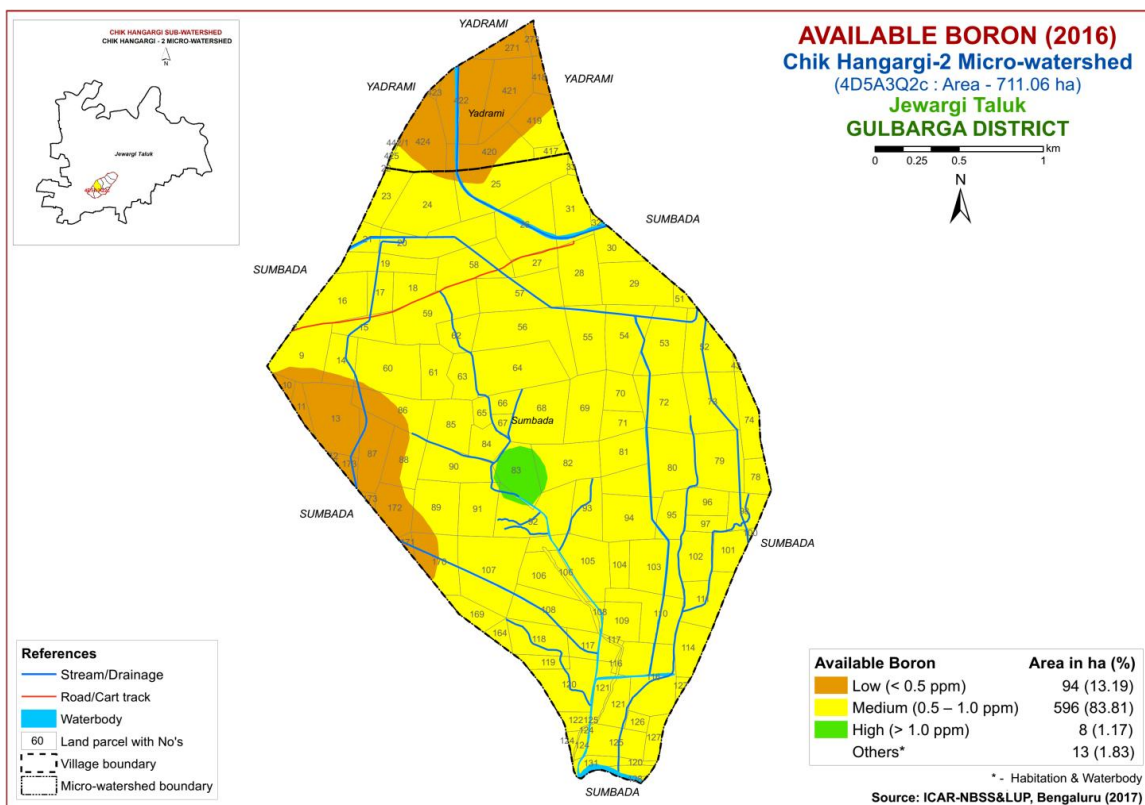
Fig.6.7 Soil Available Boron map of Chik Hangargi-2 Microwatershed
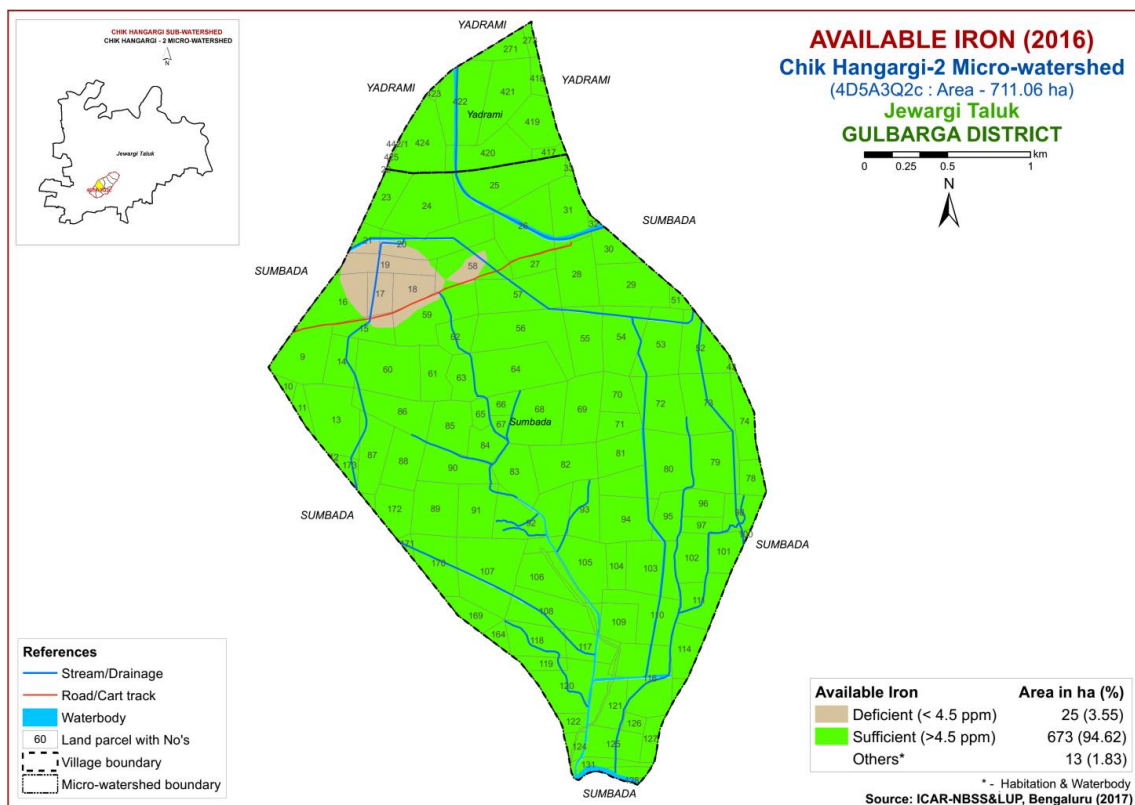
Fig.6.8 Soil Available Iron map of Chik Hangargi-2 Microwatershed
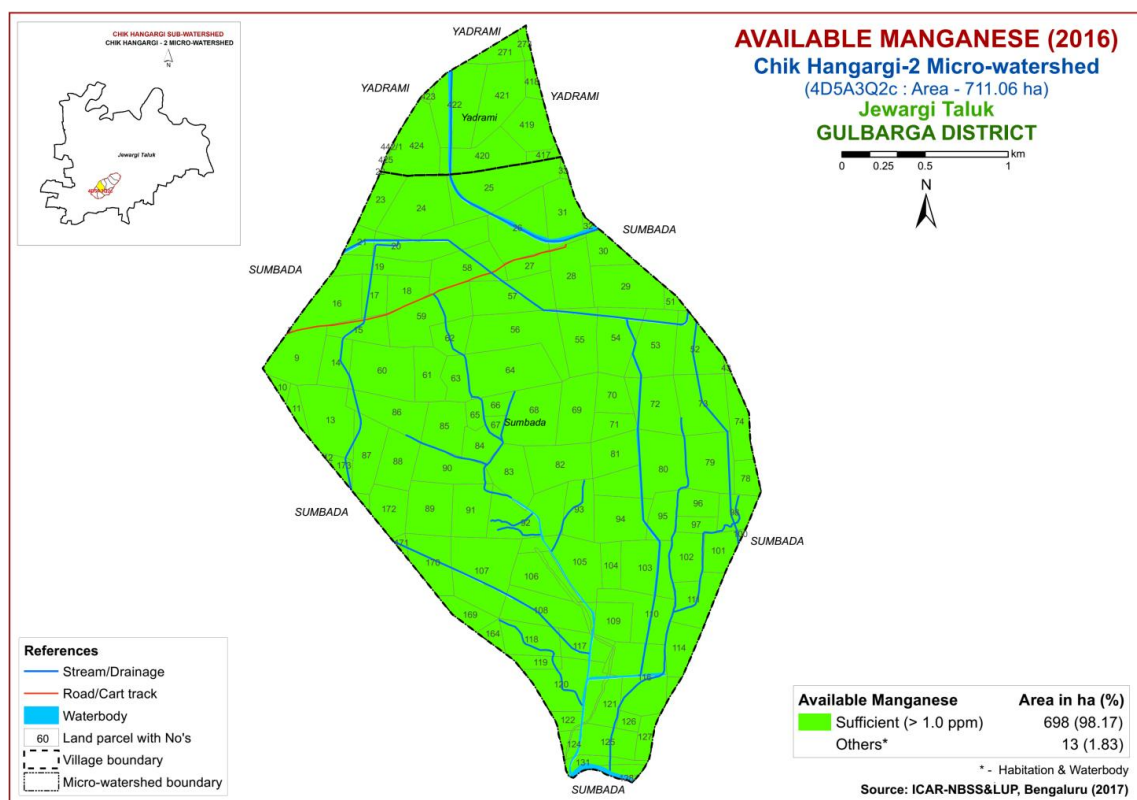
Fig.6.9 Soil Available Manganese map of Chik Hangargi-2 Microwatershed
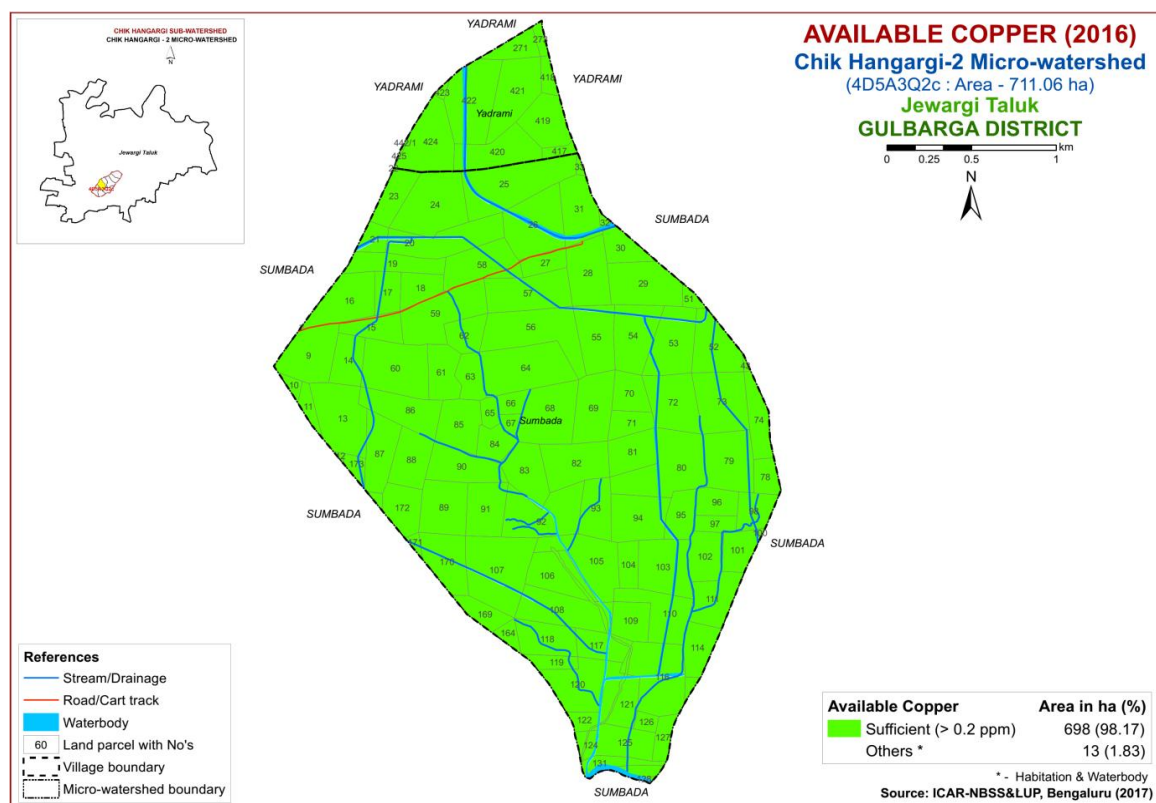
Fig.6.10 Soil Available Copper map of Chik Hangargi-2 Microwatershed
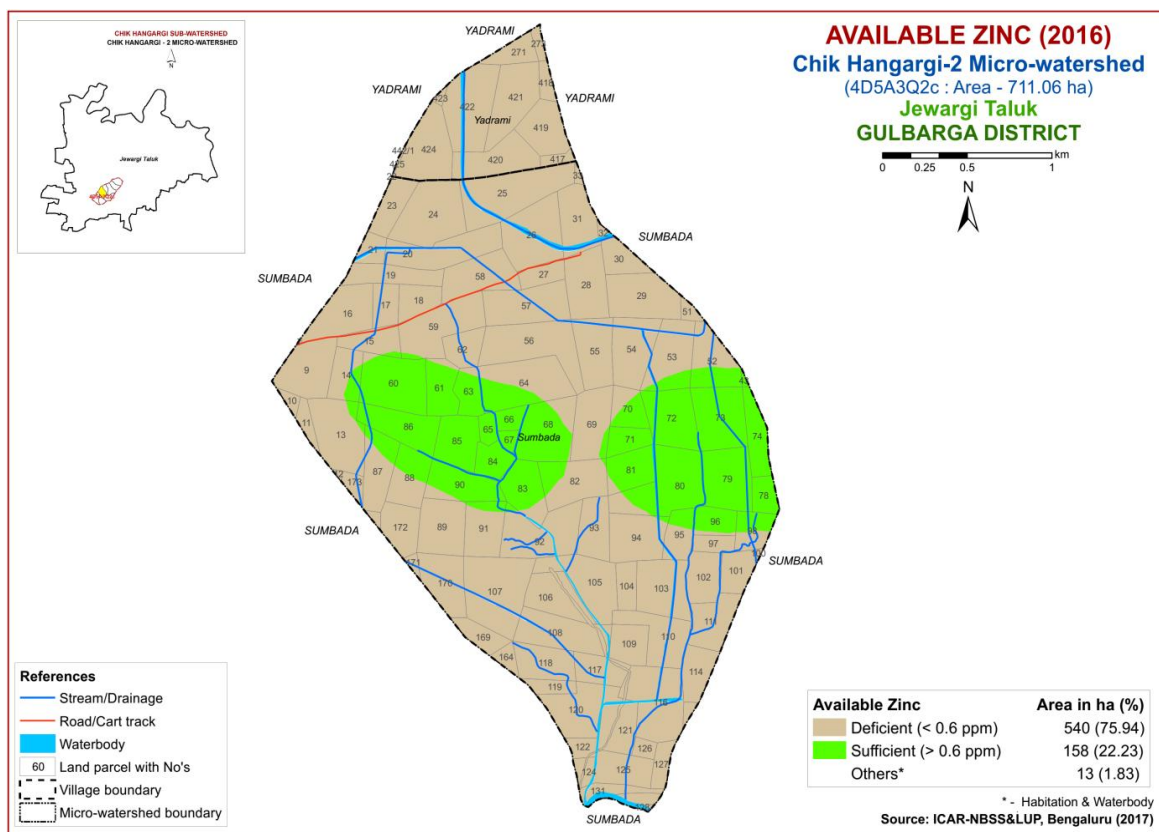
Fig.6.11 Soil Available Zinc map of Chik Hangargi-2 Microwatershed

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Chik Hangargi-2 microwatershed were assessed for their suitability for growing food, fodder, fibre and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S-Suitable and Order N-Not suitable. The orders have classes, subclasses and units. Order-S has three classes, Class S1- Highly Suitable, Class S2- Moderately Suitable and Class S3- Marginally Suitable. Order N has two classes, N1- Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the Class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability and 'w' for drainage and 'z' for calcareousness. 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 19 major agricultural and horticultural crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-III.

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

Sorghum is one of the major crops grown in Karnataka in an area of 10.47 lakh ha in Bijapur, Gulbarga, Raichur, Bidar, Belgaum, Dharwad, Bellary, Chitradurga, Mysore and 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

Table 7.1 Soil-Site Characteristics of Chik Hangargi-2 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drai-nage class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC (dS m-1)	ESP (%)	CEC [Cmol (p+) kg-1]	BS (%)
					Surf-ace	Sub-surface	Surf-ace (%)	Sub-surface (%)								
MGTmB2	751	150	MWD	<25	c	c	-	<15	<50	1-3	moderate	7.12	0.19	0.35	46.32	100
MGTmC1	751	150	MWD	<25	c	c	-	<15	<50	3-5	Slight	7.12	0.19	0.35	46.32	100
NHAmB1	751	150	MWD	25-50	c	c	-	<15	51-100	1-3	Slight	7.42	0.16	0.58	59.81	100
NHAmB2	751	150	MWD	25-50	c	c	-	<15	51-100	1-3	moderate	7.42	0.16	0.58	59.81	100
NHAmB3	751	150	MWD	25-50	c	c	-	<15	51-100	1-3	Severe	7.42	0.16	0.58	59.81	100
DIMmB1	751	150	MWD	100-150	c	c	-	<15	101-150	1-3	Slight	8.27	3.07	31.32	64.04	100
DIMmB2	751	150	MWD	100-150					101-150	1-3	moderate	8.27	3.07	31.32	64.04	100
MARmB1	751	150	MWD	>150	c	c	-	<15	>200	1-3	Slight	8.63	2.41	33.40	65.77	100

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

microwatershed are given in Figure. 7.1. An area of about 186 ha (26%) is highly suitable (Class S1) for growing sorghum and are distributed in the southeastern part of the microwatershed. Major areas with marginally suitable (S3) occur in about 235 ha (33%) and are distributed in the northern, northeastern, western, southwestern and central part of microwastershed. They have moderate limitations of rooting depth and erosion. Maximum area of about 277 ha (39%) is not suitable (N) for growing sorghum crop.

Table 7.2 Crop suitability criteria for Sorghum

Crop requirement		Rating			
Soil-site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	2-3	3-8	8-15	>15
LGP	Days	120-150	120-90	<90	
Soil drainage	class	Well to mod.Well drained	imperfect	Poorly/excessively	V. poorly
Soil reaction	pH	6.0-8.0	5.5-5.98.1-8.5	<5.58.6-9.0	>9.0
Surface soil texture	Class	C, cl, sicl, sc	l, sil, sic	Sl, ls	S, fragmental skeletal
Soil depth	Cm	100-75	50-75	30-50	<30
Gravel content	% vol.	5-15	15-30	30-60	>60
Salinity (EC)	dS m^{-1}	2-4	4-8	8-10	>10
Sodicity (ESP)	%	5-8	8-10	10-15	>15
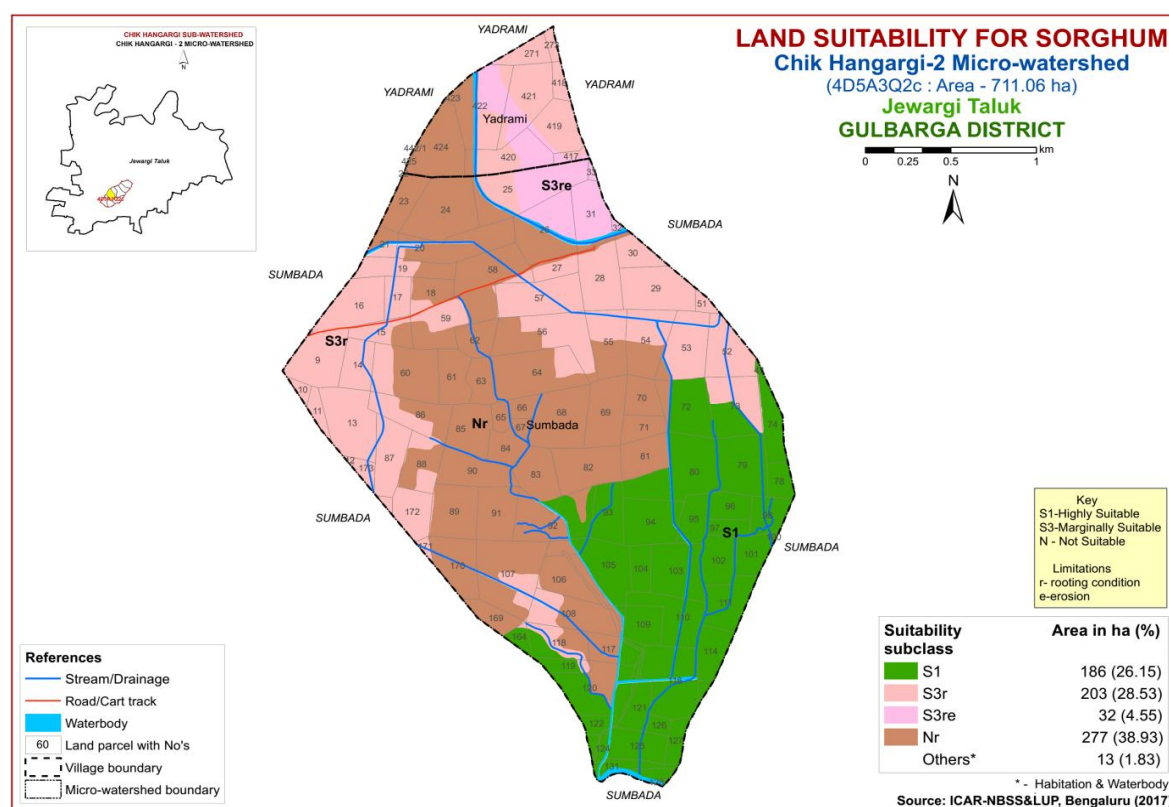
Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

Table 7.3 Crop suitability criteria for Maize

Crop requirement		Rating			
Soil–site characteristics	Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	<3	3.5	5-8	
LGP	Days	>100	100-80	60-80	
Soil drainage	Class	Well drained	Mod. to imperfectly	Poorly/excessively	V.poorly
Soil reaction	pH	5.5-7.5	7.6-8.5	8.6-9.0	
Surface soil texture	Class	l, cl, scl, sil	Sl, sicl, sic	C(s-s), ls	S,fragmental
Soil depth	Cm	>75	50-75	25-50	<25
Gravel content	% vol.	<15	15-35	35-50	>50
Salinity (EC)	dS m^{-1}	<1.0	1.0-2.0	2.0-4.0	
Sodicity (ESP)	%	<10	10-15	>15	
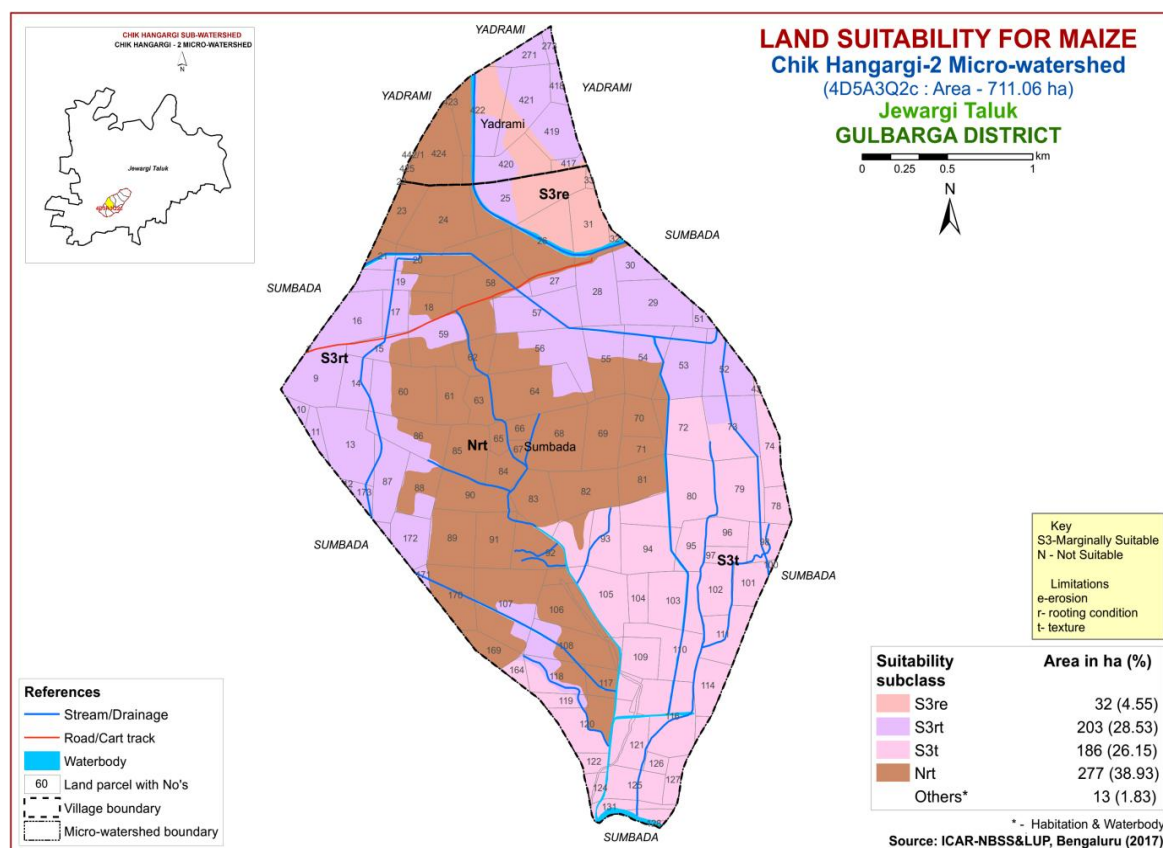
Fig. 7.2 Land Suitability map of Maize

No highly and moderately suitable lands are available for growing maize in the microwaterhsed. An area of about 421 ha (59%) is marginally suitable (Class S3) for growing maize and are distributed in all parts of the microwatershed. They have moderate limitations of rooting depth and erosion. Maximum area of about 277 ha (39%) is not suitable (N) for growing maize crop.

7.3 Land Suitability for Redgram (*Cajanus cajan*)

Redgram is the most important pulse crop grown in an area of 8.23 lakh ha in almost all the districts of the State. The crop requirements for growing redgram (Table 7.3) 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 7.3.

An area of about of 186 ha (26%) is under moderately suitable (Class S2) for growing redgram and occur in the notheastern, northern, western and southwestern part of the microwatershed. They have minor limitations of texture, rooting depth and erosion. Marginally suitable (class S3) lands are found to occur in an area of 235 ha (33%) and are distributed in the southeastern part of the microwatershed. Maximum area of about 277 ha (39%) is not suitable (N) for growing redgram crop.

Table 7.4 Land suitability criteria for Red gram

Crop requirement		Rating			
Soil –site characteristics	Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	<3	3-5	5-10	>10
LGP	Days	>210	180-210	150-180	<150
Soil drainage	class	Well drained	Mod. well drained	Imperfectly drained	Poorly drained
Soil reaction	pH	6.5-7.5	5.0-6.5 7.6-8.0	8.0-9.0	>9.0
Sub Surface soil texture	Class	l, scl, sil, cl, sl	sicl, sic, c(m)	ls	
Soil depth	Cm	>100	75-100	50-75	<50
Gravel content	% vol.	<15	15-35	3-60	>60
Salinity (EC)	dS m^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	
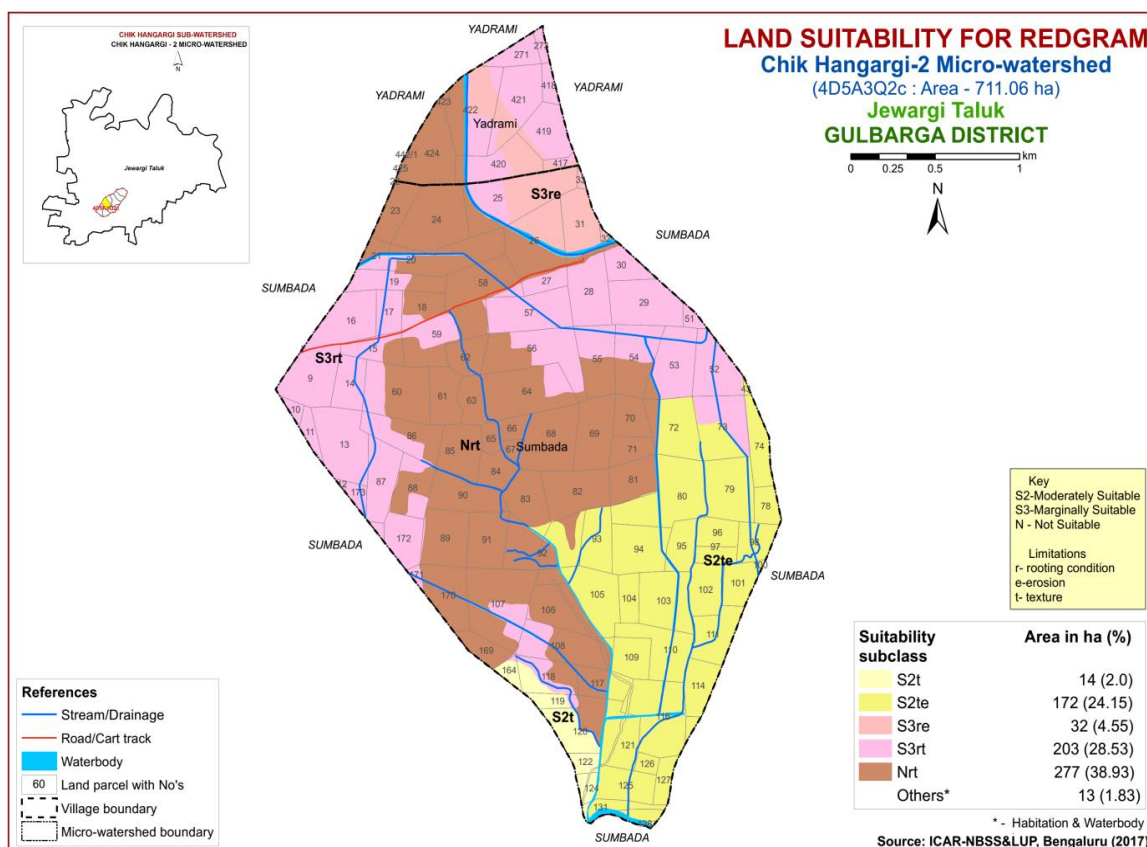
Fig. 7.3 Land Suitability map of Redgram

7.4 Land Suitability for Soybean (*Glycine max*)

Soybean is the most important pulse and oil seed crop grown in about 2.56 lakh ha area in Bijapur, Raichur, Kalaburgi, Dharwad, Belgaum and Bellary districts. The crop requirements for growing soybean were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing soybean was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.4.

Highly suitable (Class S1) lands are found to occur in very small area of 14 ha (2%) and are distributed in the southwestern part of the microwatershed. An area about of 172 ha (24%) is under moderately suitable (Class S2) for growing soybean and occur in the southeastern part of the microwatershed. Marginally suitable (Class S3) lands are found to occur in an entire area of 235 ha (33%) and are distributed in the southwestern, northern and northeastern part of the microwatershed. They have moderate limitations of rooting depth and erosion for growing soybean. Maximum area of about 277 ha (39%) is not suitable (N) for growing soybean crop.
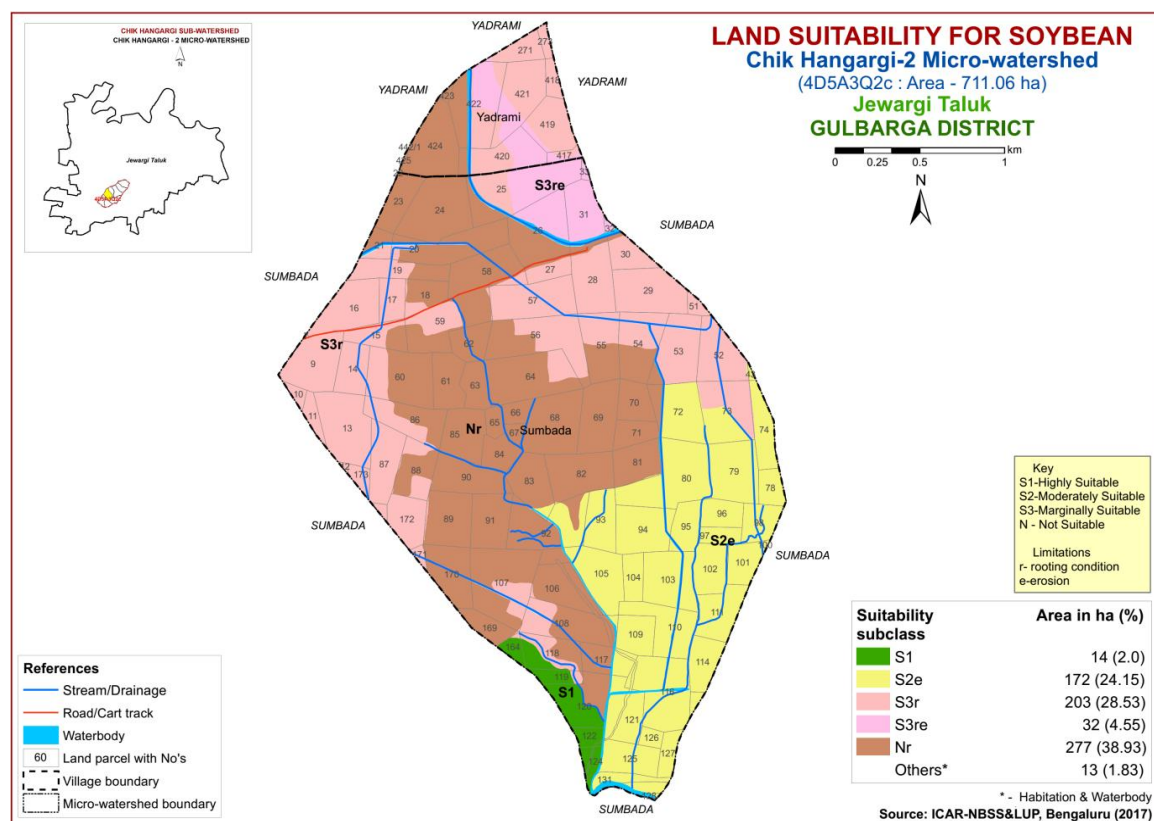
Fig. 7.4 Land Suitability map of Soybean

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 7.5) 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.

Table 7.5 Crop suitability criteria for Bengal gram

Crop requirement		Rating			
Soil–site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable(N)
Slope	%	<3	3-5	5-10	>10
LGP	Days	>100	90-100	70-90	<70
Soil drainage	class	Well drained	Mod. to well drained; Imperfectly drained	Poorly drained; excessively drained	Very Poorly drained
Soil reaction	pH	6.0-7.5	5.5-5.77.6-8.0	8.1-9.0;4.5-5.4	>9.0
Surface soil texture	Class	l, scl, sil, cl,	sicl, sic, c	Sl, c>60%	S, fragmental
Soil depth	Cm	>75	51-75	25-50	<25
Gravel content	% vol.	<15	15-35	35-60	>60
Salinity (EC)	dS m^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

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Fig. 7.5 Land Suitability map of Bengalgram

An area about of 186 ha (26%) is under highly suitable (Class S1) for growing bengalgram and occur in the southestern part of the microwatershed. Moderately suitable (Class S2) lands are found to occur in an area of 235 ha (33%) and are distributed in the western, northern and northestern part of the microwatershed. They have minor limitation of rooting depth. Marginally suitable (Class S3) lands are found to occur in an area of 277 ha (39%) and are distributed in the northwestern, central and southwestern part of the microwatershed. They have moderate limitations of rooting depth for growing bengalgram.

7.6 Land Suitability for Sunflower (*Helianthus annus*)

Sunflower is the most important oilseed crop grown in an area of 3.56 lakh ha in the State in all the districts. The crop requirements for growing sunflower (Table 7.6) 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 micro watershed is given in Figure 7.6.

An area of about 186 ha (26%) is highly suitable (Class S1) for growing sunflower and are distributed in the southeastern and a small area in the southwestern part of the microwatershed. They have minor or no limitations for growing Sunflower. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing sunflower crop.

Table 7.6 Crop suitability criteria for Sunflower

Crop requirement		Rating			
Soil–site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	<3	3-5	5-10	>10
LGP	Days	>90	80-90	70-80	<70
Soil drainage	class	Well drained	Mod. well rained	Imperfectly drained	Poorly drained
Soil reaction	pH	6.5-8.0	8.1-8.55.5-6.4	8.6-9.0;4.5-5.4	>9.0<4.5
Surface soil texture	Class	l, cl, sil, sc	Scl, sic, c,	c (>60%), sl	ls, s
Soil depth	Cm	>100	75-100	50-75	<50
Gravel content	% vol.	<15	15-35	35-60	>60
Salinity (EC)	dS m^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	
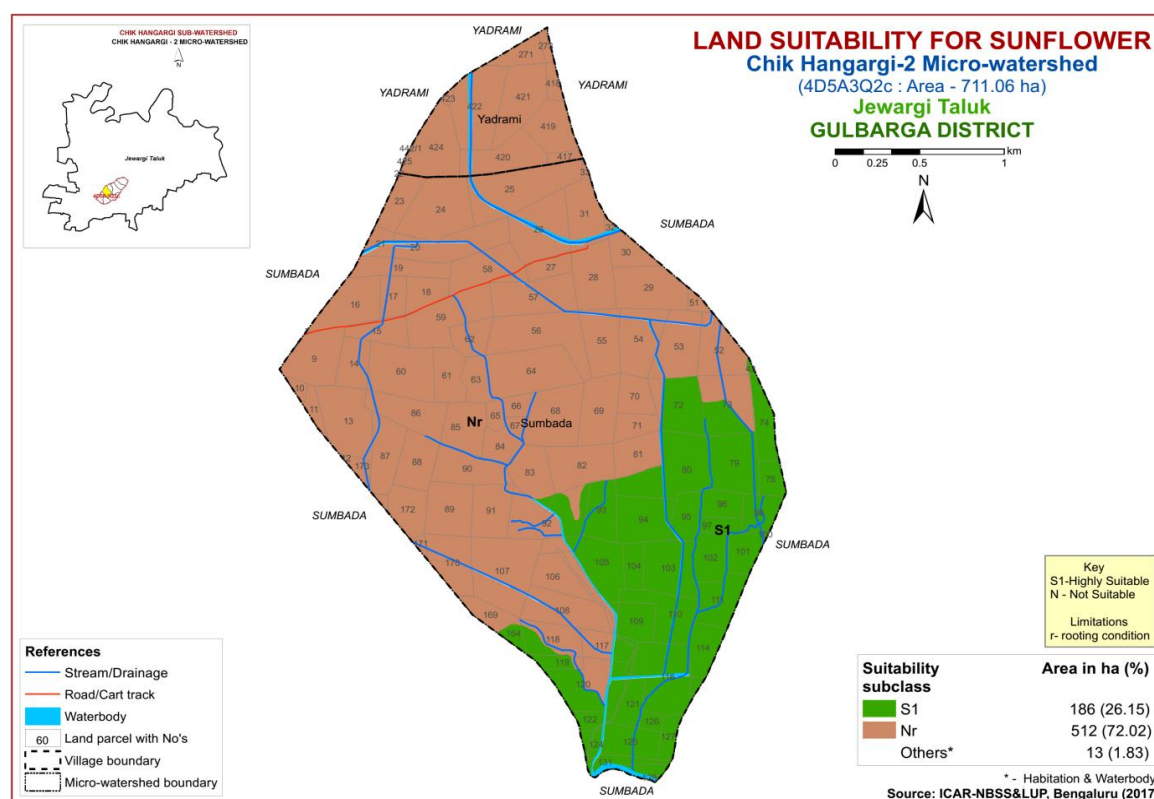
Fig. 7.6 Land Suitability map of Sunflower

7.7 Land Suitability for Cotton (*Gossypium hirsutum*)

Cotton is 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 7.7) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cotton was generated and the area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.7.

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An area is about 186 ha (26%) has soils that are highly suitable (Class S1) for cotton and are distributed in the southeastern part of the microwatershed with minor or no limitations for growing cotton. Marginally suitable (class S3) lands are found to occur in an area of 235 ha (33%) and are distributed in the northesatern and western, small patches in the southwestern part of the microwatershed. They have moderate limitations of rooting depth and erosion for growing cotton. Maximum area of about 277 ha (39%) is not suitable (Class N) for growing cotton crop.

Table 7.7 Crop suitability criteria for Cotton

Crop requirement		Rating			
Soil–site characteristics	Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable(S3)	Not suitable (N)
Slope	%	1-2	2-3	3-5	>5
LGP	Days	180-240	120-180	<120	
Soil drainage	class	Well to moderately well	Imperfectly drained	Poor somewhat excessive	Stagnant/ Excessive
Soil reaction	pH	6.5-7.5	7.6-8.0	8.1-9.0	>9.0>6.5
Surface soil texture	Class	Sic, c	Sicl, cl	Si, sil, sc, scl, l	Sl, s,ls
Soil depth	Cm	100-150	60-100	30-60	<30
Gravel content	% vol.	<5	5-10	10-15	15-35
$CaCO_3$ in root zone	%	<3	3-5	5-10	10-20
Salinity (EC)	dS m^{-1}	2-4	4.0-8.0	8.0-12	>12
Sodicity (ESP)	%	5-10	10-20	20-30	>30
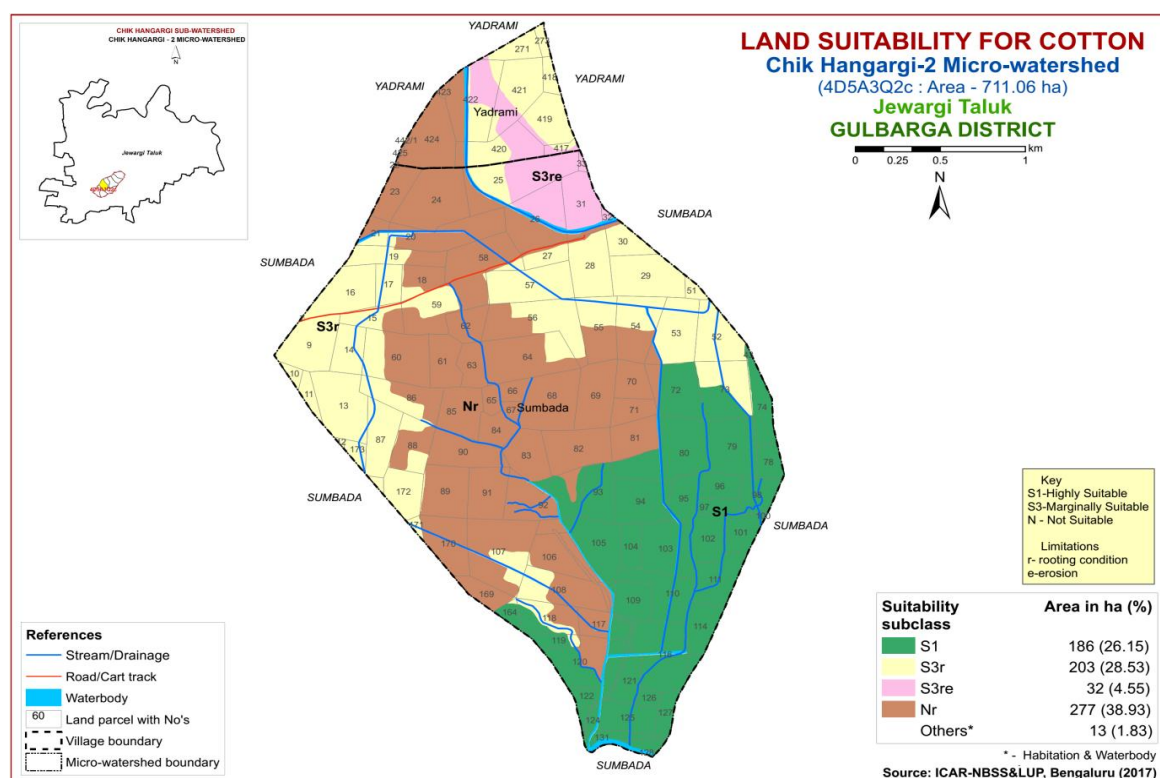
Fig. 7.7 Land Suitability map of Cotton

7.8 Land Suitability for Sugarcane (*Saccharum officinarum*)

Sugarcane is the most important commercial crop grown in 6.91 lakh ha area in Kalaburgi, Bijapur, Bagalkot, Bidar, Mysore, Chamarajanagar and Mandya districts. The crop requirements for growing sugarcane (Table 7.8) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sugarcane was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.8.

No highly and moderately suitable lands are available for growing sugarcane in the microwaterhsed. The marginally suitable (Class S3) lands cover an area of about 186 ha (26%) and mainly occur in the southeastern part of the microwatershed. They have moderate limitations of texture. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing sugarcane crop.

Table 7.8 Crop suitability criteria for Sugarcane

Crop requirement		Rating			
Soil–site characteristics	**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Slope	%	<3	3-5	5-8	>8
Soil drainage	class	Well drained	Mod./imperfectly drained	Poorly drained	V.poor/excessively drained
Soil reaction	pH	7.0-8.0	6.0-6.9 8.1-9.0	4.0-5.9 9.1-9.5	<4.0/ >9.5
Surface soil texture	Class	l, cl, sil, sicl	C(m/k), sl	C+(ss)	
Soil depth	cm	>100	100-75	75-50	<50
stoniness	%	<15	15-35	35-50	>50
Salinity (EC)	dS m^{-1}	<2.0	2.0-4.0	4.0-9.0	>9
Sodicity (ESP)	%	<10	10-15	15-25	>25
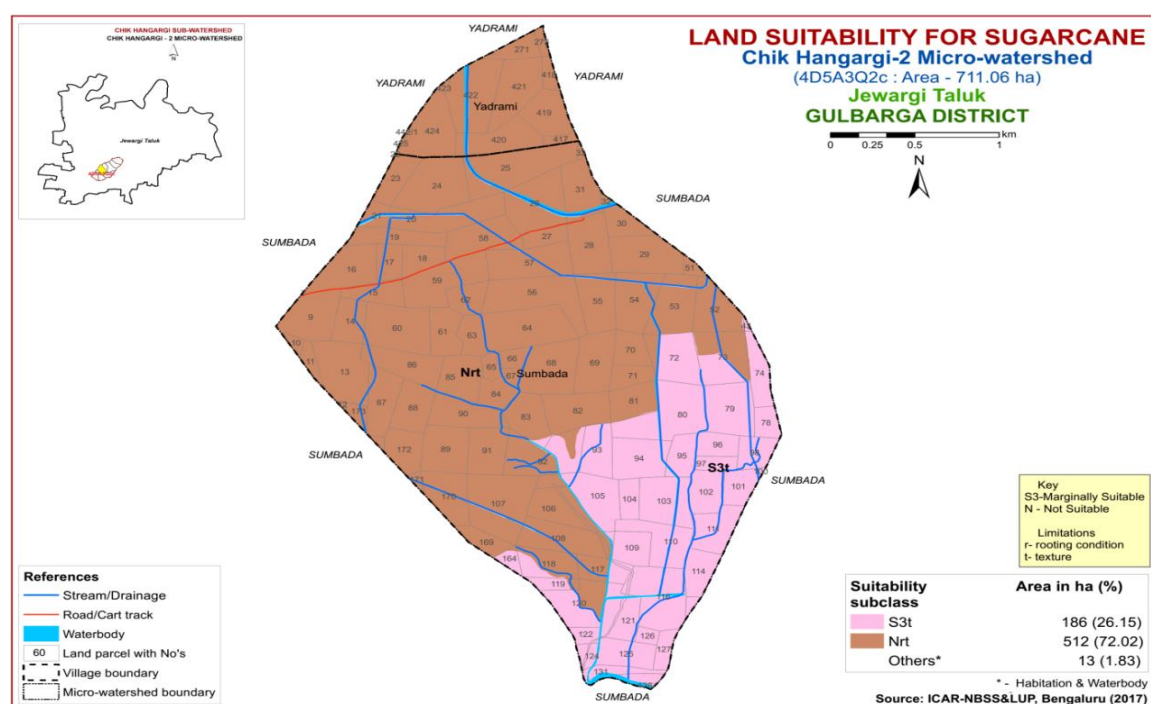
Fig. 7.8 Land Suitability map of Sugarcane

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7.9 Land suitability for Mango (*Mangifera indica*)

　　Mango is the most important fruit crop grown in an area of about 1.73 lakh ha in almost all the districts of the State. The crop requirements (Table 7.9) 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 geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.9.

　　No highly and moderately suitable lands are available for growing mango in the microwaterhsed. The marginally suitable (Class S3) lands cover an area of about 186 ha (26%) and are distributed in the southeastern part of the microwatershed. They have moderate limitation of texture. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing mango crop.

Table 7.9 Crop suitability criteria for Mango

Crop requirement			Rating			
Soil-site characteristics		Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climate	Temp. in growing season	^{0}C	28-32	24-27 33-35	36-40	20-24
	Min. temp. before flowering	^{0}C	10-15	15-22	>22	
Soil moisture	Growing period	Days	>180	150-180	120-150	<120
Soil aeration	Soil drainage	class	Well drained	Mod. To imperfectly drained	Poor drained	Very poorly drained
	Water table	M	>3	2.50-3.0	2.5-1.5	<1.5
Nutrient availability	Texture	Class	Sc, l, sil, cl	Sl, sc, sic, l, c	C (<60%)	C (>60%),
	pH	1:2.5	5.5-7.5	7.6-8.5, 5.0-5.4	8.6-9.0, 4.0-4.9	>9.0,<4.0
	OC	%	High	medium	low	
	CaCO$_3$ in root zone	%	Non calcareous	<5	5-10	>10
Rooting conditions	Soil depth	cm	>200	125-200	75-125	<75
	Gravel content	%vol	Non-gravelly	<15	15-35	>35
Soil toxicity	Salinity	dS m^{-1}	Non saline	<2.0	2.0-3.0	>3.0
	Sodicity	%	Non sodic	<10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	
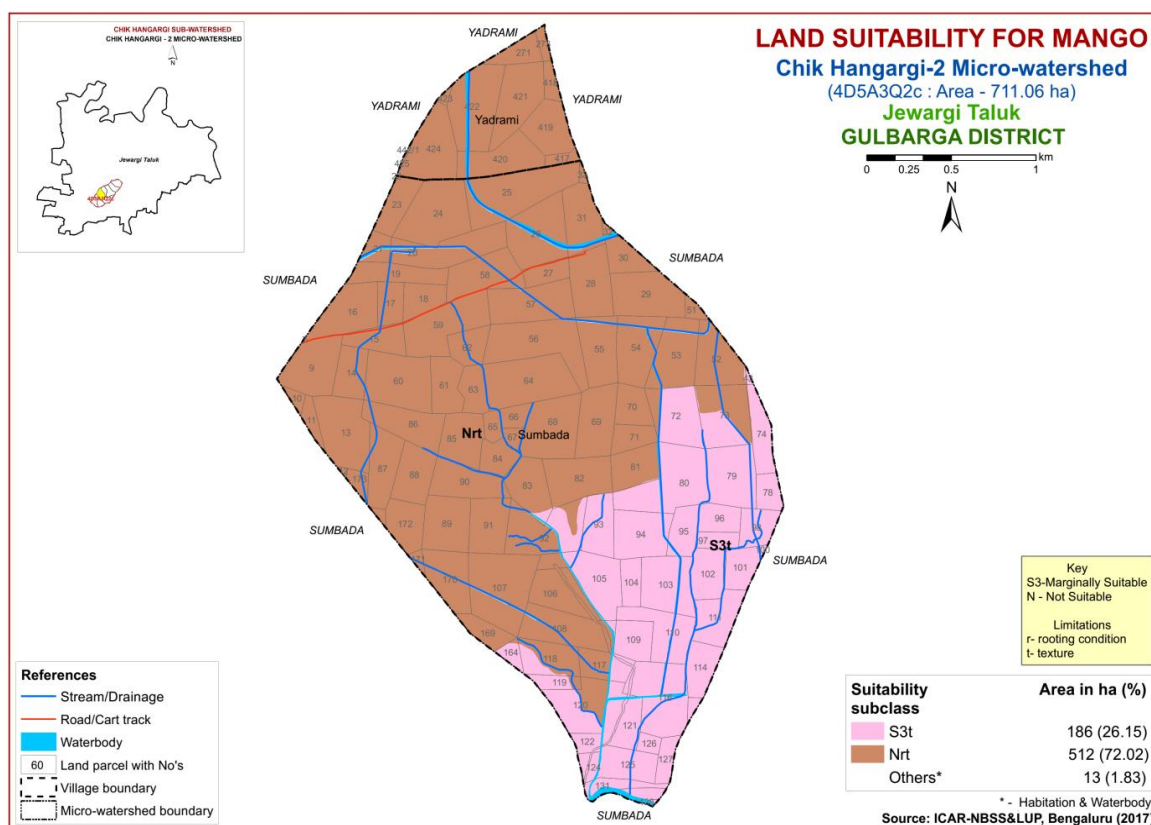
Fig. 7.9 Land Suitability map of Mango

7.10 Land suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in an area of 29373 lakh ha in almost all the districts of the State. The crop requirements (Table 7.10) for growing sapota were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sapota was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.10.

No highly suitable lands are available for growing sapota in the microwaterhsed. A small area of 14 ha (2%) are moderately suitable (Class S2) and are distributed in the southwestern part of the microwatershed with minor limitation of texture. An area of about 172 ha (24%) is marginally suitable (Class S3) and are distributed in the southeastern part of microwatershed and they have moderate limitations of texture. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing sapota.

Table 7.10 Crop suitability criteria for Sapota

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climate	Temperature in growing season	^{0} C	28-32	33-36 24-27	37-42 20-23	>42 <18
Soil moisture	Growing period	Days	>150	120-150	90-120	<120
Soil aeration	Soil drainage	class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	Scl, l, cl, sil	Sl, sicl, sc	C (<60%)	ls, s, C (>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0 5.0-5.9	8.1-9.0 4.5-4.9	>9.0 <4.5
	$CaCO_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	Cm	>150	75-150	50-75	<50
	Gravel content	% vol.	Non gravelly	<15	15-35	<35
Soil toxicity	Salinity	dS m^{-1}	Non saline	Up to 1.0	1.0-2.0	2.0-4.0
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10
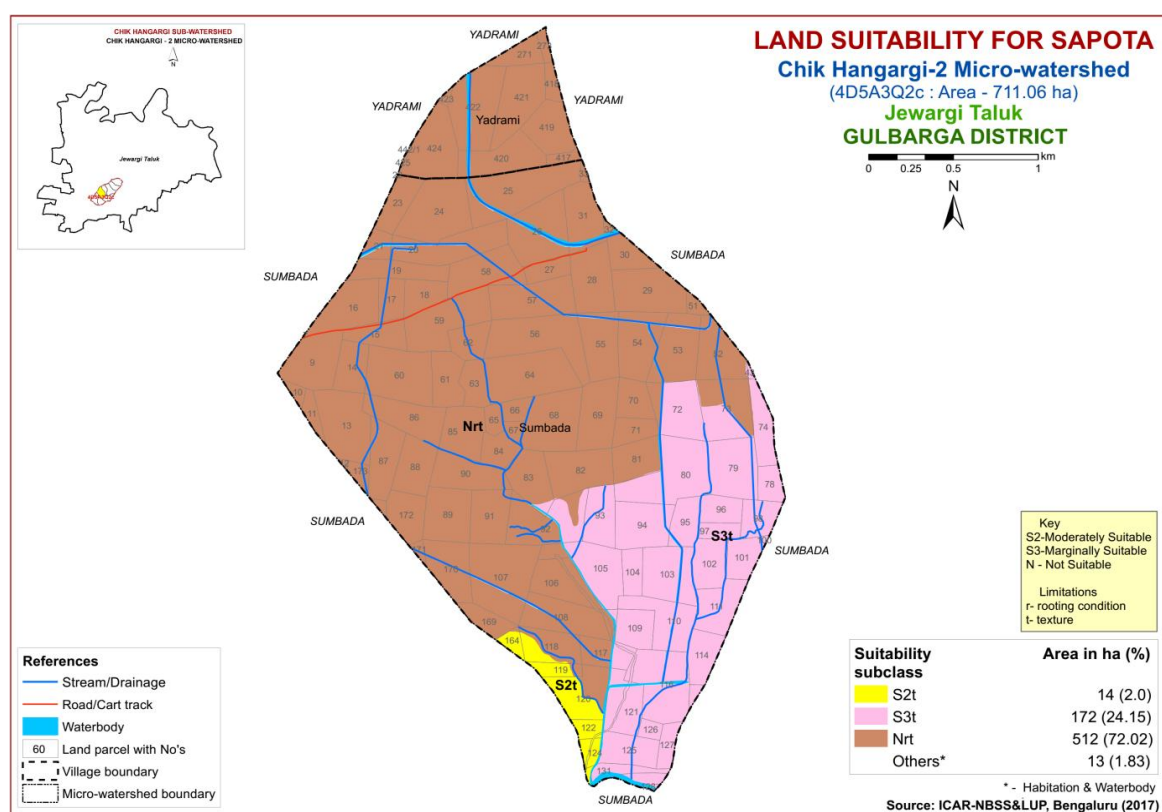
Fig. 7.10 Land Suitability map of Sapota

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7.11 Land suitability for Guava (*Psidium guajava*)

        Guava is the most important fruit crop grown in an area of 0.64 lakh ha in almost all the districts of the State. The crop requirements (Table 7.11) 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.11.

        No highly suitable lands are available for growing sapota in the microwaterhsed. A small area of 14 ha (2%) is moderately suitable (Class S2) and are distributed in the southwestern part and have minor limitation of texture. About 172 ha (24%) area is marginally suitable (S3) and distributed in the southeastern part of the microwatershed. They have moderate limitations of texture for growing guava. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing guava crop.

Table 7.11 Crop suitability criteria for Guava

Crop requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climate	Temperature in growing season	^{0}C	28-32	33-36 24-27	37-42 20-23	
Soil moisture	Growing period	Days	>150	120-150	90-120	<90
Soil aeration	Soil drainage	Class	Well drained	Mod. to imperfectly	poor	Very poor
Nutrient availability	Texture	Class	Scl, l, cl, sil	Sl,sicl,sic.,sc ,c	C (<60%)	C (>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0:5.0-5.9	8.1-8.5:4.5-4.9	>8.5:<4.5
	CaCO$_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	Cm	>100	75-100	50-75	<50
	Gravel content	% vol.	<15	15-35	>35	
Soil toxicity	Salinity	dS m^{-1}	<2.0	2.0-4.0	4.0-6.0	
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10
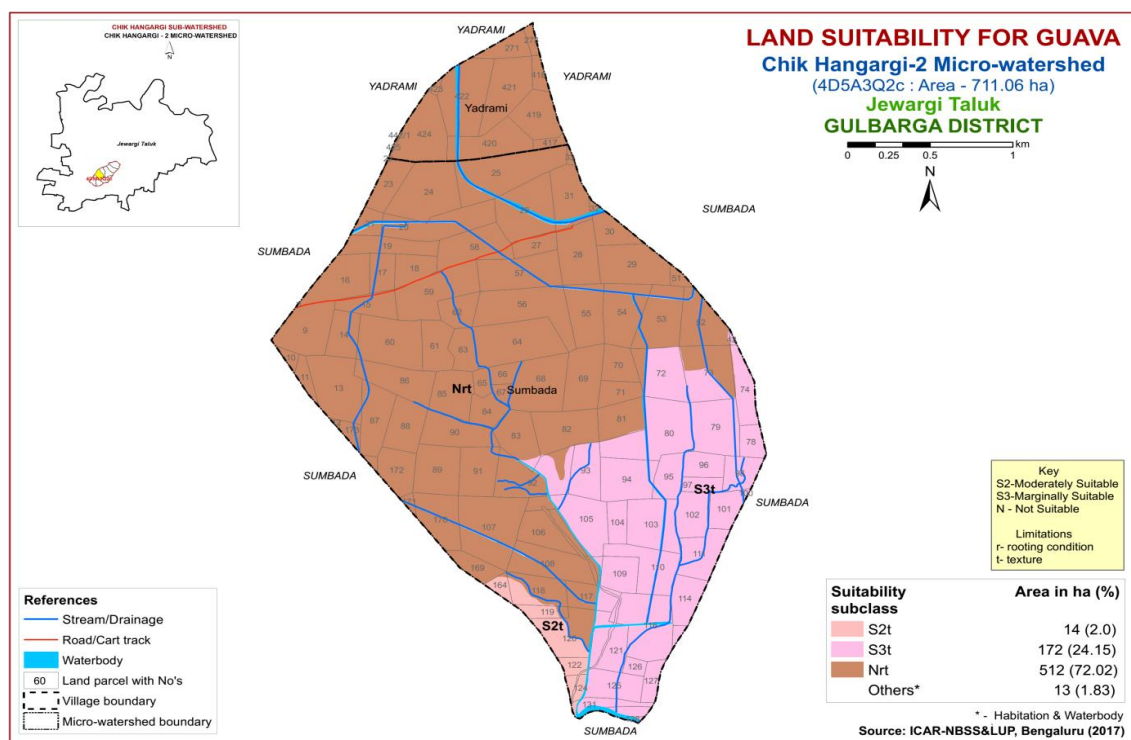
Fig. 7.11 Land Suitability map of Guava

7.12 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in almost all the districts o f the State. The crop requirements for growing jackfruit (Table 7.12) 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 7.12

No highly and moderately suitable lands are available for growing sapota in the microwaterhsed. Marginally suitable (Class S3) lands for growing jackfruit occupy an area of about 186 ha (26%) and are distributed in the southeastern part of the microwatershed. They have moderate limitations of texture. An area of about 512 ha (72%) is not suitable (Class N) for growing jackfuit crop.

Table 7.12 Crop suitability criteria for Jackfruit

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	class	well	Mod. well	Poorly	V. Poorly
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
Rooting conditions	Soil depth	Cm	>100	75-100	50-75	<50
	Gravel content	% vol.	<15	15-35	35-60	>60
Erosion	Slope	%	0-3	3-5	>5	-
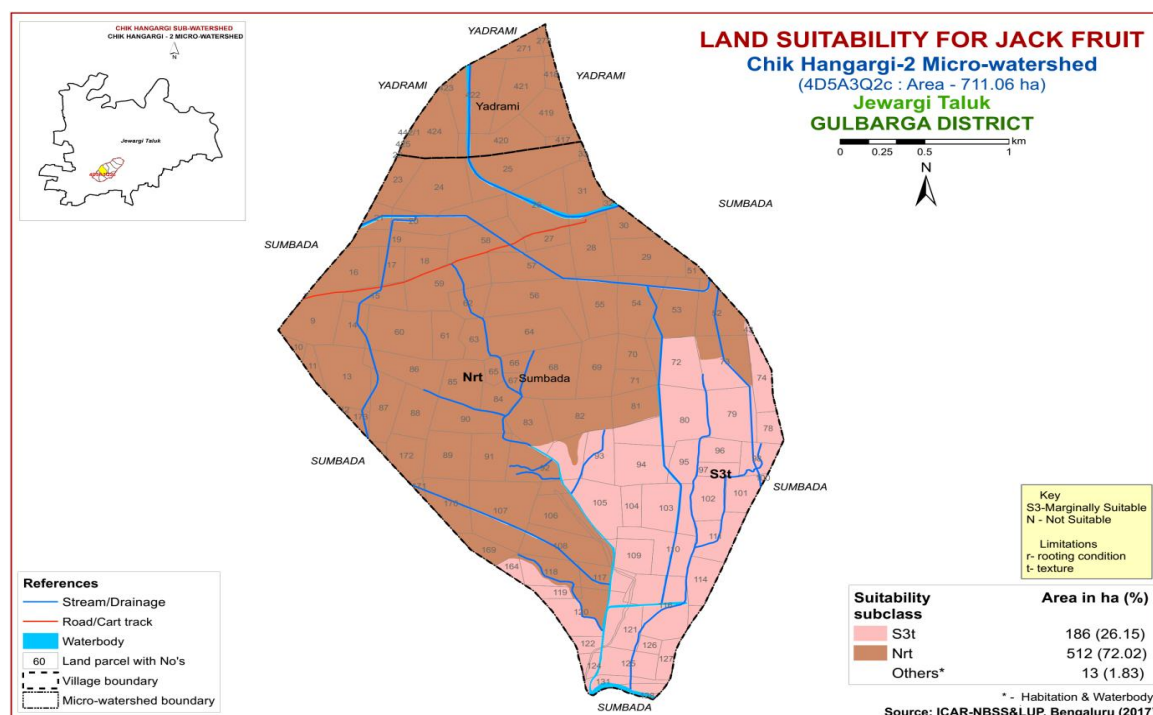
Fig. 7.12 Land Suitability map of Jackfruit

7.13 Land Suitability for Jamun (*Syzygium cumini*)

Jamun is an important fruit crop grown in almost all the districts of the State. The crop requirements for growing jamun (Table 7.13) were matched with the soil-site characteristics (Table 7.1) 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 7.13.

No highly suitable lands are available for growing sapota in the microwaterhsed. An area of 186 ha (26%) is moderately suitable (Class S2) for growing jamun and are distributed in the southwestern and southeastern part of the microwatershed. They have minor limitations of texture. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing this crop.

Table 7.13 Crop suitability criteria for Jamun

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	Class	Well	Mod. well	Poorly	V.Poorly
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
Rooting conditions	Soil depth	Cm	>150	100-150	50-100	<50
	Gravel content	% vol.	<15	15-35	35-60	>60
Erosion	Slope	%	0-3	3-5	5-10	>10

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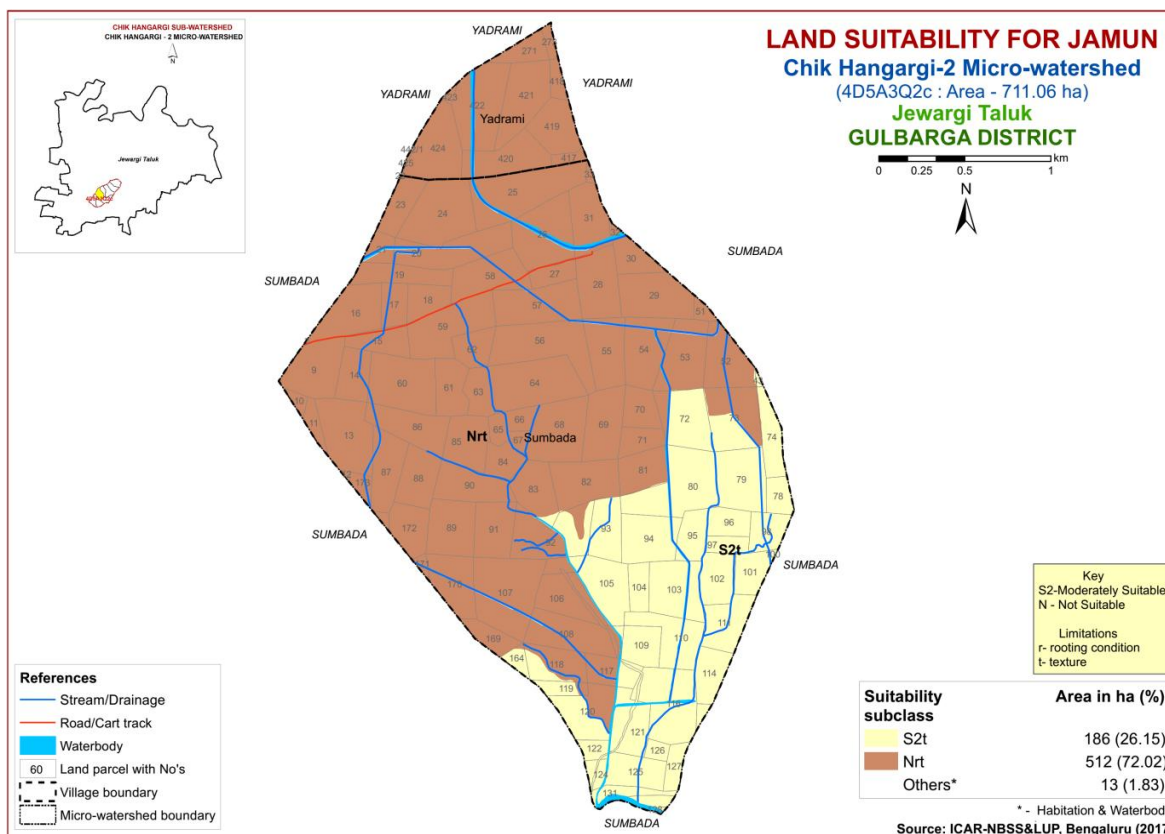
Fig. 7.13 Land Suitability map of Jamun

7.14 Land Suitability for Musambi (*Citrus limetta*)

Musambi is the most important fruit crop grown in almost all the districts of the State. The crop requirements for growing musambi (Table 7.14) 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 7.14.

An area of about 186 ha (26%) has soils that are highly suitable (Class S1) for growing musambi and are distributed in the southestern and southerstern part of the microwatershed. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing this crop.

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Table 7.14 Crop suitability criteria for Musambi

Crop requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climate	Temperature in growing season	^{0}C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	Class	Well drained	Mod. to imperfectly drained	poorly	Very poorly
Nutrient availability	Texture	Class	Scl, l, sicl, cl, s	Sc, sc, c	C(>70%)	S, ls
	pH	1:2.5	6.0-7.5	5.5-6.47.6-8.0	4.0-5.4 8.1-8.5	<4.0 >8.5
	CaCO$_3$ in root zone	%	Non 34calcareous	Upto 5	5-10	>10
Rooting conditions	Soil depth	Cm	>150	100-150	50-100	<50
	Gravel content	% vol.	Non gravelly	15-35	35-55	>55
Soil toxicity	Salinity	dS m^{-1}	Non saline	Upto 1.0	1.0-2.5	>2.5
	Sodicity	%	Non sodic	5-10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

Fig. 7.14 Land Suitability map of Musambi

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7.15 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 0.11 lakh ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.15) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.15.

An area of about 186 ha (26%) has soils that are highly suitable (Class S1) for growing lime and are distributed in the southeastern and a small area in the southwestern part of the microwatershed. Maximum area of about 512 ha (72%) is not suitable (Class N) for growing this crop.

Table 7.15 Crop suitability criteria for Lime

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climate	Temperature in growing season	^{0}C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	Class	Well drained	Mod. to imperfectly drained	poorly	Very poorly
Nutrient availability	Texture	Class	Scl, l, sicl, cl, s	Sc, sc, c	C(>70%)	S, ls
	pH	1:2.5	6.0-7.5	5.5-6.47.6-8.0	4.0-5.4 8.1-8.5	<4.0 >8.5
	$CaCO_3$ in root zone	%	Non 34calcareous	Upto 5	5-10	>10
Rooting conditions	Soil depth	Cm	>150	100-150	50-100	<50
	Gravel content	% vol.	Non gravelly	15-35	35-55	>55
Soil toxicity	Salinity	dS m^{-1}	Non saline	Upto 1.0	1.0-2.5	>2.5
	Sodicity	%	Non sodic	5-10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

Fig. 7.15 Land Suitability map of Lime

7.16 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important fruit and nut crop grown in an area of 1.24 lakh ha in almost all the districts of the State. The crop requirements for growing cashew (Table 7.16) 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 7.16. Entire area about 698 ha (98%) is not suitable (Class N) for growing cashew in the microwatershed. They have very severe limitations of texture and rooting depth.

Table 7.16 Crop suitability criteria for cashew

Crop requirement		Rating			
Soil –site characteristics	Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Slope	%	<5	5-15	15-30	
LGP	Days	>210	150-210	90-150	
Soil drainage	class	Well drained	moderately well drained	imperfectly drained	poorly drained
Soil reaction	pH	6.3-7.3	5.6-6.2	5.1-5.5 7.4-8.0	<5.0
Surface soil texture	Class	l, sl, scl	Cl, sil, ls, s	Sic, c (non swelling)	S (swelling)
Soil depth	Cm	>150	76-150	50-75	<50
Gravel content	% vol.	<15	15-35	35-50	>50

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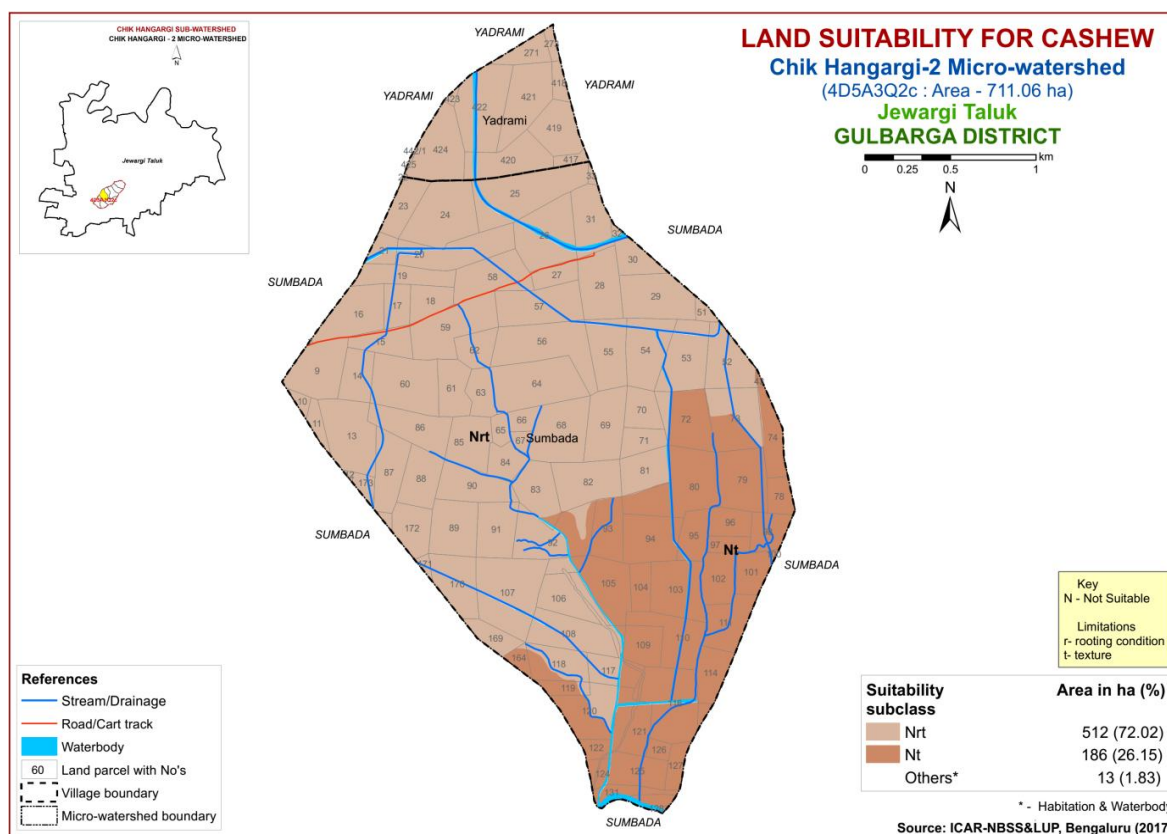
Fig. 7.16 Land Suitability map of Cashew

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

Custard apple is one of the most important fruit crop grown in almost all the districts of the State. The crop requirements for growing custard apple (Table 17) 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 7.17.

Table 7.17 Crop suitability criteria for Custard Apple

Crop requirement			Rating			
Soil –site characteristics		Unit	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Soil aeration	Soil drainage	Class	Well drained	Mod. well drained	Poorly drained	V. Poorly drained
Nutrient availability	Texture	Class	Scl, cl, sc, c (red), c(black)	-	Sl, ls	-
	pH	1:2.5	6.0-7.3	7.3-8.4	5.0-5.5 8.4-9.0	>9.0
Rooting conditions	Soil depth	Cm	>75	50-75	25-50	<25
	Gravel content	% vol.	<15-35	35-60	60-80	-
Erosion	Slope	%	0-3	3-5	>5	-

58
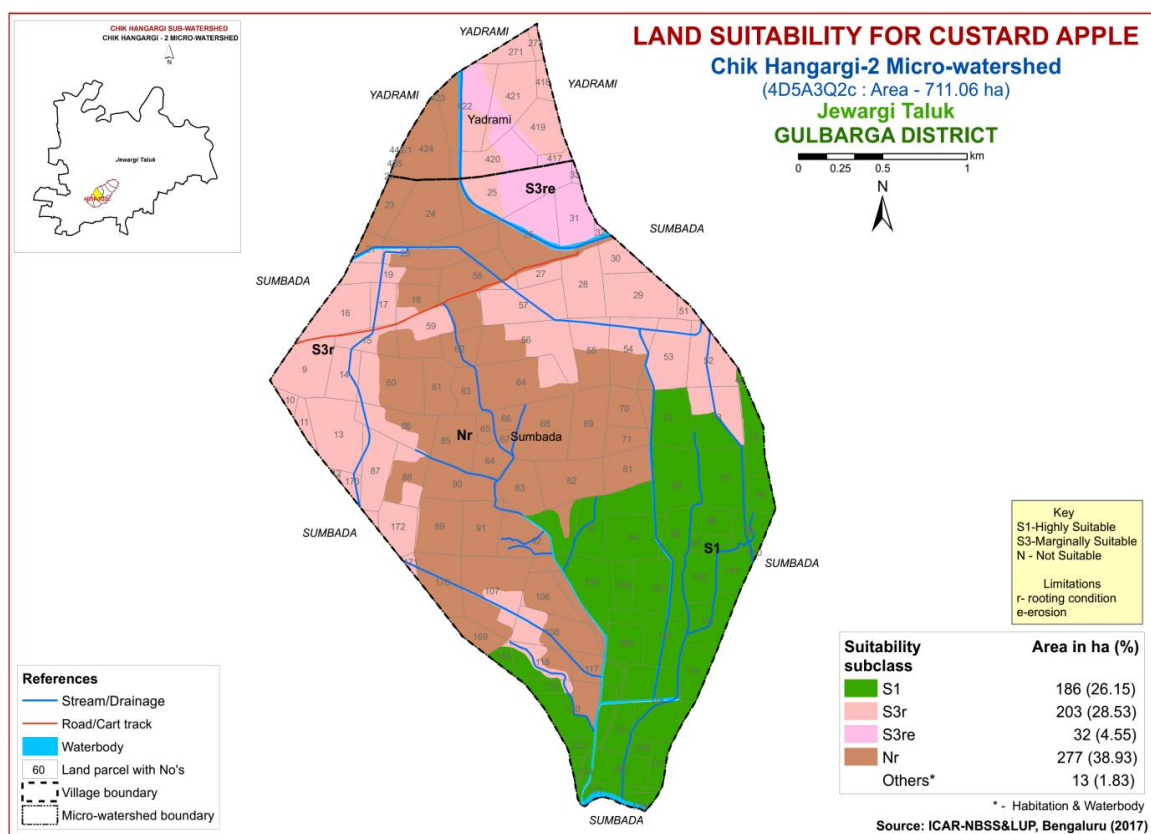
Fig. 7.17 Land Suitability map of Custard Apple

An area of about 186 ha (26%) has soils that are highly suitable (Class S1) for growing custard apple and are distributed in the southeastern and a small area in the southwestern part of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 235 ha (33%) and are distributed in the western, northeastern and small patch in the southwestern part of the microwatershed. They have moderate limitations of rooting depth and erosion. An area of about 277 ha (39%) is not suitable (Clss N) for growing this crop.

7.18 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the fruit and medicinal crop grown in almost all the districts of the State. The crop requirements for growing amla (Table 18) 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 7.18.

An area of about 186 ha (26%) has soils that are highly suitable (Class S1) for growing amla and are distributed in the southeastern and a small area in the southwestern part of the microwatershed. Marginally suitable lands cover an area of about 235 ha (33%) and are distributed in the western, northeastern and small area in the southwestern part of the microwastershed. They have moderate limitations of rooting depth and erosion for growing amla. Maximum area of about 277 ha (39%) is not suitable (Clss N) for growing Amla crop.

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Table 7.18 Land suitability criteria for Amla

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V. Poorly drained
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	7.8-8.4	>8.4
Rooting conditions	Soil depth	Cm	>75	50-75	25-50	<25
	Gravel content	% vol.	<15-35	35-60	60-80	
Erosion	Slope	%	0-3	3-5	5-10	>10
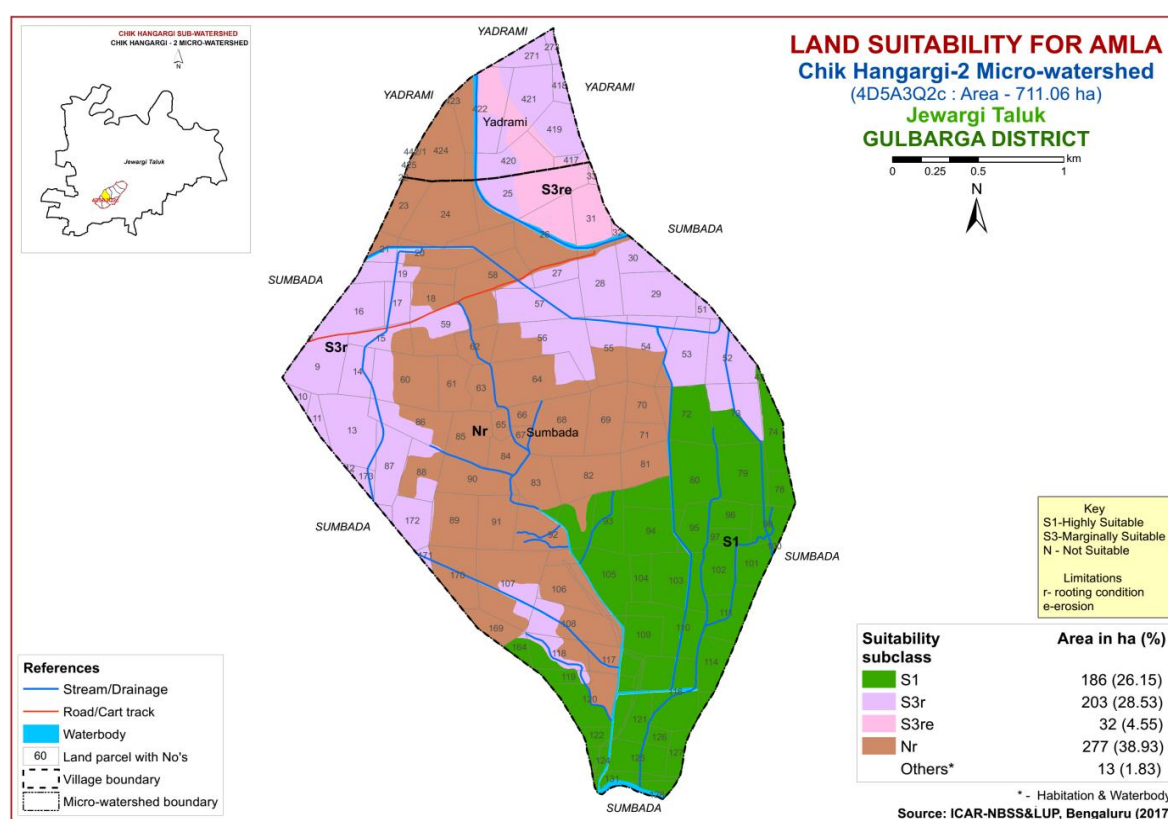
Fig. 7.18 Land Suitability map of Amla

7.19 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is the most important spice crop grown in almost all the districts of the state. The crop requirements for growing tamarind (Table 7.19) 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 is given in Figure 7.19.

An area of about 186 ha (26%) has soils that are moderately suitable (Class S2) and are distributed in the southeastern and southwestern part of the microwatershed with

minor limitations of rooting depth and texture. Maximum area of about 512 ha (72%) is not suitable (Class N) for raising this crop.

Table 7.19 Land suitability criteria for Tamarind

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V.Poorly drained
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
Rooting conditions	Soil depth	Cm	>150	100-150	75-100	<75
	Gravel content	% vol.	<15	15-35	35-60	60-80
Erosion	Slope	%	0-3	3-5	5-10	>10
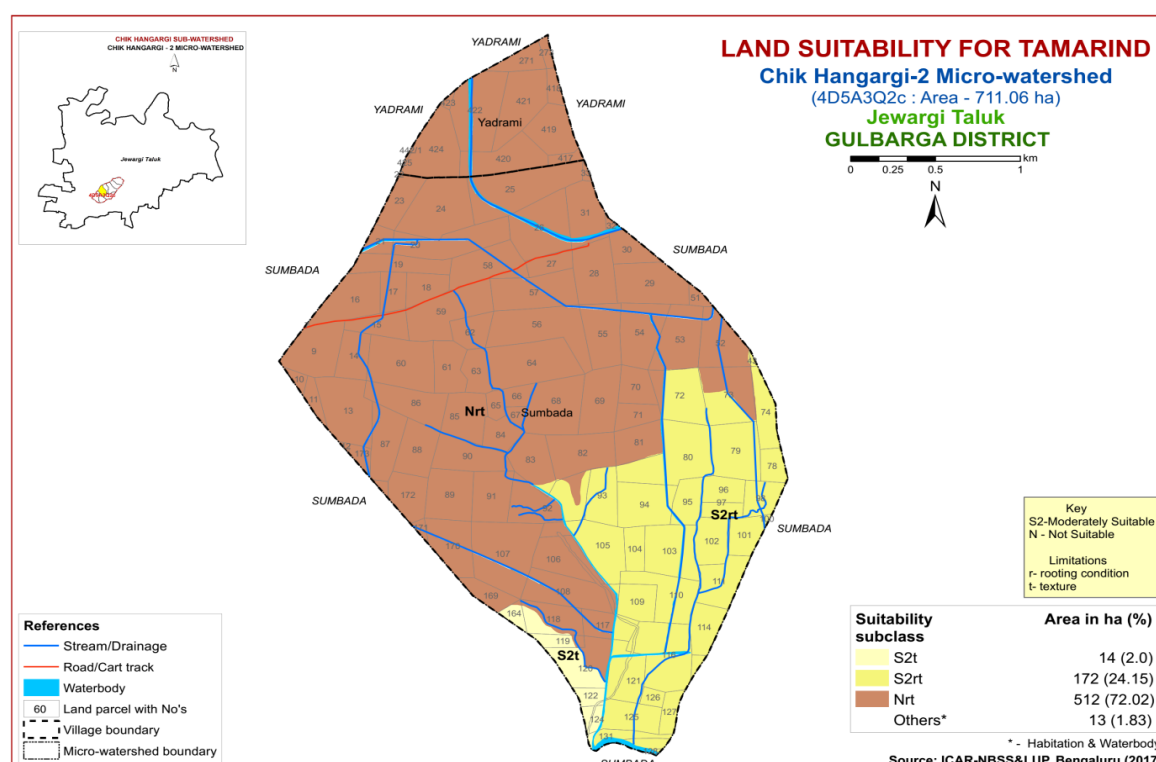
Fig. 7.19 Land Suitability map of Tamarind

7.20 Land Use Classes (LUCs)

The 8 soil map units identified in Chik Hangargi-2 microwatershed have been regrouped into 3 Land Use Classes (LUC's) for the purpose of preparing a Proposed Crop Plan. Land Use Classes 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 Land Use Classes (Fig. 7.20) map has been generated. These Land Use Classes are expected to behave similarly for a given level of management.

The map units that have been grouped into 3 land use classes along with brief description of soil and site characteristics are given below.

(LUCs)	Soil map units	Soil and site characteristics
1	1 MGTmB2 2MGTmC1	Very shallow black soils (<25-50 cm), 1-5% slopes, slight to moderate erosion
2	3 NHAmB1 4 NHAmB2 5 NHAmB3	Shallow black soils (25-50 cm), 1-3 % slope, slight to severe erosion.
3	6 DIMmB1 7 DIMmB2 8 MARmB1	Deep to very deep black soils (100->150) 1-3 % slope, slight to moderate erosion
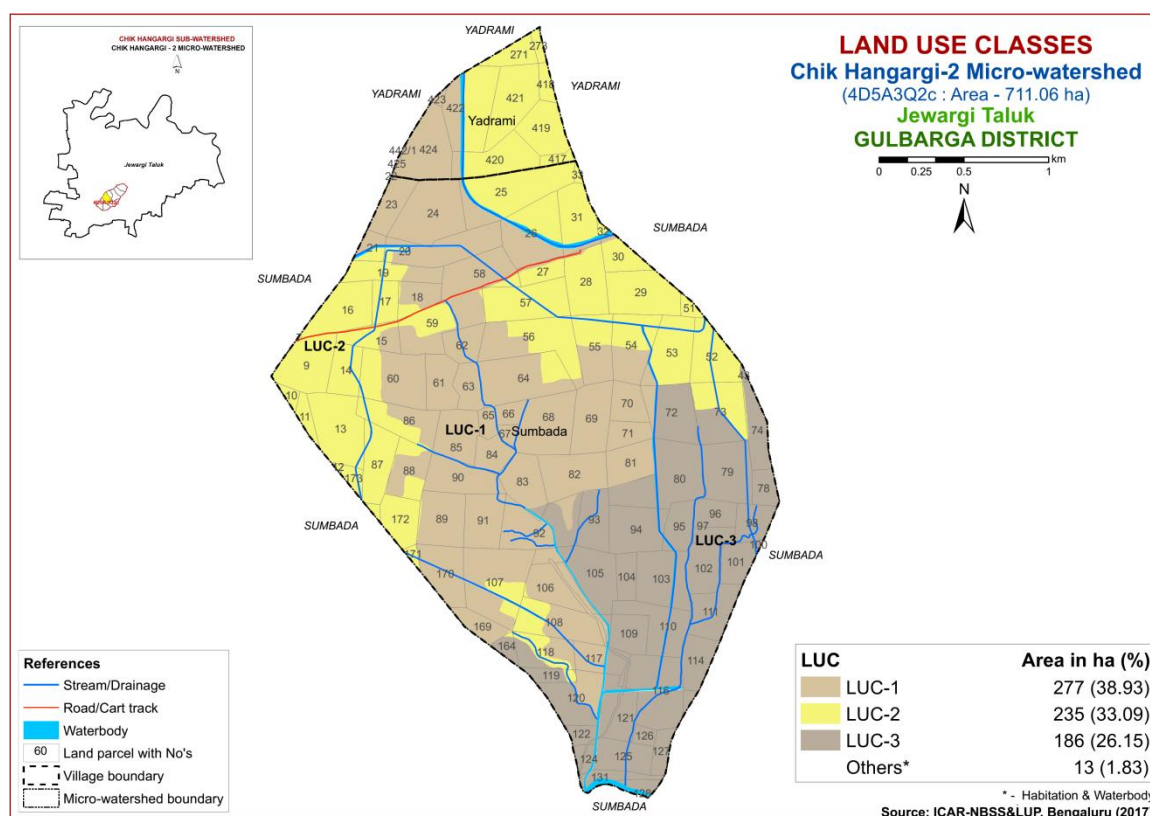
Fig. 7.20 Land Use Classes Map-Chik Hangargi-2 Microwatershed

7.21 Proposed Crop Plan for Chik Hangargi-2 Microwatershed

After assessing the land suitability for the 19 crops, the proposed crop plan has been generated for the 3 identified LUCs by considering only the highly (Class S1) and moderately (Class S2) suitable lands for each of the 19 crops. The resultant proposed crop plan is presented below in Table 7.20.

Table 7.20 Proposed Crop Plan for Chik Hangargi-2 Microwatershed

| LUC | Mapping unit | Survey No's | Soil Characteristics | Crops proposed | | | | Suitable Intervention |
				Field crops	Forestry Crop/Grasses	Horticulture crops (Rainfed Condition)	Horticulture crops With suitable intervention	
LUC-1 277 ha (39%)	1 MGTmB2 2MGTmC1	**Sumbada:** 18, 20, 21, 22, 23, 24, 26, 55, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 81, 82, 83, 84, 85, 86, 88, 89, 90, 91, 92, 106, 107, 108, 117, 169, 170 **Yadrami:** 423, 424, 425, 442/1	Very shallow black soils (<25cm), 1-5% slopes, slight to moderate erosion	Horse gram, Green gram, chick pea	Neem, Glyricydia , Silviculture, Agave, Simaroba	-	-	Cresent bunds
LUC-2 235 ha (33%)	3 NHAmB1 4 NHAmB2 5 NHAmB3	**Sumbada:** 7,9,10,11,12,13,14,15, 16,17,19,25,27,28,29, 30,31,32,33,51,52,53, 54,56,57,73,87,118, 171,172,173 **Yadrami:** 271,273,417,418,419, 420,421,422	Shallow black soils (25-50 cm), 1-3 % slope, slight to severe erosion.	Bajra, Linseed, Green gram, Black gram, Chick pea	Subabhul, Neem, Teak	Custard apple, Charoli, Ber, Amla **Vegetables**: Ladies finger, Brinjal, Cowpea, **Flowers**: Marigold, Chrysanthemu	Custard apple, Charoli, Ber, Amla **Vegetables**: Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers**:	Drip irrigation, suitable soil and water conservation measures like cultivation on raised beds with mulches and drip

						m	Marigold, Chrysanthemum	
LUC-3 186 ha (26%)	6 DIMmB1 7 DIMmB2 8 MARmB1	**Sumbada:** 43,72,74,78,79,80,93, 94,95,96,97,98,100, 101,102,103,104,105, 109,110,111,114,116,1 19,120,121,122,124,1 25,126,127,131,164,	Deep to very deep Black soils (100->150)1-3 % slope, slight to moderate erosion	Sorghum, Cotton, Red Gram, Black gram, Green gram, Soybean, Sesame, Sunflower, Safflower, **Rabi:** Sorghum, Chickpea, coriander	-	**Vegetables**: Ladies finger, Brinjal, Cowpea, coriander **Field crops**: Sorghum, Cotton, Red Gram, Sunflower, Safflower, **Perennial components**: Guava, Tamarind, Sapota, Lime, Mosambi **Flowers**: Marigold, Chrysanthemu m	Banana, Papaya, Lime, Mosambi, Guava, Tamarind **Vegetables**: Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers**: Marigold, Chrysanthemu m	Drip irrigation, suitable soil and water conservation measures like cultivation on raised beds with mulches and drip, Graded bunds, Strengthening of field bunds

SOIL HEALTH MANAGEMENT

8.1 Soil Health

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

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

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

The most important characterististics 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 Chik Hangargi-2 Microwatershed
- ❖ The soil phases with sizeable area identified in the microwatershed belonged to the soil series of (MGT) 277 ha, (NHA) 235 ha, (DIM) 172 ha and (MAR) 14 ha.
- ❖ As per land capability classification, 98 % area in the microwatershed falls under arable land category (Class II and IV). The major limitations identified in the arable lands were soil and erosion.
- ❖ On the basis of soil reaction, 80% area is strongly alkaline (pH 8.4 - 9.0) and 18% area is very strongly alkalime (>9.0) in the microwatershed, thus all soils in the microwatershed are alkaline in nature.

❖ **Soil Health Management**

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

Alkaline soils

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

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

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

Soil Degradation

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 711 ha area in the microwatershed, about of 442 ha is suffering from moderate, 224 ha slight and 32 ha severe erosion. The areas suffering from severe and 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 and Interventions needed

Net planning (Saturation Plan) in IWMP is focusing on preparation of

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

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

❖ **Soil Depth:** The depth of a soil decides the amount of moisture and nutrients it can hold, what crops can be taken up or not, depending on the rooting depth and the length of growing period available for raising any crop. Deeper the soil, better for a wide variety of crops. If sufficient depth is not available for growing deep rooted crops, either choose medium or short duration crops or deeper planting pits need to be opened and additional good quality soil brought from outside has to be filled into the planting pits.

❖ **Surface soil texture:** Lighter soil texture in the top soil means, better rain water infiltration, less run-off and soil moisture conservation, less capillary rise and less evaporation losses. Lighter surface textured soils are amenable to good soil tilth and are highly suitable for crops like groundnut, root vegetables (carrot, 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 Chik Hangargi-2 microwatershed.

❖ **Organic Carbon:** The OC content (an index of available Nitrogen) is low (<0.5%) in maximum of about 475 ha (67%) and medium (0.5-0.75%) in about 217 ha (30%) area, and high (>0.5%) in 6 ha (1%). The areas that are low and medium in OC needs to be further improved by applying farmyard manure and rotating crops with cereals and legumes or mixed cropping.

❖ **Promoting green manuring:** Growing of green manuring crops costs Rs. 1250/ha (green manuring seeds) and about Rs. 2000/ha towards cultivation that totals to Rs.

3250/- per ha. On the other hand, application of organic manure @ 10 tons/ha costs Rs. 5000/ha. The practice needs to be continued for 2-3 years or more. Nitrogen fertilizer needs to be supplemented by 25% in addition to the recommended level in 692 ha area where OC is medium (0.5-0.75%) and low (<0.5%). For example, for rainfed maize, recommended level is 50 kg N per ha and an additional 12 kg /ha needs to be applied for all the crops grown in these plots.

❖ **Available Phosphorus**: In 670 ha (94%) area, the available phosphorus is low (<23 kg/ha), medium (23-57 kg/ha) in about 25 ha (3%) area. Hence for all the crops, 25% additional P-needs to be applied.

❖ **Available Potassium:** Available potassium is high (>337 kg/ha) in maximum area of 539 ha (76%) and medium (145-337 kg/ha) in about 159 ha (22%) area in the microwatershed. The areas that are medium available potassium an additional 25% potassium needs to be applied.

❖ **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. It is medium in an area of about 502 ha (70%) and high (>20 ppm) in about 108 ha (15%) and low in 88 ha (12%). These areas, which are low and medium in available sulphur needs to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.

❖ **Available Iron:** It is deficient in an area of 25 ha (4%) in the microwatershed. To manage iron deficiency, iron sulphate @ 25kg /ha needs to be applied for 2-3 years.

❖ **Available Zinc:** It is deficient (<0.6 ppm) in maximum area 540 ha (76%) of the microwatershed and sufficient (>0.6 ppm) in 158 ha (22%) of the microwatershed. Application of zinc sulphate @25kg/ha is recommended for areas that are deficient in availabel zinc.

❖ **Soil alkalinity:** The entire microwatershed area of 698 ha (98%) has soils that are strongly 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 for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth and salinity/alkalinity are the major constraints in various plots. With suitable management interventions, the productivity can be enhanced. In order to increase water holding capacity of light textured soils, growing of green manure crops and application of organic manure is recommended.

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Chik Hangargi-2 microwatershed, the land resource inventory database generated under Sujala-III project has been transformed as information through series of interpretative (thematic) maps using soil phase map as a base. The various thematic maps (1:7920 scale) generated were

➢ Soil depth

➢ Surface soil texture

➢ Available water capacity

➢ Soil slope

➢ Soil gravelliness

➢ Land capability

➢ Present land use and land cover

➢ Crop suitability

➢ Rainfall

➢ Hydrology

➢ Water Resources

➢ Socio-economic data

➢ Contour plan with existing features- network of waterways, pothissa boundaries, cut up/ minor terraces etc.

➢ Cadastral map (1:7920 scale)

➢ Satellite imagery (1:7920 scale)
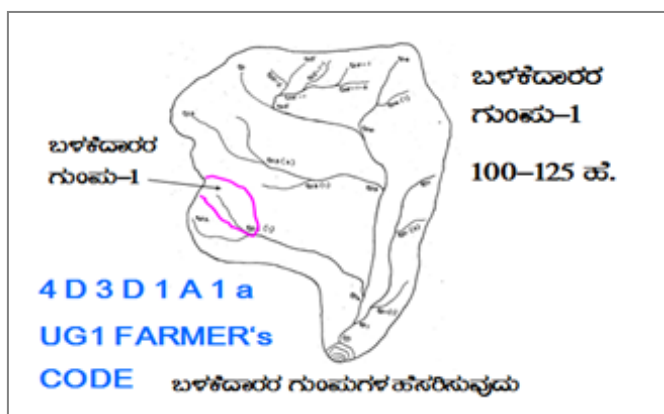
Apart from these, Hand Level/ Hydro Marker/ Dumpy Level/ Total Station and Kathedars' List to be collected.

Steps for Survey and Preparation of Treatment Plan

The boundaries of Land User Groups' and Survey No. boundaries are traced in the field.
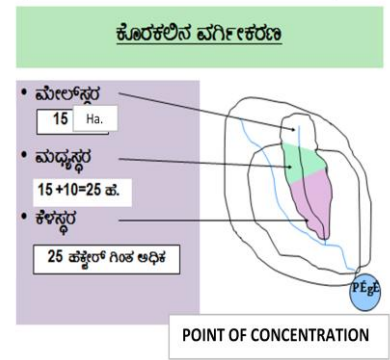
➢ Naming of user groups and farmers

➢ Identification of arable and non arable lands

➢ Identification of drainage lines and gullies

➢ Identification of non treatable areas

➢ Identification of priority areas in the arable lands

➢ Treatment plan for arable lands

➢ Location of water harvesting and recharge structures

9.1 Treatment Plan

The treatment plan recommended for arable lands is briefly described below

9.1.1 Arable Land Treatment

A. BUNDING

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

USER GROUP-1

CLASSIFICATION OF GULLIES

ಕೊರಕಲಿನ ವರ್ಗೀಕರಣ

UPPER REACH — ಮೇಲ್ಸ್ಥರ — 15 Ha.

MIDDLE REACH — ಮಧ್ಯಸ್ಥರ — 15 +10=25 ಹೆ.

LOWER REACH — ಕೆಳಸ್ಥರ — 25 ಹೆಕ್ಟೇರ್ ಗಿಂತ ಅಧಿಕ

POINT OF CONCENTRATION

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.

HAND LEVEL
SPIRIT LEVEL
EYE PIE END
OBJECT END

HYDRO MARKER (WATER TUBE)
STOP COCK
GRADUATED SCALE
1.5 1.0 0.5 0.0 → 0.6
1.5 ← 1.5 1.0 0.5 0.0
TUBE
A

FALL: 1.5 - 0.6 = 0.9 m.
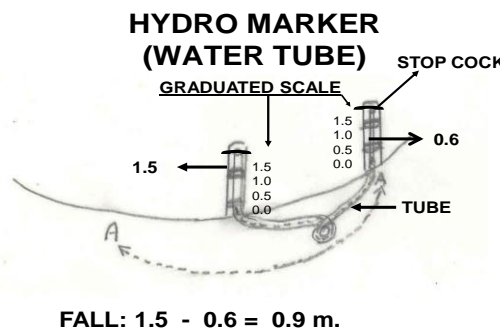
Vertical and Horizontal intervals between bunds as recommended by the Watershed Development Department.

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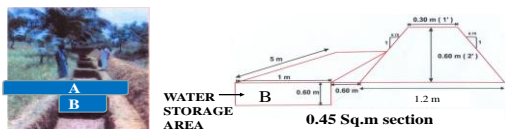
Top width (m)	Base width (m)	Height (m)	Side slope (Z:1;H:V)	Cross section (sq m)	Soil Texture	Remarks
0.3	0.9	0.3	01:01	0.18	Sandy loam	Vegetative bund
0.3	1.2	0.3	1.5:1	0.225	Sandy clay	
0.3	1.2	0.5	0.9:1	0.375	Red gravelly soils	
0.3	1.2	0.6	0.75:1	0.45		
0.3	1.5	0.6	01:01	0.54	Red sandy loam	
0.3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

Formation of Trench cum Bund

Dimensions of the Borrow Pits/Trenches to be excavated (machinery are decided considering the Bund Section).
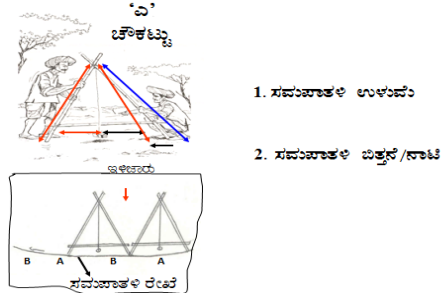
Details of Borrow Pit dimensions are given below:

TRENCH CUM BUND

WATER STORAGE AREA

0.45 Sq.m section

IDEAL FOR HORTICULTURE CROPS

'A' FRAME FOR INTERBUND MANAGEMENT

'ಎ' ಚೌಕಟ್ಟು

1. ಸಮಪಾತಳಿ ಉಳುಮೆ

2. ಸಮಪಾತಳಿ ಬಿತ್ತನೆ /ನಾಟಿ

ಇಳಿಜಾರು

ಸಮಪಾತಳಿ ರೇಖೆ

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
m²	m	m³	L(m)	W(m)	D(m)	QUANTITY (m³)	m	
0.375	6	2.25	5.85	0.85	0.45	2.24	0.15	Shallow
0.45	6	2.7	5.4	1.2	0.43	2.79	0.6	Shallow
0.45	6	2.7	5	0.85	0.65	2.76	1	Moderately Shallow
0.54	5.6	3.02	5.5	0.85	0.7	3.27	0.1	Moderately shallow
0.54	5.5	2.97	5	1.2	0.5	3	0.5	Shallow
0.72	6.2	4.46	6	1.2	0.7	5.04	0.2	Moderately shallow
0.72	5.2	3.74	5.1	0.85	0.9	3.9	0.1	Moderately deep

B. Water Ways

a) Existing 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 are formed in the field.

9.1.3 Treatment of Natural Water Course/ Drainage Lines

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

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

c) Considering the Catchment, Nala bed and bank conditions, suitable structures are decided.

d) Number of storage structures (Check dam/ Nala bund/ Percolation tank) will be decided considering the commitments and available runoff from 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.

9.2 Recommended Soil and Water Conservation Measures

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

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

A map (Fig. 9.1) showing soil and water conservation plan with different kinds of structures recommended has been generated which shows the spatial distribution and extent of area. A maximum area of about 86 ha (26%) needs graded bunds or strengthening of existing field bunds and about 512 ha (72%) area requires crescent bunding or trench cum bund. The conservation plan generated may be presented to all the stakeholders including the farmers and after considering their suggestions, the conservation plan for the microwatershed may be finalised in a participatory approach.
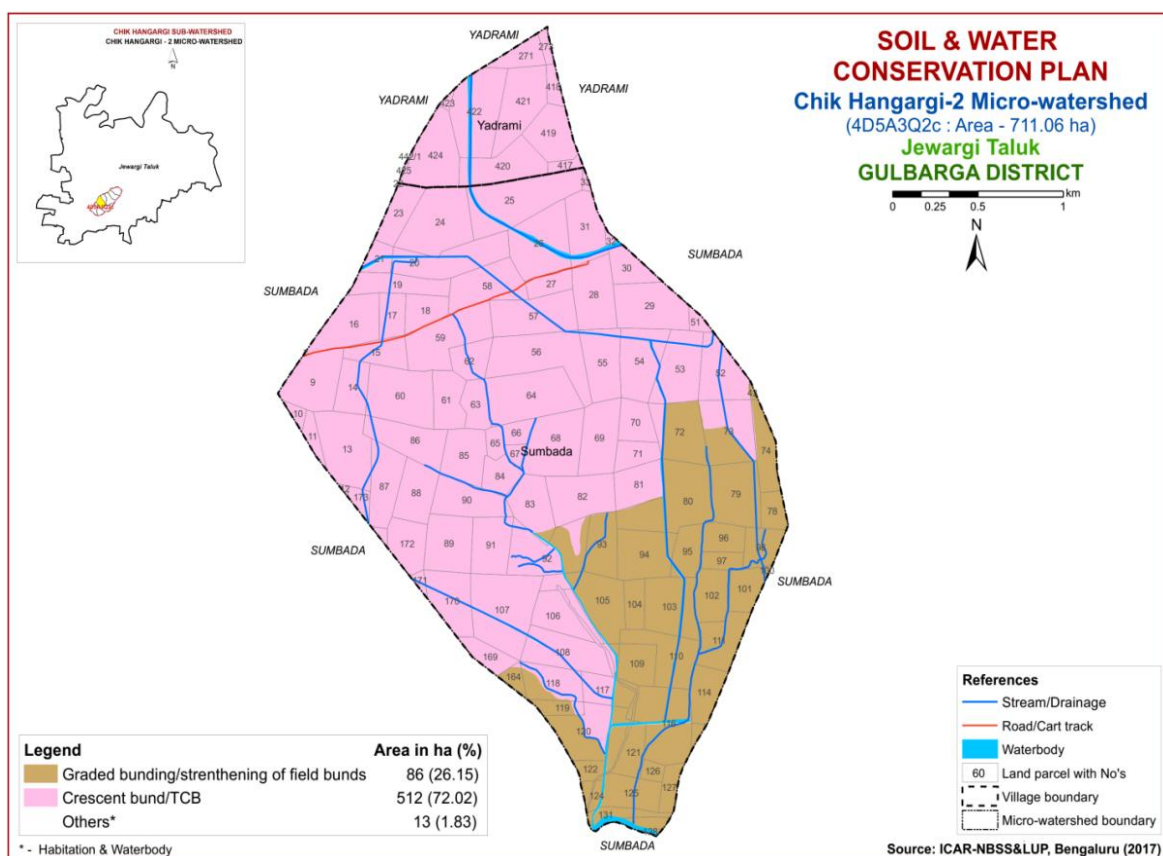
Fig. 9.1 Soil and Water Conservation Plan map of Chik Hangargi-2
Microwatershed

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 and field bunds for growing annual and perennial crops. The method of planting these trees is given below.

It is recommended to open pits during the 1st week of March along the contour and heap the dug out 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 Nerale (*Sizyzium cumini*) and Bamboo. Dry areas are to be planted with species like Honge, Bevu, Seetaphal *etc*.

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	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

Chik Hangargi-2 Microwatershed
Soil Phase Information

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	7	0.05	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	9	9.37	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Lemon (Rg+Lm)	Not Available	IVs	Crescent bund/TCB
Sumbada	10	1	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	11	1.93	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	12	0.2	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	13	11.32	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	14	5.28	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	15	4.83	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	16	9.05	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	17	3.79	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	18	4.27	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	19	6.02	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	20	10.4	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	21	2.57	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	22	0	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	23	5	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	24	12.72	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram+Jowar (Rg+Gg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	25	14.99	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Redgram+Jowar (Rg+Jw)	Not Available	IVse	Crescent bund/TCB
Sumbada	26	11.78	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	27	3.15	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	28	9.07	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	29	10.25	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram+Cotton+Jowar(Rg+Gg+Ct+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	30	4.07	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	31	7.72	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Redgram (Rg)	Not Available	IVse	Crescent bund/TCB
Sumbada	32	0.57	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Redgram (Rg)	Not Available	IVse	Crescent bund/TCB
Sumbada	33	0.43	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Not Available (NA)	Not Available	IVse	Crescent bund/TCB
Sumbada	43	0.25	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Not Available (NA)	Not Available	IIs	Graded bunding /strenthening of field bunds
Sumbada	51	1.14	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	52	8.09	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	53	9.88	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	54	9.34	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	55	8.33	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	56	13.52	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar+Cotton Rg+Jw+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	57	10.41	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram+Jowar (Rg+Gg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	58	8.98	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Paddy (Rg+Pd)	Not Available	IVs	Crescent bund/TCB
Sumbada	59	11.64	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Sugarcane+Jowar+Paddy (Rg+Sc+Jw+Pd)	Not Available	IVs	Crescent bund/TCB
Sumbada	60	11.8	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	1 Open well	IVs	Crescent bund/TCB
Sumbada	61	5.78	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Maize (Rg+Mz)	1 Open well	IVs	Crescent bund/TCB
Sumbada	62	4.33	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	63	3.98	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	64	13.31	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	65	1.84	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	66	2.09	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	67	1.17	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Sumbada	68	10.97	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	69	8.68	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	70	4.5	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	71	3.56	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	72	9.41	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Jowar+Paddy (Rg+Jw+Pd)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	73	10.55	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram (Rg+Gg)	Not Available	IVs	Crescent bund/TCB
Sumbada	74	5.27	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Greengram (Gg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	78	3.02	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	79	9.88	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Greengram+Cotton (Rg+Gg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	80	14.41	DIMmB2	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram+Cotton+Paddy+Scrub Land	1 Farm Pond,1 Open well	IIse	Graded bunding/strenthening of field bunds
Sumbada	81	6.22	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	82	9.27	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	83	7.27	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Sumbada	84	3.91	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Paddy (Rg+Pd)	Not Available	IVs	Crescent bund/TCB
Sumbada	85	7.12	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	86	8.3	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	87	7.56	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	1 Open well	IVs	Crescent bund/TCB
Sumbada	88	6.83	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Sugarcane+Cotton (Rg+Sc+Ct)	Not Available	IVs	Crescent bund/TCB

III

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	89	8.55	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	90	7.79	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	91	7.18	MGTmC1	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Gently sloping (3-5%)	Slight	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	92	11.8	MGTmC1	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Gently sloping (3-5%)	Slight	Redgram+Greengram+Current Fallow+Scrub Land	Not Available	IVs	Crescent bund/TCB
Sumbada	93	6.22	DIMmB2	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Sumbada	94	8.8	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Greengram+Cotton (Rg+Gg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	95	4.65	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	96	3.94	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Greengram (Rg+Gg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	97	2.46	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Greengram (Rg+Gg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	98	4.49	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Greengram (Rg+Gg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	100	0.2	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Not Available (NA)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	101	4.35	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	102	5.76	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	103	9.75	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	104	3.27	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	105	10.46	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	106	6.88	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	107	15.1	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton +Lemon (Rg+Ct+Lm)	Not Available	IVs	Crescent bund/TCB
Sumbada	108	10.03	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	109	4.91	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	110	8.48	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	111	7.03	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	114	5.04	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	116	12.73	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	117	4.72	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	118	6.63	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	119	2.3	MARmB1	LUC-3	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	120	9.39	MARmB1	LUC-3	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	121	6.78	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Sumbada	122	1.74	MARmB1	LUC-3	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	124	1.65	MARmB1	LUC-3	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Not Available (NA)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	125	6.12	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	126	1.4	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	127	3.31	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	128	0.3	Waterbody	Others	Others	Others	Others	Others	Others	Others	Waterbody	Not Available	Others	Others
Sumbada	131	2.26	DIMmB1	LUC-3	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Waterbody	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	164	1.6	MARmB1	LUC-3	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IIs	Graded bunding/strenthening of field bunds
Sumbada	169	3.48	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	170	7.81	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	171	0.71	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Sumbada	172	5.72	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram+Cotton (Rg+Ct)	Not Available	IVs	Crescent bund/TCB
Sumbada	173	2.09	NHAmB1	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Yadrami	271	3.54	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVs	Crescent bund/TCB
Yadrami	273	1.08	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Yadrami	417	1.26	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Not Available (NA)	Not Available	IVse	Crescent bund/TCB
Yadrami	418	1.72	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB

Village	Survey No.	Area (ha)	Soil Phase	Land Use Classess	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Yadrami	419	6.98	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Greengram+Cotton (Rg+Gg+Ct)	Not Available	IVs	Crescent bund/TCB
Yadrami	420	8.71	NHAmB3	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Redgram+Greengram (Rg+Gg)	Not Available	IVse	Crescent bund/TCB
Yadrami	421	9.92	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Yadrami	422	12.74	NHAmB2	LUC-2	Shallow (25-50 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Yadrami	423	0.46	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Yadrami	424	10.31	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IVs	Crescent bund/TCB
Yadrami	425	0.12	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IVs	Crescent bund/TCB
Yadrami	442/1_	0.09	MGTmB2	LUC-1	Very shallow (<25 cm)	Clay	Non gravelly (<15%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Grass Land (GL)	Not Available	IVs	Crescent bund/TCB

VII

Appendix II

Village	Survey No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Sumbada	7	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	9	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	10	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 – 57 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	11	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	12	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	13	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	14	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	15	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	16	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	17	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	18	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	19	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Deficient (< 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	20	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	21	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	22	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	23	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	24	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	25	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	26	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	27	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	28	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	29	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Sumbada	30	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	31	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	32	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (> 0.75 %)	High (> 57 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	33	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	43	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	51	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	52	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	53	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	54	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	55	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	56	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	57	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	58	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	59	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	60	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	61	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	62	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	63	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	64	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	65	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	66	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	67	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	68	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	69	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

X

Village	Survey No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Sumbada	70	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	71	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	72	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	73	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	74	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	78	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	79	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	80	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	81	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	82	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	83	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	High (> 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	84	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	85	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	86	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	87	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	88	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	89	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	90	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	91	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	92	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	93	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	94	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	95	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	96	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Sumbada	97	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	98	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Sumbada	100	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	101	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	102	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	103	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	104	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	105	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	106	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	107	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	108	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	109	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	110	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	111	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	114	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	116	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	117	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	118	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	119	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	120	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	121	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	122	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	124	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	125	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Sumbada	126	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	127	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	128	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Sumbada	131	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5 – 0.75 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	164	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)		Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	169	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	170	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	171	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	172	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Sumbada	173	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	271	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	273	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	417	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	418	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	419	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	420	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	421	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	422	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	423	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	424	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	425	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Medium (0.5 – 1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Yadrami	442/1_ GRASS_ FIELD	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145 – 337 kg/ha)	Medium (10 – 20 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Appendix III

Chik Hangargi-2 Microwatershed
Soil Suitability Information

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Tamarind	Mango	Sapota	Guava	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Sugarcane	Redgram	Bengalgram	Soyabean
Sumbada	7	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	9	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	10	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	11	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	12	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	13	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	14	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	15	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	16	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	17	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	18	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	19	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	20	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	21	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	22	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	23	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	24	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	25	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Sumbada	26	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	27	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	28	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	29	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	30	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	31	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Sumbada	32	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Sumbada	33	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Sumbada	43	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	51	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	52	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	53	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	54	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	55	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	56	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	57	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	58	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	59	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	60	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	61	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	62	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	63	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	64	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	65	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	66	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	67	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr

Village	Survey No.	Sorghum	Maize	Sunflower	Cotton	Tamarind	Mango	Sapota	Guava	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Sugarcane	Redgram	Bengalgram	Soyabean
Sumbada	68	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	69	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	70	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	71	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	72	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	73	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	74	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	78	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	79	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	80	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	81	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	82	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	83	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	84	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	85	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	86	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	87	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	88	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	89	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	90	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	91	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	92	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	93	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	94	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	95	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	96	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	97	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	98	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	100	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	101	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	102	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	103	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	104	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	105	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	106	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	107	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	108	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	109	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	110	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	111	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	114	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	116	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	117	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Sumbada	118	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	119	S1	S3t	S1	S1	S2t	S3t	S2t	S2t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2t	S1	S1
Sumbada	120	S1	S3t	S1	S1	S2t	S3t	S2t	S2t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2t	S1	S1
Sumbada	121	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	122	S1	S3t	S1	S1	S2t	S3t	S2t	S2t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2t	S1	S1

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Tamarind	Mango	Sapota	Guava	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Sugarcane	Redgram	Bengalgram	Soyabean
Sumbada	124	S1	S3t	S1	S1	S2t	S3t	S2t	S2t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2t	S1	S1
Sumbada	125	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	126	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	127	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	128	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Sumbada	131	S1	S3t	S1	S1	S2rt	S3t	S3t	S3t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2te	S1	S2e
Sumbada	164	S1	S3t	S1	S1	S2t	S3t	S2t	S2t	S3t	S2t	S1	S1	Nt	S1	S1	S3t	S2t	S1	S1
Sumbada	169	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nr	S3r	Nr
Sumbada	170	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nr	S3r	Nr
Sumbada	171	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	172	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Sumbada	173	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	271	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	273	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	417	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Yadrami	418	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	419	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	420	S3re	S3re	Nr	S3re	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3re	S3re	Nrt	S3re	S2r	S3re
Yadrami	421	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	422	S3r	S3rt	Nr	S3r	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	S3r	S3r	Nrt	S3rt	S2r	S3r
Yadrami	423	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Yadrami	424	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Yadrami	425	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr
Yadrami	442/1	Nr	Nrt	Nr	Nr	Nrt	Nrt	Nrt	Nrt	Nrt	Nrt	Nr	Nr	Nrt	Nr	Nr	Nrt	Nrt	S3r	Nr

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

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EXECUTIVE SUMMARY

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

Methodology: *Chick Hangargi-2 micro-watershed (Chick Hangargi sub-watershed, Jewargi taluk, Gulbarga district) is located in between $16^045'$ – $16^051'$ North latitudes and $76^032'$ – $76^035'$ East longitudes, covering an area of about 711.06 ha, bounded by Sumbada and Yedrami villages with length of growing period (LGP)120-150 days. We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and ecosystem services were quantified.*

Results: *The socio-economic outputs for Chick Hangargi-2 (Chick Hangargi sub-watershed, Jewargi taluk, Gulbarga district) are presented here.*

Social Indicators;

❖ *Male and female ratio is 59.0 to 41.0 per cent to the total sample population.*

❖ *Younger age 18 to 50 years group of population is around 48.7 per cent to the total population.*

❖ *Literacy population is around 66.7 per cent.*

❖ *Social groups belong to other back ward caste (OBC) is around 80.0 per cent.*

❖ *Wood is the source of energy for a cooking among 90.0 per cent.*

❖ *About 20.0 per cent of households have a yashaswini health card.*

❖ *About 10.0 per cent of farm households are having MGNREGA card for rural employment.*

❖ *Dependence on ration cards for food grains through public distribution system among all sample households.*

❖ *Swach bharath program providing closed toilet facilities around 20.0 per cent of sample households.*

❖ *Women participation in decisions making among all the households were found.*

Economic Indicators;

❖ *The average land holding is 1.70 ha indicates that majority of farm households are belong to marginal and small farmers. The dry land is total cultivated land area among all the sample farmers.*

- *Agriculture is the main occupation among 18 per cent and agriculture is the main and agriculture labour is a subsidiary occupation is 56.4 per cent of sample households.*
- *The average value of domestic assets is around Rs. 19206 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets is around Rs. 5036 per household, about 59.0 per cent of sample farmers having weeder.*
- *The average value of livestock is around Rs. 13667 per household; about 33.3 per cent of household are having livestock.*
- *The average per capita food consumption is around 757.9 grams (1664.8 kilo calories) against national institute of nutrition (NIN) recommendation at 827 gram. Around 90.0 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs. 61121 per household. About 80.0 per cent of farm households are below poverty line.*
- *The per capita monthly average expenditure is around Rs. 1612.*

Environmental Indicators-Ecosystem Services;

- *The value of ecosystem service helps to support investment to decision on soil and water conservation and in promoting sustainable land use.*
- *The onsite cost of different soil nutrients lost due to soil erosion is around Rs. 683 per ha/year. The total cost of annual soil nutrients is around Rs. 476440 per year for the total area of 698 ha.*
- *The average value of ecosystem service for food grain production is around Rs 259749/ ha/year. Per hectare food grain production services is maximum in redgram (Rs. 504654) followed by cotton (Rs. 242593) and sorghum (Rs. 32000).*
- *The average value of ecosystem service for fodder production is around Rs 3293/ ha/year in sorghum.*
- *The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum in redgram (Rs 62518), cotton (Rs 53778) and sorghum (Rs 40152).*

Economic Land Evaluation;

- *The major cropping pattern is redgram (58.8 %) followed by cotton (32.8 %), sorghum (7.9 %) and paddy (0.5 %).*
- *In Chick Hangargi-2 micro-watershed, major soil is Margutti (MGT) series is having very shallow soil depth cover around 38.93 % of area. On this soil farmers are presently growing cotton (20.8 %) and redgram (79.2 %).*

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Novinihala (NHA) are having shallow soil depth cover 33.09 % of area, the crops are redgram (67.4 %) and sorghum (32.6 %) and Dimal (DIM) series are having deep soil depth cover around 24.15 % of area, the crops are cotton (67.4 %) and redgram (32.6%).

❖ *The total cost of cultivation and benefit cost ratio (BCR) in study area for cotton range between Rs 33716/ha in MGT soil (with BCR of 1.40) and Rs 29641/ha in DIM soil (with BCR of 1.61).*

❖ *In redgram the cost of cultivation range between in MGT soil Rs. 29316/ha (with BCR of 1.60) and Rs 21477/ha in NHA soil (with BCR of 1.47).*

❖ *In sorghum the cost of cultivation Rs 20465/ha in NHA soil (with BCR of 1.45).*

❖ *The land management practices reported by the farmers are crop rotation, tillage practices, fertilizer application and use of farm yard manure (FYM). Due to higher wages farmer are following labour saving strategies is not prating soil and water conservation measures. Less ownership of livestock limiting application of FYM.*

❖ *It was observed soil quality influences on the type and intensity of land use. More fertilizer applications in deeper soil to maximize returns.*

Suggestions;

❖ *Involving farmers is watershed planning helps in strengthing institutional participation.*

❖ *The per capita food consumption and monthly income is very low. Diversifying income generation activities from crop and livestock production in order to reduce risk related to drought and market prices.*

❖ *Majority of farmers reported that they are not getting timely support/extension services from the concerned development departments.*

❖ *By strengthing agricultural extension for providing timely advice improved technology there is scope to increase in net income of farm households.*

❖ *By adopting recommended package of practices by following the soil test fertiliser recommendation, there is scope to increase yield in sorghum (53.1 %), cotton (31.1 to 12.6 %) and redgram (8.9 to 3.4 %).*

INTRODUCTION

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

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

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

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

Objectives of the study

1. To characterize socio-economic status of farm households
2. To evaluate the economic viability of land use and land related constraints
3. To estimate the ecosystem service provided by the watershed and
4. To suggest alternatives for sustainable agriculture production.

METHODOLOGY

Study area

Chick Hangargi-2 micro-watershed located in north-eastern dry zone of Karnataka (Figure 1): The total geographic area of this zone is about 1.76 M ha covering 8 taluks of Gulbarga district and 3 taluks of Raichur. Net cultivated area in the zone is about 1.31 M ha of which about 0.09 M ha are irrigated. The mean elevation of the zone is 300-450 m MSL. The main soil type is deep to very deep soils with small pockets of shallow to medium black soils. The zone is cropped predominantly during rabi due to insufficient rainfall (465-785 mm). The principal crops of the zone are jowar, bajra, oilseeds, pulses, cotton and sugarcane. It represents Agro Ecological Sub Region (AESR) 6.2 having LGP 120-150 days.

Chick Hangargi-2 micro-watershed (Chick Hangargi sub-watershed, Jewargi taluk, Gulbarga district) is located in between 16^045' – 16^051' North latitudes and 76^032' – 76^035' East longitudes, covering an area of about 711.06 ha, bounded by Sumbada and Yedrami villages.

Sampling Procedure:

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

Sources of data and analysis:

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

LOCATION MAP OF CHIK HANGARGI-2 MICRO WATERSHED
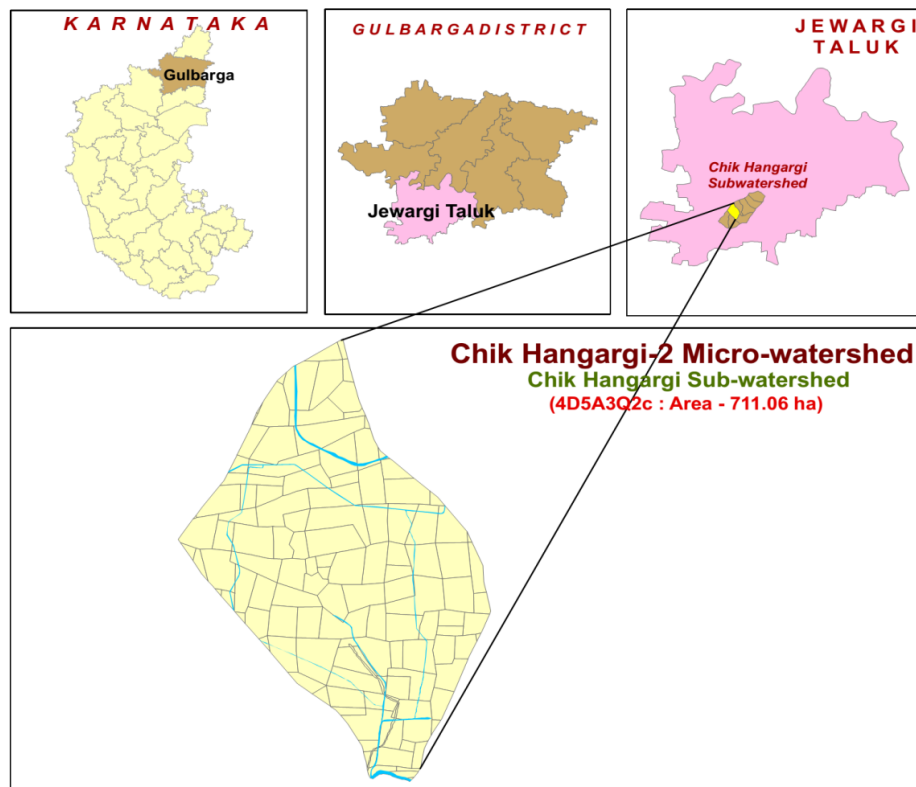
Figure 1: Location of study area

Steps followed in socio-economic assessment

1. • After the completion of soil profile study link the cadastral number to the soil profile in the micro watershed.

2. • Download the names of the farmers who are owning the land for each cadastral number in the Karnataka BHOOMI Website.

3. • Compiling the names of the farmers representing for all the soil profiles studied in the micro watershed for socio-economic Survey.

4. • Conducting the socioeconomic survey of selected farm households in the micro watershed .

5. • Farm households database created using the Automated Land Potential Evaluation System (ALPES) for analysis of socio economic status for each micro watershed .

6. • Synthesis of tables and preparation of report for each micro watershed .
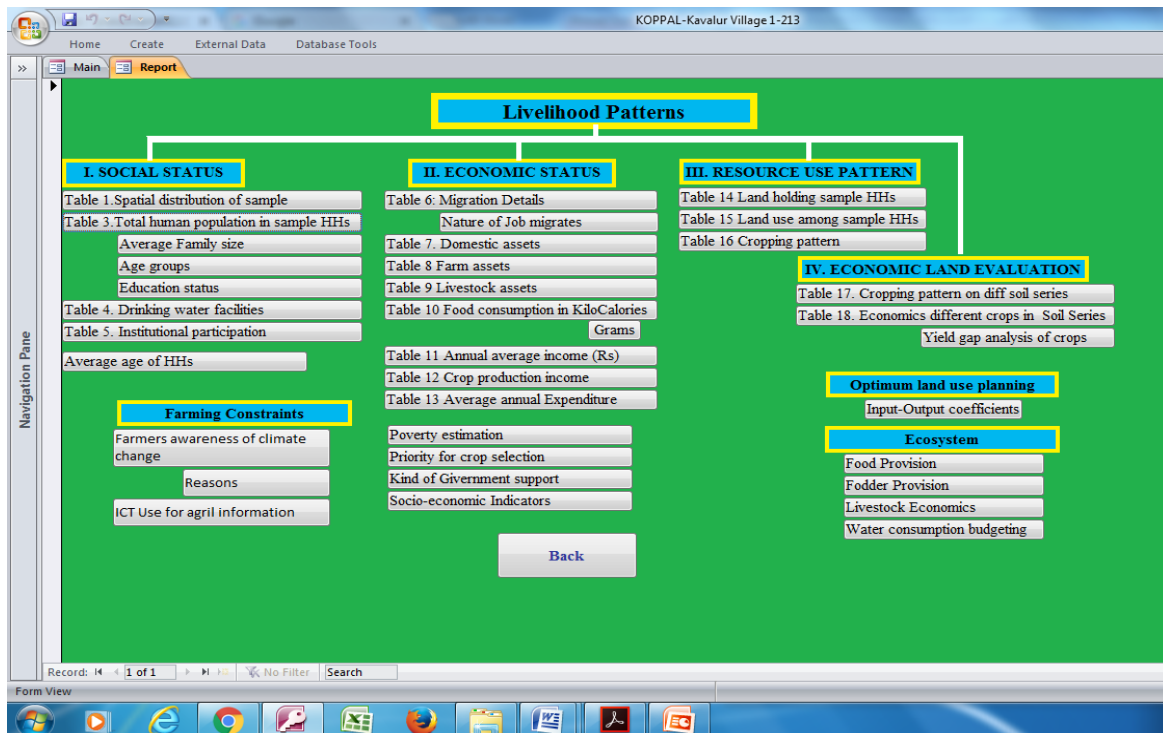
Figure 2: ALPES FRAMEWORK

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

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

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

Net returns = Gross returns-Operational cost.

Benefit Cost Ratio = Net returns/Total cost.

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

Economic Valuation of Soil ecosystem services:

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

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

1
- Collect the Soil Map Units (SMU) / Land Use Type (LUT) with soil fertility analysis.

2
- Integrate the erosion rates per SMU/LUT.

3
- Estimate the nutrients lost per tone of soil erosion for each SMU/LUT.

4
- Estimate the value of soil nutrients lost per ton of soil erosion for each SMU/LUT by taking the market price of soil nutrients.
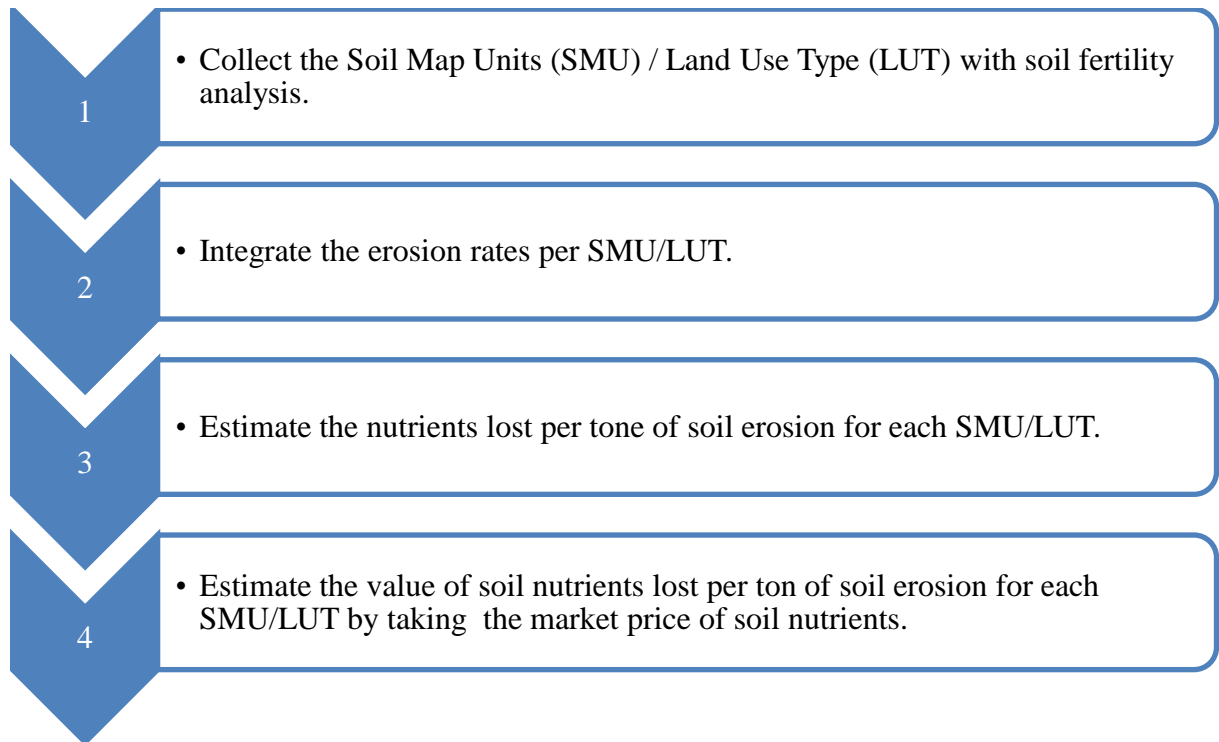
RESULTS AND DISCUSSIONS

The demographic information shows that the household population dynamics encompasses the socioeconomic status of the farmer. For a rural family, the household size should be optimal to earn a comfortable livelihood through farm and non-farm wage earning. The total number of population in watershed area was 39, out of which 59.0 per cent were males and 41.0 per cent females. Average family size of the households is 3.9. Age is an important factor, which affects the potential employment and mobility status of respondents. The data on age wise distribution of farmers in the sample households indicated that majority of the farmers are coming under the age group of 30 to 50 years (30.8 %) followed by 0 to 18 years (28.2 %), more than 50 years (23.1 %) and 18 to 30 years (17.9 %). Hence, in the study area in general, the respondents were of young and middle age, indicating thereby that the households had almost settled with whatever livelihood options they were practicing and sample respondents were young by age who could venture into various options of livelihood sources. Data on literacy indicated that 33.3 per cent of respondents were illiterate and 66.7 per cent literate (Table 1).

Table 1: Human population among sample households in Chick Hangargi-2 Microwatershed

Particulars	Units	Value
Total human population in sample HHs	Number	39
Male	% to total Population	59.0
Female	% to total Population	41.0
Average family size	Number	3.9
Age group		
0 to 18 years	% to total Population	28.2
18 to 30 years	% to total Population	17.9
30 to 50 years	% to total Population	30.8
>50 years	% to total Population	23.1
Average age	Age in years	33.3
Education Status		
Illiterates	% to total Population	33.3
Literates	% to total Population	66.7
Primary School (<5 class)	% to total Population	12.8
Middle School (6- 8 class)	% to total Population	12.8
High School (9- 10 class)	% to total Population	35.9
Others	% to total Population	5.1

The ethnic groups among the sample farm households found to be 80.0 per cent belonging to other backward caste (OBC) followed by 20.0 per cent belonging to general caste (Table 2 and Figure 3). About 90 per cent of sample households are using wood as source of fuel for cooking. All the sample farmers are having electricity connection. About 20.0 per cent are sample households having health cards. About 10 per cent having MNREGA job cards for employment generation. Among all the farm households are having ration cards for taking food grains from public distribution system. About 20.0 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Chick Hangargi-2 Microwatershed

Particulars	Units	Value
Social groups		
OBC	% of Households	80.0
General	% of Households	20.0
Types of fuel use for cooking		
Fire wood	% of Households	90.0
Gas	% of Households	10.0
Energy supply for home		
Electricity	% of Households	100.0
Number of households having Health card		
Yes	% of Households	20.0
No	% of Households	80.0
MGNREGA Card		
Yes	% of Households	10.0
No	% of Households	90.0
Ration Card		
Yes	% of Households	100.0
No	% of Households	0.0
Households with toilet		
Yes	% of Households	20.0
No	% of Households	80.0
Drinking water facilities		
Tube Well	% of Households	100.0

The data collected on the source of drinking water in the study area is presented in Table 2. All the sample respondents are having tube well source for water supply for domestic purpose.
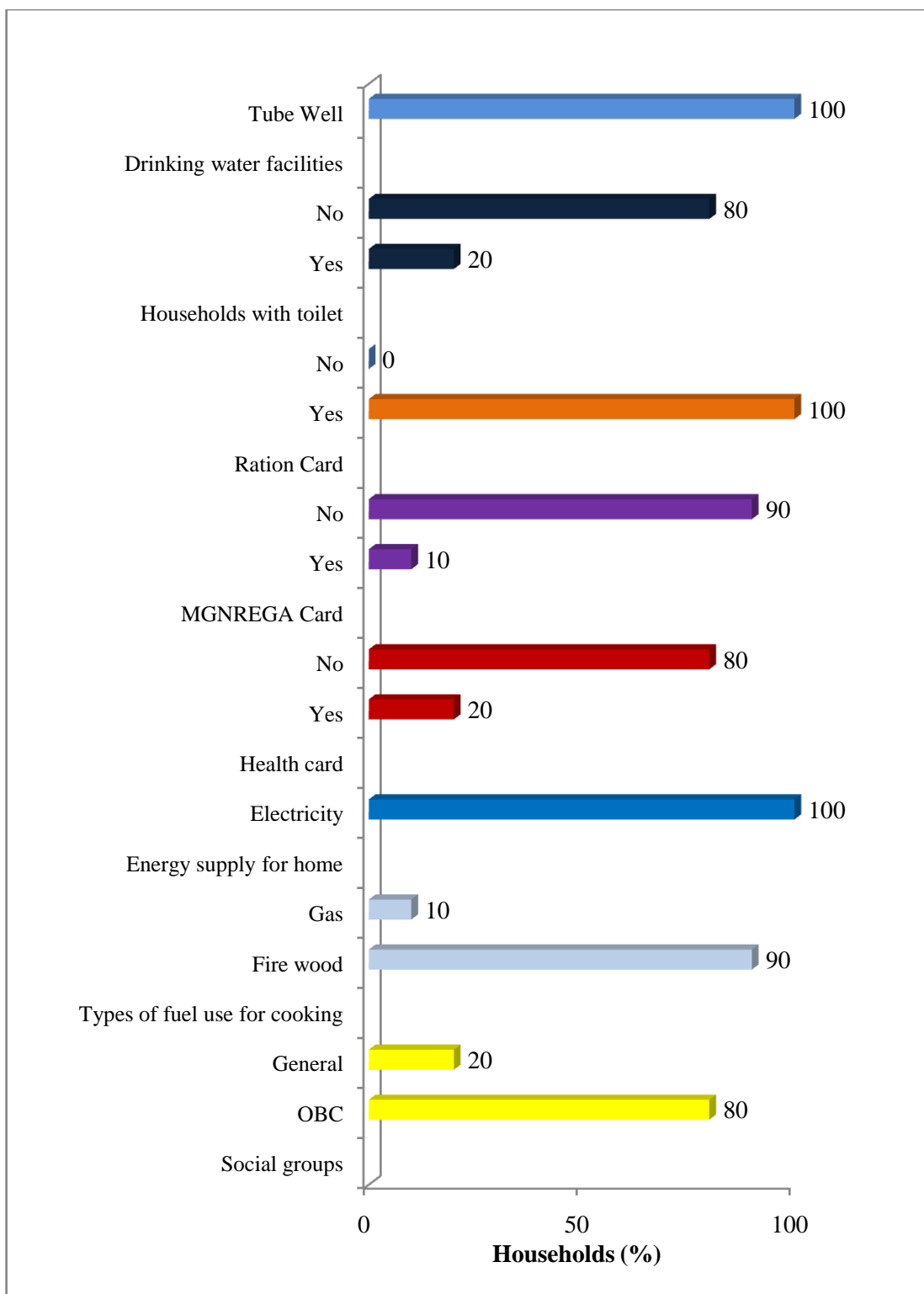
Figure 3: Basic needs of sample households in Chick Hangargi-2 Microwatershed

The occupational pattern (Table 3) among sample households shows that agriculture is the main occupation around 18 per cent and agriculture is the main occupation and agriculture labour is a subsidiary occupation was 56.4 per cent of sample farmers.

Table 3: Occupational pattern in sample population in Chick Hangargi-2 Microwatershed

Occupation		% to total
Main	**Subsidiary**	
Agriculture	Agriculture	18.0
	Agriculture Labour	56.4
Studying		25.6
Family labour availability		**Man days/month**
Male		25.00
Female		20.00
Total		45.00

The important assets especially with reference to domestic assets were analyzed and are given in Table 4 and Figure 4. The important domestic assets possessed by all categories of farmers are television (100 %) followed by mobile phones (80 %), mixer/grinder (10 %), motorcycle (20 %). The average value of domestic assets is around Rs 19206 per households.

Table 4: Domestic assets among the sample households in Chick Hangargi-2 Microwatershed

Particulars	% of households	Average value in Rs
Mixer/grinder	10.0	2000
Mobile Phone	80.0	6625
Motorcycle	20.0	60000
Television	100.0	8200
Average Value	19206	
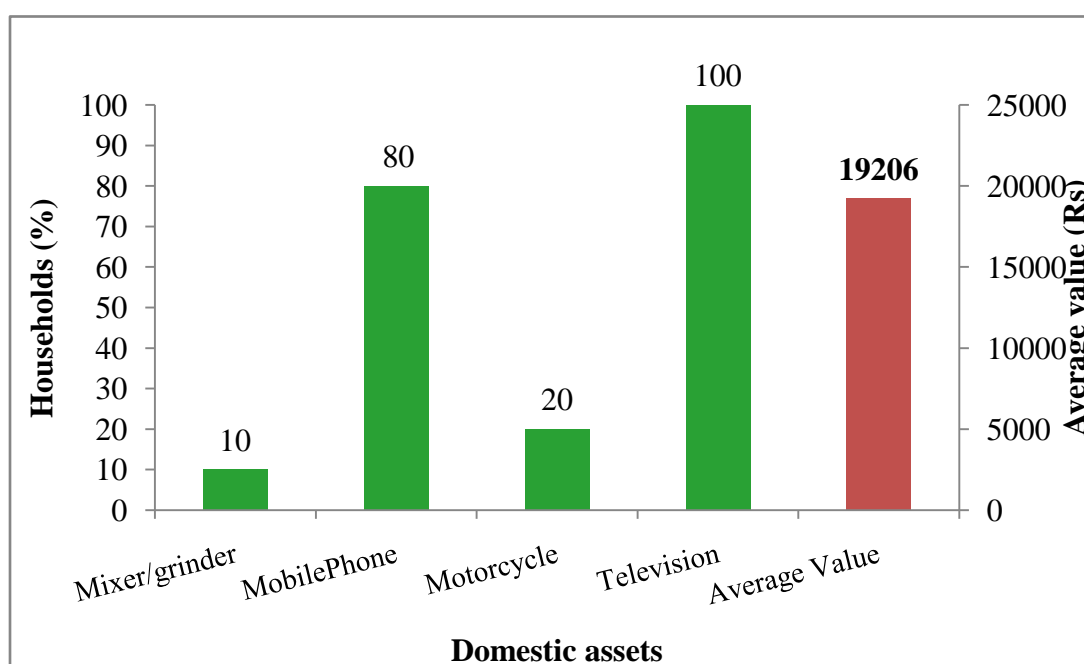
Figure 4: Domestic assets among the sample households in Chick Hangargi-2 Micro watershed

The most popularly owned farm equipments were sickles, plough, cattle shed; pump sets, chaff cutter, bullock cart, sprayer and thresher. Plough and sickle were commonly present in all the sampled farmers; these were primary implements in agriculture. The per cent of households owned weeder (50 %), plough (30), bullock cart (30 %) and sprayer (10 %) was found among the sample farmers. The average value of farm assets is around Rs 5036 per households (Table 5 and Figure 5).

Table 5: Farm assets among samples households in Chick Hangargi-2 Microwatershed

Particulars	% of households	Average value in Rs
Bullock cart	30.0	11667
Plough	30.0	6167
Sprayer	10.0	2000
Weeder	50.0	310
Average Value	5036	
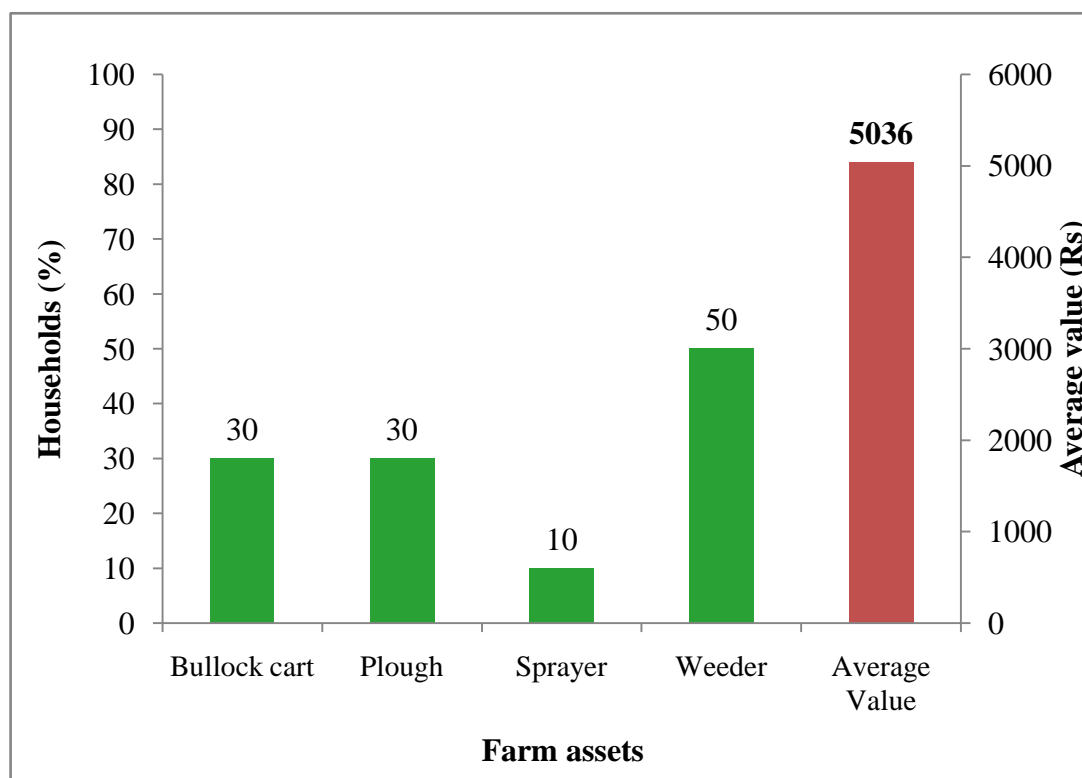
Figure 5: Farm assets among samples households in Chick Hangargi-2 Microwatershed

Livestock is an integral component of the conventional farming systems (Table 6 and Figure 6). The highest livestock population is local milching cow were around 50 per cent fallowed by sheep's (25 %) and local dry cow (25 %). The average livestock value was Rs 13667 per household.

Table 6: Livestock assets among sample households in Chick Hangargi-2 micro-watershed

Particulars	% of livestock population	Average value in Rs
Local Dry Cow	25	10000
Local Milching Cow	50	21000
Sheeps	25	10000
Average value	13667	
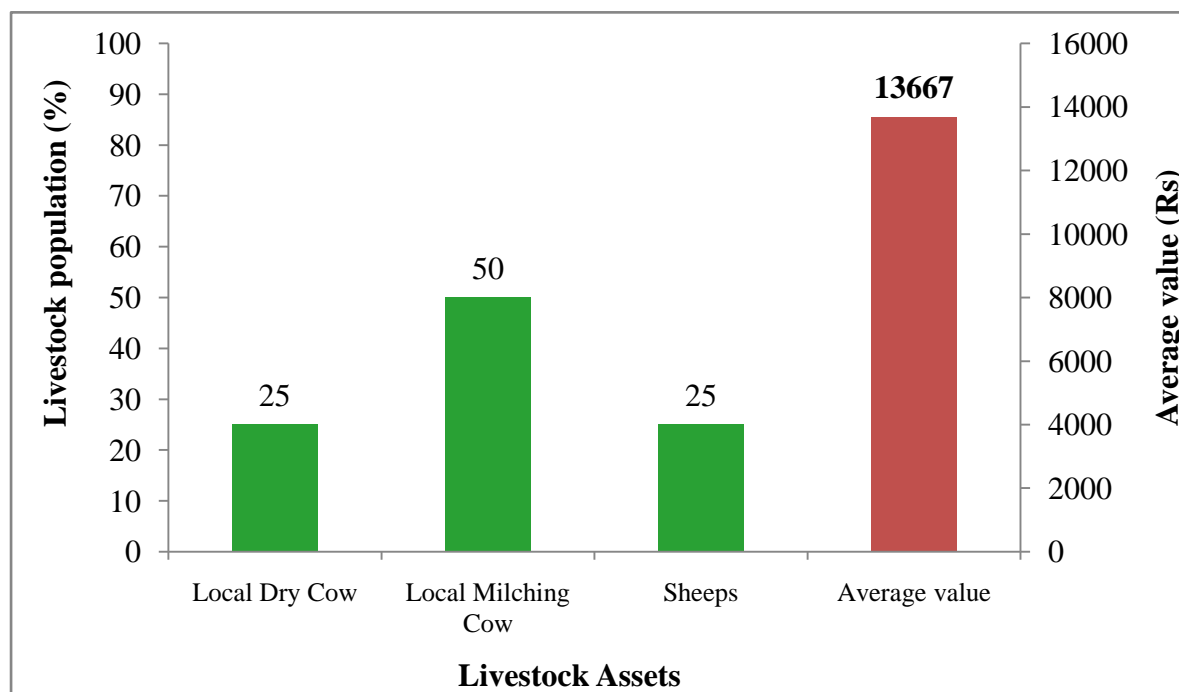
Figure 6: Livestock assets among sample households in Chick Hangargi-2 micro-watershed

Average milk produced in sample households is 1310 litters/ annum. Among the farm households of fodder sorghum and paddy are the main crops for domestic food and fodder for animals. About 1823 kg /ha of average fodder is available per season for the livestock feeding (Table 7).

Table 7: Milk produced and fodder availability of sample households in Chick Hangargi-2 Microwatershed

Particulars	
Name of the Livestock	Ltr./Lactation/animal
Local Milching Cow	1310
Average Milk Produced	1310
Fodder produces	Fodder yield (kg/ha.)
Sorghum	1563
Paddy	2083
Average fodder availability	1823
Livestock having households (%)	27
Livestock population (Numbers)	14

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

Table 8: Women empowerment of sample households in Chick Hangargi-2 Microwatershed   % to Grand Total

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

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 9 and Figure 7. More quantity of cereals is consumed by sample farmers which accounted for 969 kcal per person. The other important food items consumed was pulses 150.2 kcal followed by cooking oil 218.5 kcal, milk 84.7 kcal, vegetables 28.3 kcal, egg 164.2 kcal and meat 50.0 kcal. In the sampled households, farmers were consuming less (1664.8 kcal) than NIN- recommended food requirement (2250 kcal).

Table 9: Per capita daily consumption of food among the sample households in Chick Hangargi-2 Microwatershed

| Particulars	NIN recommendation (gram/ per day/ person)	Present level of consumption (gram/ per day/ person)	Kilo Calories /day/person
Cereals	396	285.0	969.00
Pulses	43	43.8	150.16
Milk	200	130.3	84.68
Vegetables	143	117.8	28.27
Cooking Oil	31	38.3	218.50
Egg	0.5	109.4	164.17
Meat	14.2	33.3	50.00
Total	**827.7**	**757.9**	**1664.77**
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		70	90
% Above NIN		30	10

Note: * day/person
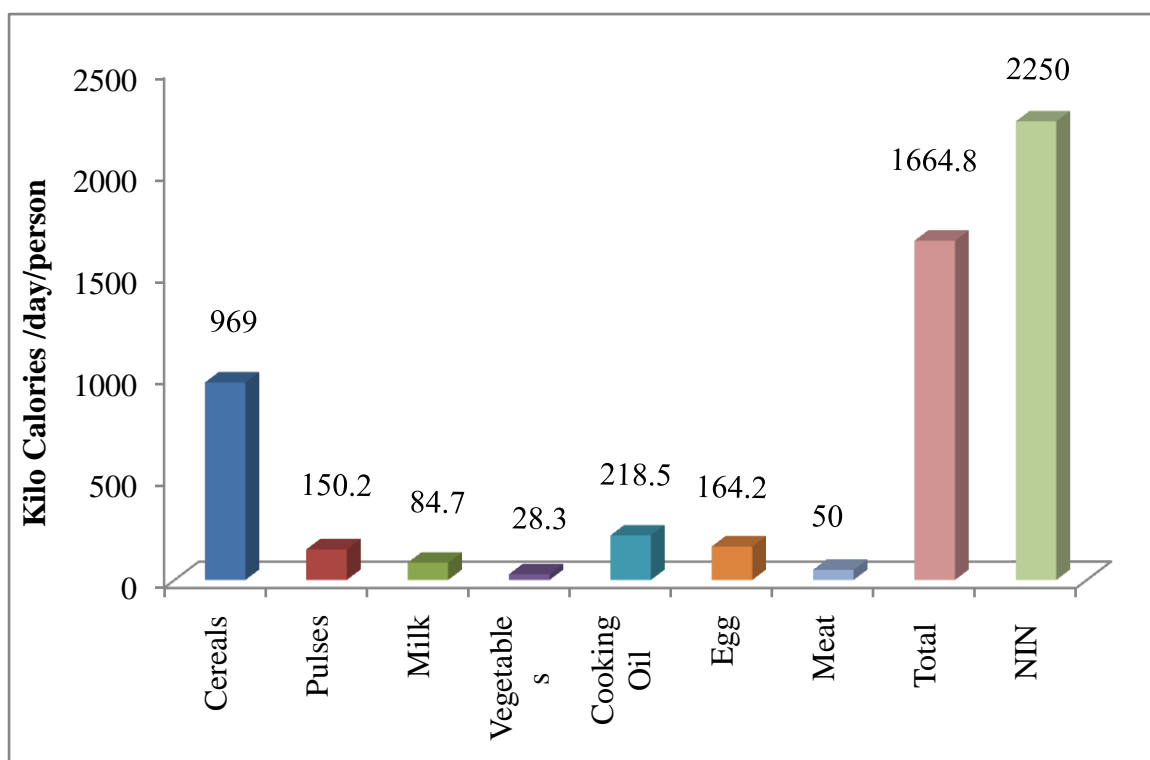
Figure 7: Per capita daily consumption of food among the sample households in Chick Hangargi-2 Microwatershed

Annual income of the sample HHs: The average annual household income is around Rs 61121. Major source of income to the farmers in the study area is from crop production (Rs 30841) followed by livestock (Rs. 30280). The monthly per capita income is Rs.1306 which is less than the threshold monthly income of Rs 975 for considering above poverty line. Due to the fact that erratic rainfall and shortage of water, farmers are diverting from crop production activities to enable the household for a comfortable livelihood. The incomes from the other aforesaid sources are very meagre (Table 10).

Table 10: Annual average income of HHs from various sources in Chick Hangargi-2 Microwatershed

Particulars	Income *
Nonfarm income (Rs)	0 (0)
Livestock income (Rs)	30280 (10)
Crop Production (Rs)	30841 (100)
Total Annual Income (Rs)	*61121*
Average monthly per capita income (Rs)	1306
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	80.0
% of households above poverty line	20.0

* Figure in the parenthesis indicates % of Households

The average annual expenditure of farm households indicated that farmers in the study area spend highest on food (Rs. 34764) followed by education, clothing, social function and health. Now a day's education is most important among all of us. In today's competitive world, education is a necessity for man after food, clothing, and shelter. It is the only fundamental way by which a desired change in the society can happen. The average per capita monthly expenditure is around Rs 1612 and about 80.0 per cent of farm households are below poverty line and 20.0 per cent of farm households are above poverty line (Table 11 and Figure 8).

Table 11: Average annual expenditure of sample HHs in Chick Hangargi-2 Microwatershed

Particulars	Value in Rupees	Per cent
Food	34764	46.1
Education	700	0.9
Clothing	5800	7.7
Social functions	24200	32.1
Health	10000	13.3
Total Expenditure (Rs/year)	75464	100.0
Monthly per capita expenditure (Rs)	1612	
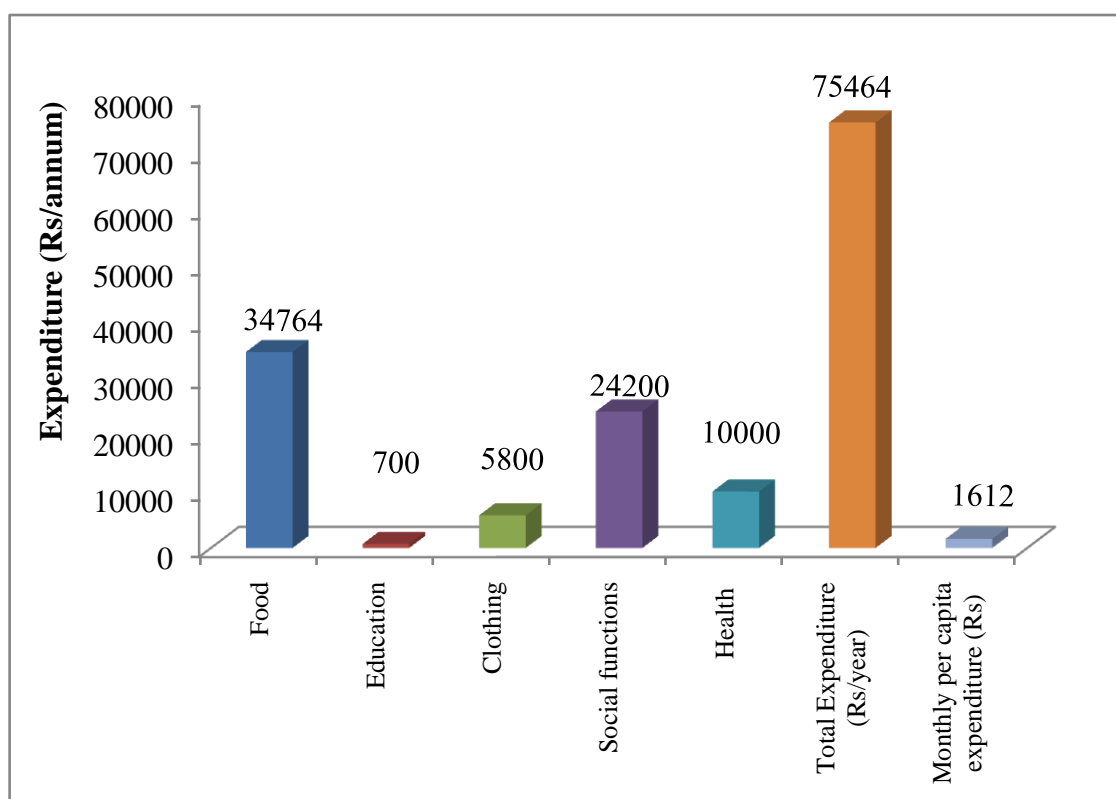
Figure 8: Average annual expenditure of sample HHs in Chick Hangargi-2 Microwatershed

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Land holding: Total area cultivated by them is 17 ha. The average land holding of sample HHs is 1.7 ha. Large number of sample HHs (80 %) belong to small size group with an average holding size of 1.2 ha followed by medium farmer (10 %) with a average land holding size of 3.3 ha and large size (10 %) with an average land holding is 4 ha (Table 12).

Table 12: Distribution of land holding among the sample households in Chick Hangargi-2 Microwatershed

Particulars	Units	Values
Small farmers		
Total land	ha	9.6
Sample size	Per cent	80
Average land holding	ha	1.2
Medium farmers		
Total land	ha	3.3
Sample size	Per cent	10
Average land holding	ha	3.3
Large farmers		
Total land	ha	4.0
Sample size	Per cent	10
Average land holding	ha	4.0
Total sample households		
Total land	ha	17.0
Sample size	Per cent	100
Average land holding	ha	1.7

Land use: The total land holding in the Chick Hangargi-2 micro-watershed is 17.0 ha (Table 13). Of which 17.0 ha is rain fed land. The average land holding per household is worked out to be 1.70 ha.

Table 13: Land use among samples households in Chick Hangargi-2 Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	0.0	0.0
Rainfed Land	100.0	17.0
Fallow Land	0.0	0.0
Total land holding	100.0	17.0
Average land holding	1.70	

In the Microwatershed, the prevalent present land uses under perennial plants are Neem trees (100 %).

The land use decisions are usually based on experience of farmers, tradition, expected profit, personal preferences, resources and social requirements. The present dominant crops grown in dry lands in the study area were by redgram (58.8 %) followed by cotton (32.8 %) and paddy (0.5 %). which are taken during Kharif and sorghum (7.9 %) rabi season respectively. The cropping intensity was 108.5 per cent (Table 14 and Figure 9).

Table 14: Present cropping pattern and cropping intensity in Chick Hangargi-2 Microwatershed
% to Grand Total

Crops	Kharif	Rabi	Grand Total
Cotton	32.8	0.00	32.8
Paddy	0.5	0.0	0.5
Redgram	58.8	0.0	58.8
Sorghum	0.0	7.9	7.9
Grand Total	92.1	7.9	100.0
Crop intensity	108.5		
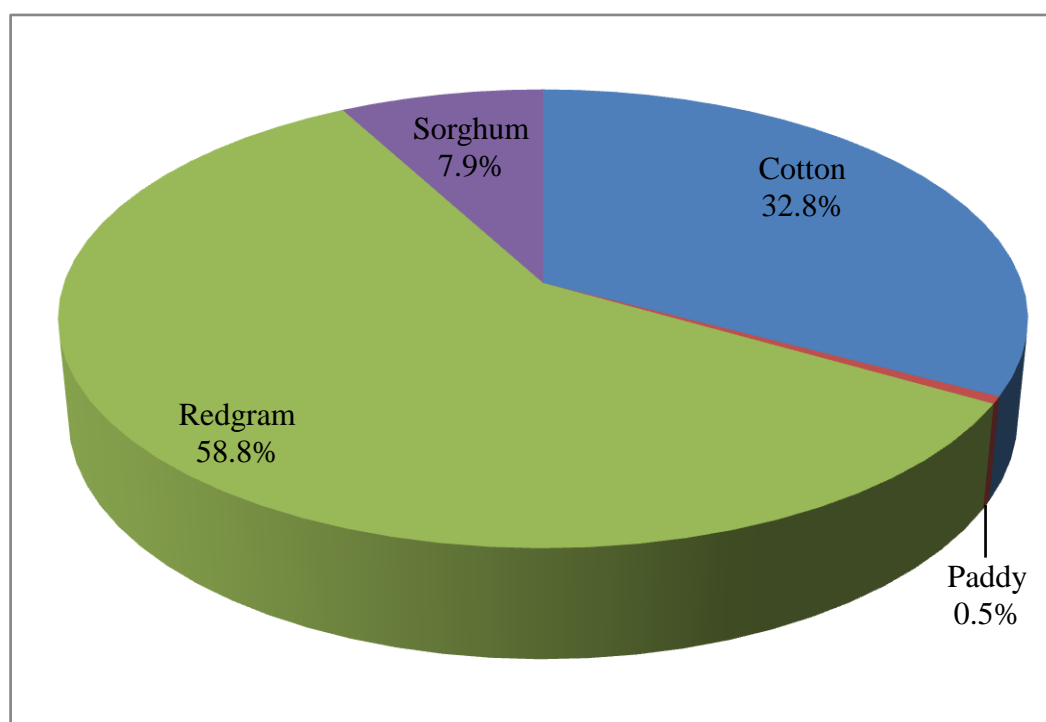
Figure 9: Present cropping pattern in Chick Hangargi-2 Microwatershed

Economic land evaluation

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

In Chick Hangargi-2 Microwatershed, 4 soil series are identified and mapped (Table 15). The distribution of major soil series are Margutti (MGT) covering an area around 277 ha (38.93 %) followed by Novinihala (NHA) 235 ha (33.09 %), Dimal (DIM) 172 ha (24.15%), and Mannur (MAR) 14 ha (2.0).

Table 15: Distribution of soil series in Chick Hangargi-2 Microwatershed

Sl. No	Soil series	Description	Area in ha (%)
1	MGT	Marguti soils are very shallow (<25cm), well drained. They have very dark grayish brown to dark brown, clayey soils and occur on very gently sloping to moderately sloping uplands	277 (38.93)
2	NHA	Novinihala soils are shallow (25-50 cm), well drained. They have very dark grayish brown to dark brown clayey soils and occur on very gently sloping to moderately sloping uplands	235 (33.09)
3	DIM	Dimal soils are deep (100-150 cm), moderately well drained. They have very dark grayish brown to very dark gray clayey soils and occur on nearly level to very gently sloping to moderately sloping uplands	172 (24.15)
4	MAR	Mannur soils are very deep (>150 cm), moderately well drained. They have very dark gray to brown clayey soils and occur on nearly level to very gently sloping uplands	14 (2.0)

Present cropping pattern on different soil series are given in Table 16. Crops grown on Margutti (MGT) soils are cotton and redgram. Redgram and sorghum on Novinihala (NHA) soils and cotton and red gram on Dimal (DIM) can grow.

Table 16: Cropping pattern on major soil series in Chick Hangargi-2 micro-watershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Grand Total
			Kharif	Rabi	
MGT	Very shallow (<25 cm)	Cotton	20.8	0.0	20.8
		Redgram	79.2	0.0	79.2
NHA	Shallow (25-50 cm)	Redgram	67.4	0.0	67.4
		Sorghum	0.0	32.6	32.6
DIM	Deep (100-150 cm)	Cotton	67.4	0.0	67.4
		Redgram	32.6	0.0	32.6

Land is used for agricultural use for growing cereals, pulse, oilseeds and commercial crops. The soil/ land potential are measures in terms of physical yield and net income. The alternative land use options for each micro-watershed are given below (Table 17).

Table 17: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Chick Hangargi-2 Microwatershed.

Soil Series	Small Farmers	Medium Farmers	Large Farmers
MGT	Cotton (1.40) & Redgram (1.46)		Redgram 2.00
NHA	Redgram (2.47) &Sorghum (1.45)		
DIM	Redgram 1.96	Cotton 1.61	

The productivity of different crops grown in Chick Hangargi-2 micro-watershed under potential yield of the crops is given in Table 18.

Table 18: Economic land evaluation and bridging yield gap for different crops in Chick Hangargi-2 micro-watershed

Particulars	MGT (<25 cm)		NHA (25-50 cm)		DIM (100-150 cm)	
	Cotton	Red gram	Red gram	Sor ghum	Cotton	Red gram
Total cost (Rs/ha)	33716	29316	21477	20465	29641	25240
Gross Return (Rs/ha)	47048	44460	52768	29640	47787	49400
Net returns (Rs/ha)	13332	15144	31292	9175	18146	24160
BCR	1.40	1.60	2.47	1.45	1.61	1.96
Farmers Practices (FP)						
FYM (t/ha)	3.0	5.6	2.4	4.2	3.0	2.5
Nitrogen (kg/ha)	43.5	36.9	26.6	22.5	82.8	28.1
Phosphorus (kg/ha)	41.1	57.5	68.0	57.5	69.5	71.9
Potash (kg/ha)	0.0	0.0	0.0	0.0	0.0	0.0
Grain (Qtl/ha)	11.9	11.3	11.9	13.3	15.1	12.5
Price of Yield (Rs/Qtl)	4000	4000	4500	2000	3200	4000
Soil test based fertilizer Recommendation (STBR)						
FYM (t/ha)	12.4	7.4	7.4	7.4	12.4	7.4
Nitrogen (kg/ha)	185.3	27.8	27.8	101.9	148.2	30.9
Phosphorus (kg/ha)	92.6	61.8	61.8	71.0	92.6	61.8
Potash (kg/ha)	55.6	20.1	24.7	39.5	55.6	18.5
Grain (Qtl/ha)	17.3	12.4	12.4	28.4	17.3	12.4
% of Adoption/yield gap (STBR-FP) / (STBR)						
FYM (%)	75.9	24.1	67.8	43.8	75.5	66.3
Nitrogen (%)	76.5	-32.7	4.3	77.9	44.1	8.9
Phosphorus (%)	55.7	6.9	-10.0	19.0	24.9	-16.4
Potash (%)	100.0	100.0	100.0	100.0	100.0	100.0
Grain (%)	31.1	8.9	3.4	53.1	12.6	-1.2
Value of yield and Fertilizer (Rs)						
Additional Cost (Rs/ha)	14455	2264	5259	5581	12239	4868
Additional Benefits (Rs/ha)	21541	4400	1882	30143	6960	-600
Net change Income (Rs/ha)	7086	2136	-3377	24562	-5279	-5468

The data on cost of cultivation and benefit cost ratio (BCR) of different crops is given in Table 18. The total cost of cultivation in study area for cotton range between Rs 33716/ha in MGT soil (with BCR of 1.40) and Rs 29641/ha in DIM soil (with BCR of 1.61), redgram range between Rs. 29316/ha in MGT soil (with BCR of 1.60) and Rs 21477/ha in NHA soil (with BCR of 1.47), sorghum cost of cultivation in NHA soil Rs 20465/ha (with BCR of 1.45).

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Table 18. There is a huge gap between FYM application by farmers and recommended FYM in all the crops across the soils. There is a larger yield gap in crops grown across different soil series. Adequate knowledge about recommended package of practices is the pre-requisite for their use in cultivation of crops. It is a fact that, recommended practices are major contributing factors to yield. Inadequate knowledge about recommended practices leads to their improper adoption. Strengthening of extension services by concerned agency is required to increase adoption of recommended cultivation practices and ultimately reducing the gap. By adopting soil-test fertiliser recommendation, there is scope to increase yield and income to a maximum of Rs 24562 in sorghum and a minimum of Rs 2136 in redgram cultivation

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

Table 19: Estimation of onsite cost of soil erosion in Chick Hangargi-2 Microwatershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total
Organic matter	93.67	65382	590.12	411905
Phosphorous	0.06	41	2.60	1817
Potash	2.59	1805	51.72	36100
Iron	0.08	54	3.72	2599
Manganese	0.05	34	13.39	9347
Cupper	0.02	16	12.68	8848
Zinc	0.01	4	0.23	161
Sulpher	0.19	136	7.79	5439
Boron	0.01	6	0.32	225
Total	96.67	67478	682.58	476440

The onsite cost of different soil nutrients lost due to soil erosion is given in Table 19 and Figure 10. The average value of soil nutrient loss is around Rs 682.6 per ha/year. The total cost of annual soil nutrients is around Rs 476440 per year for the total area of 698 ha.
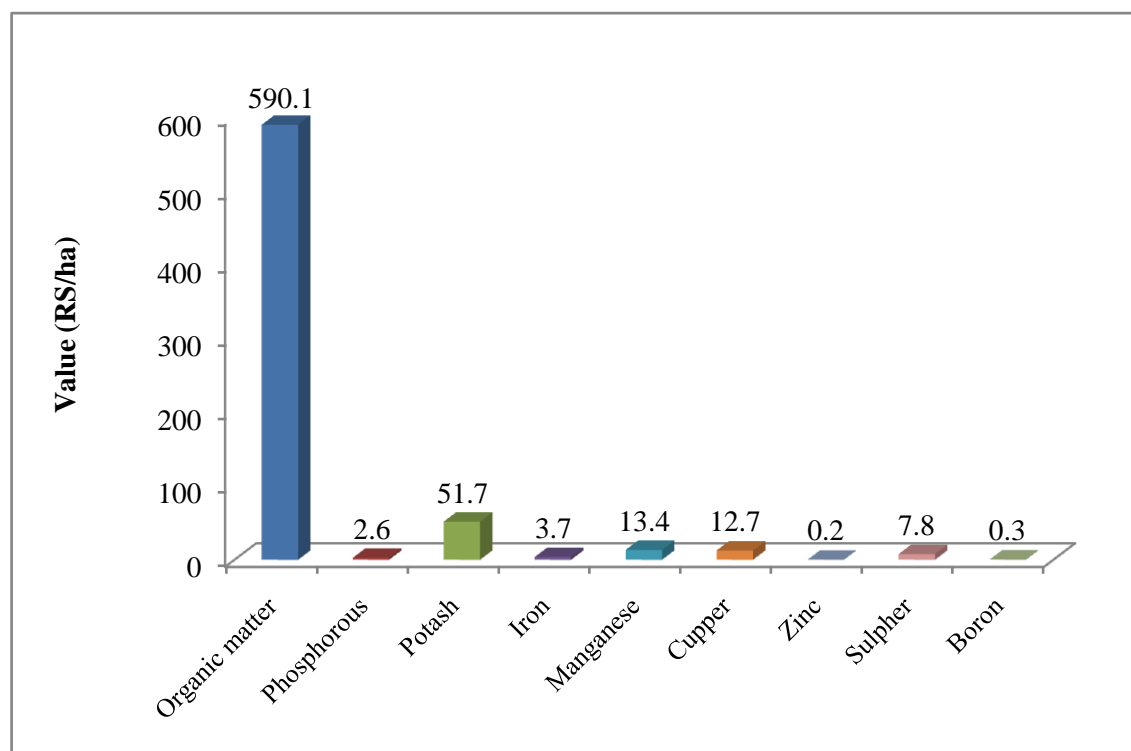

Figure 10: Estimation of onsite cost of soil erosion in Chick Hangargi-2 Microwatershed

The average value of ecosystem service for food grain production is around Rs 14448/ ha/year (Table 20 and figure 11). Per hectare food grain production services is maximum in redgram (Rs 21082) followed by cotton (Rs 16373) and sorghum (Rs 5889).

Table 20: Ecosystem services of food grain production in Chick Hangargi-2 Microwatershed

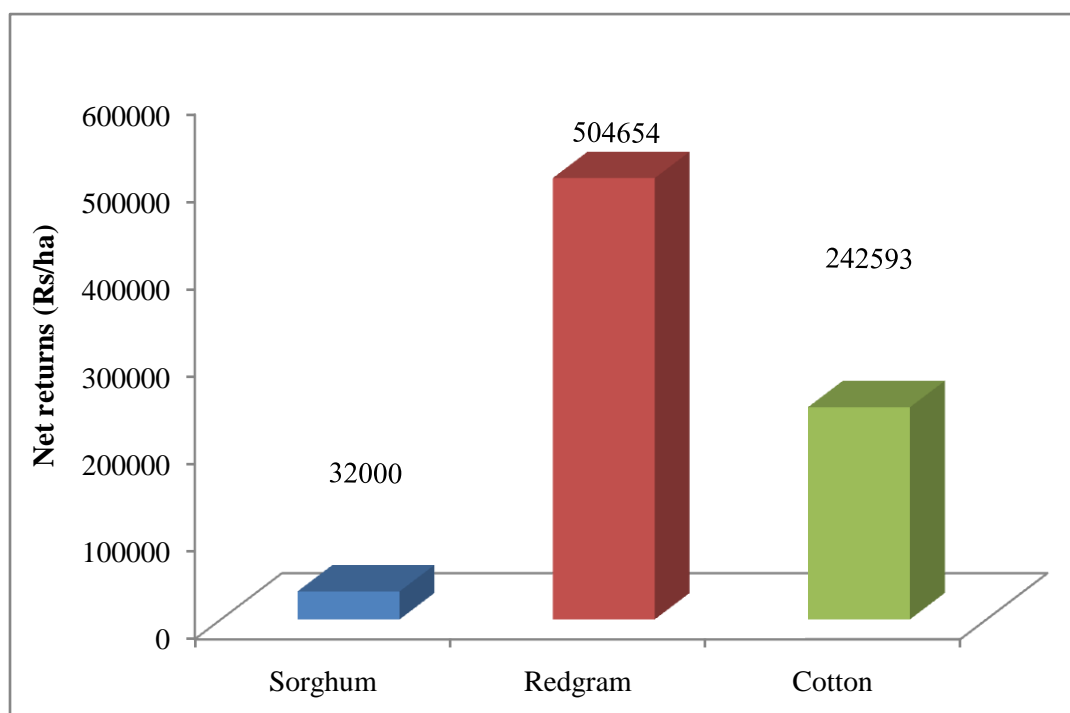| Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net returns (Rs/ha)
Cereals	Sorghum	1.2	13	2000	26347	20465	5889
Pulses	Redgram	10.6	11	4143	47576	26494	21082
Commercial Crops	Cotton	5.0	13	3600	48052	31678	16373
Average value		16.8	12	3248	40658	26212	14448

Figure 11: Ecosystem services of food grain production in Chick Hangargi-2
Microwatershed

The average value of ecosystem service for fodder production is around Rs 3293/
ha/year (Table 21). Per hectare fodder production services is in sorghum (Rs 3293).

Table 21: Ecosystem services of fodder production in Chick Hangargi-2 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Net Returns (Rs/ha)
Cereals	Sorghum	1.2	3.3	1000	3293

The water demand for production of different crops was worked out in arriving at
the ecosystem services of water support to crop growth. The data on water requirement
for producing one quintal of grain is considered for estimating the total value of water
required for crop production. The per hectare value of water used and value of water was
maximum (Table 22) in redgram (Rs 62518), cotton (Rs 53778) and sorghum (Rs 40152).

Table 22: Ecosystem services of water supply in Chick Hangargi-2 Microwatershed

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Cotton	13.3	5378	53778	403
Redgram	11.5	6252	62518	544
Sorghum	13.2	4015	40152	305
Average value	38	5215	52150	417

The main farming constraints in Chick Hangargi-2 micro-watershed to be found are less rainfall, lack of good quality seeds, non availability fertilizers, high crop pests & diseases, animal pests & diseases, lack of transportation, lack of storage, damage of crops by wild animals and non availability of plant protection chemicals. Majority of farmers depend up on money lender of the sources of loan for purpose of crop production. Farmers to sell the agriculture produce through village market and the farmers getting the agriculture related information on mobile, newspaper and television. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 23).

Table 23: Farming constraints related land resources of sample households in Chick Hangargi-2 Microwatershed

Sl.No	Particulars	Per cent
1	Less Rainfall	70.0
2	Lack of good quality seeds	50.0
3	Non availability Fertilizers	10.0
4	High Crop Pests & Diseases	20.0
5	Animal Pests & Diseases	40.0
6	Lack of transportation	60.0
7	Lack of storage	90.0
8	Damage of crops by Wild Animals	70.0
9	Non availability of Plant Protection Chemicals	100.0
10	**Source of loan**	
	Bank	50.0
	Money Leander	50.0
11	**Market for selling**	
	Regulated	10.0
	Village market	90.0
12	**Sources of Agri-Technology information**	
	Mobile	10.0
	Newspaper	50.0
	Television	40.0

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