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

BACHAWAR (4D5B1D2d) MICROWATERSHED

Yadgir Taluk and District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

THE WORLD BANK

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

ICAR - NBSS & LUP

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

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

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

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PREFACE

In Karnataka, as in other Indian States, the livelihoods of rural people are intertwined with farming pursuits. The challenges 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 Bachawar Microwatershed, Yadgir Taluk and District, Karnataka" for integrated development was taken up in collaboration with the State Agricutural Universities, IISC, KSRSAC, KSNDMC as Consortia partners. The project provides detailed land resource information at cadastral level (1:7920 scale) for all the plots and socio-economic status of farm households covering thirty per cent farmers randomely selected representing landed and landless class of farmers in the micro-watershed. The project report with the accompanying maps for the Microwatershed will provide required detailed database for evolving effective land use plan, alternative land use options and conservation plans for the planners, administrators, agricutural extention personnel, KVK officials, developmental departments and other land users to manage the land resources in a sustainable manner.

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

Nagpur
Date: 26-10-2019

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

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

The present study covers an area of 429 ha in Bachawar microwatershed in Yadgir taluk & district, Karnataka. The climate is semiarid and categorized as drought-prone with an average annual rainfall of 866 mm, of which about 652 mm is received during south-west monsoon, 138 mm during north-east and the remaining 76 mm during the rest of the year. An area of 272 ha in the microwatershed is covered by soils, 149 ha by rock outcrops and about 7 ha by others (habitation and water bodies). The salient findings from the land resource inventory are summarized briefly below.

- *The soils belong to 3 soil series and 5 soil phases (management units) and 2 land management units.*
- *The length of crop growing period is about 120-150 days starting from 1st week of June to 4th 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 320 m grid interval.*
- *Land suitability for growing 29 major agricultural and horticultural crops was assessed and maps showing the degree of suitability along with constraints were generated.*
- *Entire area in the microwatershed is suitable for agriculture.*
- *About 64 per cent area of the microwatershed has soils are very shallow to moderately shallow (<25-75 cm).*
- *About 14 per cent area in the microwatershed has sandy soils, 50 per cent has loamy soils and 1 per cent clayey soils.*
- *About of 1 per cent area of the microwatershed has non gravelly (<15%) soils and 62 per cent has gravelly (15-35%) soils.*
- *Entire cultivated area of the microwatershed is very low (<50 mm/m) in available water capacity.*

- *An area of 28 per cent has very gently sloping (1-3% slope) lands and 35 per cent has gently sloping (3-5% slope) lands in the microwatershed.*
- *An area of about 28 per cent area is moderately (e2) eroded and 35 per cent area is severely (e3) eroded.*
- *An area of about 2 per cent is slightly acid (pH 6.0-6.5), 28 per cent is neutral (pH 6.5-7.3), 32 per cent is slightly alkaline (pH 7.3-7.8) and 1 per cent is moderately alkaline (pH 7.8-8.4) in reaction.*
- *The Electrical Conductivity (EC) of the soils in the entire cultivated area of the microwatershed is dominantly <2 dsm^{-1} indicating that the soils are non-saline.*
- *Entire cultivated area of the microwatershed has soils that are high (>0.75%) in organic carbon content.*
- *Entire cultivated area of the microwatershed is medium (23-57 kg/ha) available phosphorus content.*
- *Entire cultivated area of the microwatershed is medium (145-337 kg/ha) in available potassium content.*
- *Available sulphur is low (<10 ppm) in 23 per cent, medium (10-20 ppm) in 31 per cent and high (>20 ppm) in 9 per cent of the microwatershed.*
- *Available boron is low (<0.5 ppm) in the entire cultivated area of the microwatershed.*
- *Available iron is sufficient (>4.5 ppm) in the entire cultivated area of the microwatershed.*
- *Available manganese and copper are sufficient in the entire cultivated area of the microwatershed.*
- *Available zinc is deficient (<0.6 ppm) in 34 per cent and sufficient (<0.6 ppm) in 30 per cent area of the microwatershed.*
- *The land suitability for 29 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	-	-		*Guava*	-	-
Maize	-	-		*Sapota*	-	-
Bajra	-	-		*Pomegranate*	-	-
Groundnut	-	-		*Musambi*	-	-
Sunflower	-	-		*Lime*	-	-
Redgram	-	-		*Amla*	-	-
Bengal gram	-	-		*Cashew*	-	-
Cotton	-	-		*Jackfruit*	-	-
Chilli	-	-		*Jamun*	-	-
Tomato	-	-		*Custard apple*	-	-
Brinjal	-	-		*Tamarind*	-	-
Onion	-	-		*Mulberry*	-	-
Bhendi	-	-		*Marigold*	-	-
Drumstick	-	-		*Chrysanthemum*	-	-
Mango	-	-				

- *Apart from the individual crop suitability, a proposed crop plan has been prepared for the identified LMUs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fodder, fibre and horticulture crops.*
- *Maintaining soil-health is vital for 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 sub marginal lands, field bunds and also in the hillocks, mounds and ridges. This would help in not only supplementing the farm income but also provide fodder and fuel and generate lot of biomass which would help in maintaining an ecological balance and also contribute to mitigating the climate change.*

Chapter 1

INTRODUCTION

Land is a scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use the land in a rational and judicious manner. But what is happening in many areas of the state is a cause for concern to everyone involved in the management of land resources at the grassroots level. The area available for agriculture is about 51 per cent of the total 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 uncultivated areas are facing various degrees of degradation, particularly soil erosion. Salinity and alkalinity has emerged as a major problem in more than 3.5 lakh ha in the irrigated areas of the state. Nutrient depletion and declining factor productivity is common in both rainfed and irrigated areas. The degradation is continuing at an alarming rate and there appears to be no systematic effort among the stakeholders to contain this process. In recent times, an aberration of weather due to climate change phenomenon has added another dimension leading to unpredictable situations to be tackled by the farmers.

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

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

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

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

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

Chapter 2

GEOGRAPHICAL SETTING

2.1 Location and Extent

The Bachawar microwatershed is located in the northern part of Karnataka in Yadgir Taluk & District, Karnataka State (Fig.2.1). It comprises parts of Yagapura, Yakkihalli and Yaragola villages. It lies between 16^0 54'- 16^0 53' North latitudes and 77^0 6'-77^0 8' East longitudes covering an area of about 428.65 ha. It is about 15 km northeast of Yadgir town and is surrounded by Yakkihalli village on the east, Yaragola on the northwest and west and Yagapura on the northwestern side.

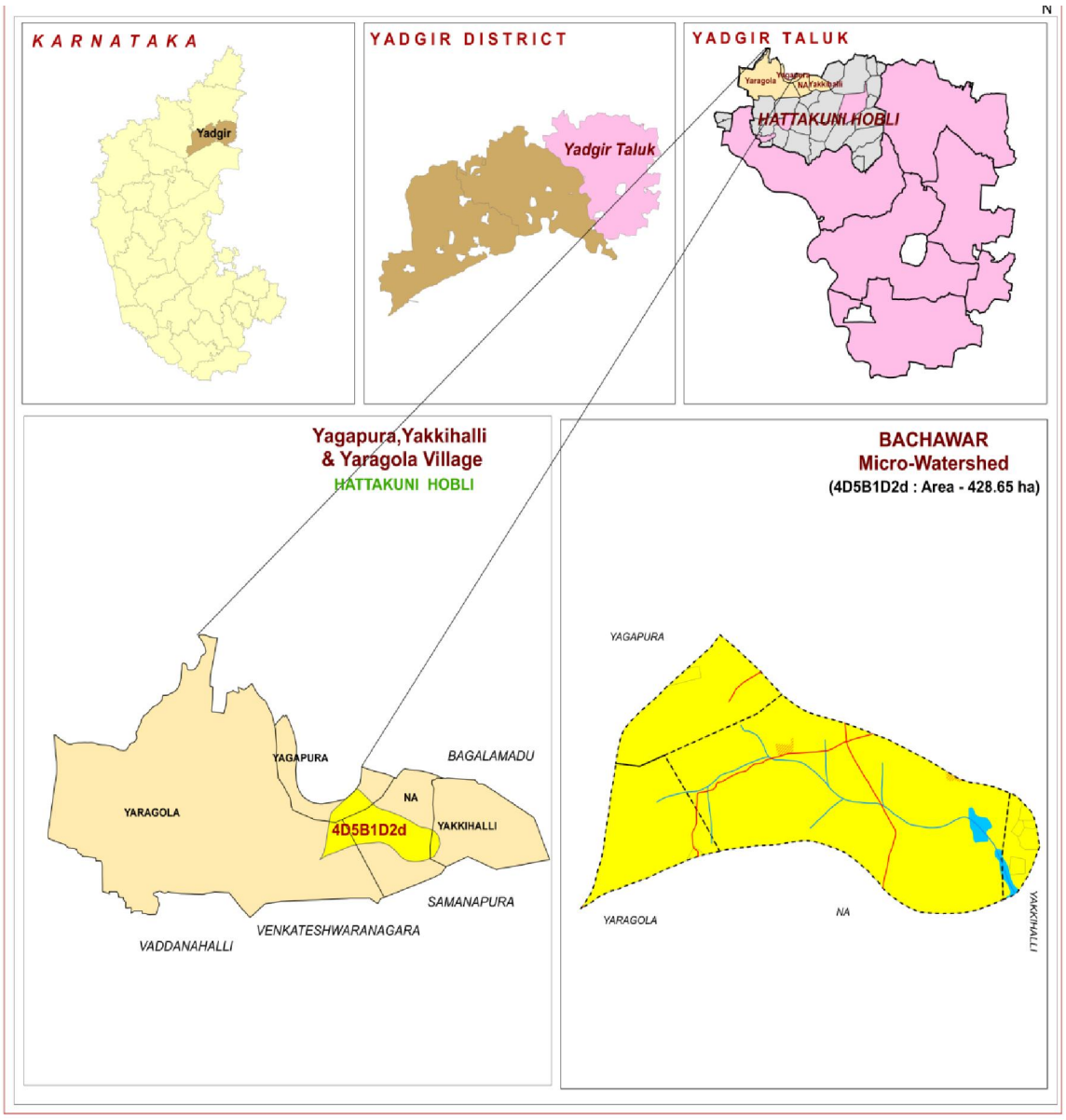


Fig.2.1 Location map of Bachawar Microwatershed

2.2 Geology

Major rock formation observed in the microwatershed is granite gneiss (Fig.2.2). Granite gneisses are essentially pink to gray and are coarse to medium grained. They consist primarily of quartz, feldspar, biotite and hornblende. The gray granite gneisses are highly weathered, fractured and fissured up to a depth of about 10 m. Dolerite dykes and quartz veins are common with variable width and found to occur in Bachawar microwatershed. Underlying formation is gneiss over limestone and shale.

Fig.2.2 Granite gneiss rocks

2.3 Physiography

Physiographically, the area has been identified as granite gneiss landscape based on geology. The area has been further subdivided into five landforms, *viz;* mounds/ridges, summits, side slopes and very gently sloping uplands, plains and valleys based on slope and its relief features. The elevation ranges from 425-548 m above MSL. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

The area is drained by several parallel streams like Bori, Amerja and Kanga which finally join the river Bhima along its course. Though, they are not perennial, during rainy season they carry 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 Yadgir district lies in the northern plains of Karnataka and falls under semiarid tract of the state and is categorized as drought- prone with total annual rainfall of 866 mm (Table 2.1). Of the total rainfall, maximum of 652 mm is received during the south–west monsoon period from June to September, the north-east monsoon from October to early December contributes about 138 mm and the remaining 76 mm during the rest of the year. The summer season starts during the middle of February and continues up to the first week of June. The period from December to the middle of February is the coldest season. December is the coldest month with mean daily maximum and minimum temperatures being 29.5^0C and 10^0C respectively. During peak summer, temperature shoots up to 45^0C. Relative humidity varies from 26% in summer to 62% in winter. Rainfall distribution is shown in Figure 2.3. The average Potential Evapo-Transpiration (PET) is 141 mm and varies from a low of 81 mm in December to 199 mm in the month of May. The PET is always higher than precipitation in all the months except end of June to end of September. Generally, the Length of crop Growing Period (LGP) is 120-150 days and starts from 1st week of June to 4th week of October.

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

Sl. No.	Months	Rainfall	PET	1/2 PET
1	January	4.30	86.0	43.0
2	February	2.30	125.5	62.7
3	March	15.10	166.0	83.0
4	April	18.50	179.8	89.9
5	May	36.0	198.8	97.9
6	June	118.0	175.1	87.5
7	July	171.80	156.3	78.1
8	August	182.9	150.3	75.1
9	September	179.7	142.0	71.0
10	October	105.3	138.5	69.2
11	November	26.4	97.60	48.6
12	December	6.0	80.90	40.4
Total		**866.3**		

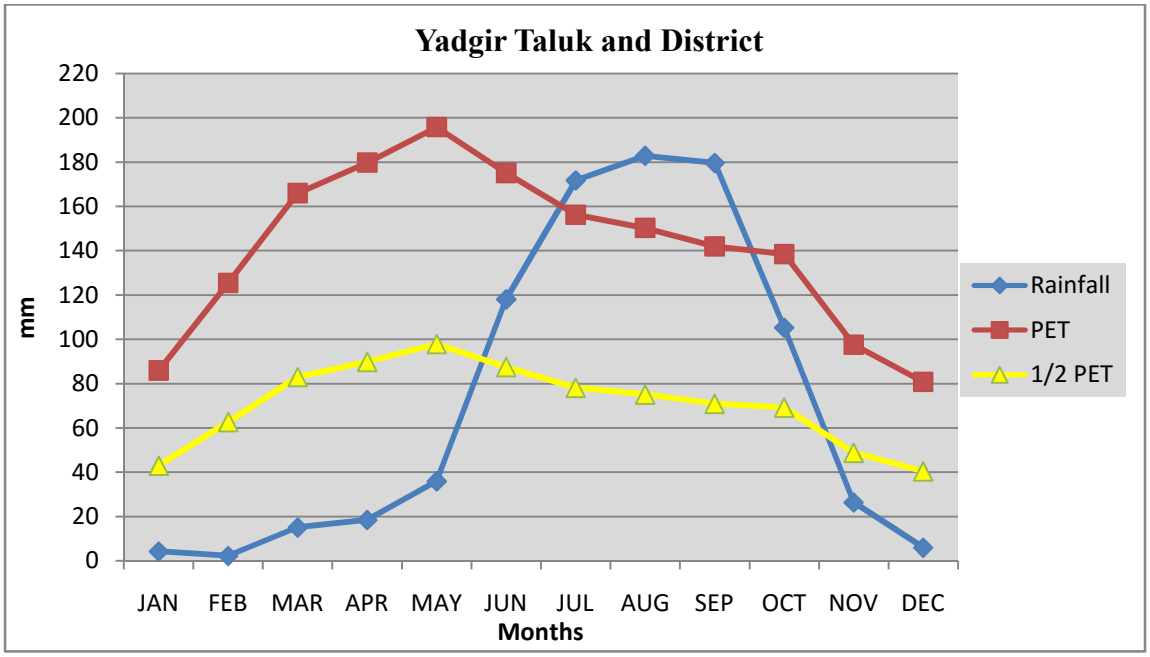


Fig 2.3 Rainfall distribution in Yadgir Taluk, Yadgir District

2.6 Natural Vegetation

The natural vegetation is sparse comprising few tree species, shrubs and herbs. The mounds, ridges and boulders occupy very sizeable area which is 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 Bachawar Microwatershed

2.7 Land Utilization

About 72 per cent area (Table 2.2) in Yadgir district is cultivated at present. An area of about 2 per cent is permanently under pasture, 20 per cent under current fallows and 6 per cent under non-agricultural land and 5 per cent under currently barren. Forests occupy an area of about 7 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 paddy, cotton, jowar and red gram. While carrying out land resource inventory, the land use/land cover particulars are collected from all the survey numbers and a current land use map of the microwatershed is prepared. The current land use map prepared shows the arable and non-arable lands, other land uses and different types of crops grown in the area. The current land use map of Bachawar microwatershed is presented in Fig.2.5. The different crops and cropping systems adopted in the microwatershed is presented in the Figures 2.6.

Table 2.2 Land Utilization in Yadgir District

Sl. No.	Agricultural land use	Area (ha)	Per cent
1	Total geographical area	516088	-
2	Total cultivated area	373617	72.4
3	Area sown more than once	74081	14.3
4	Cropping intensity	-	119.8
5	Trees and grooves	737	0.14
6	Forest	33773	6.54
7	Cultivable wasteland	2385	0.46
8	Permanent Pasture land	11755	2.28
9	Barren land	27954	5.41
10	Non- Agriculture land	29623	5.73
11	Current Fallows	105212	20.4

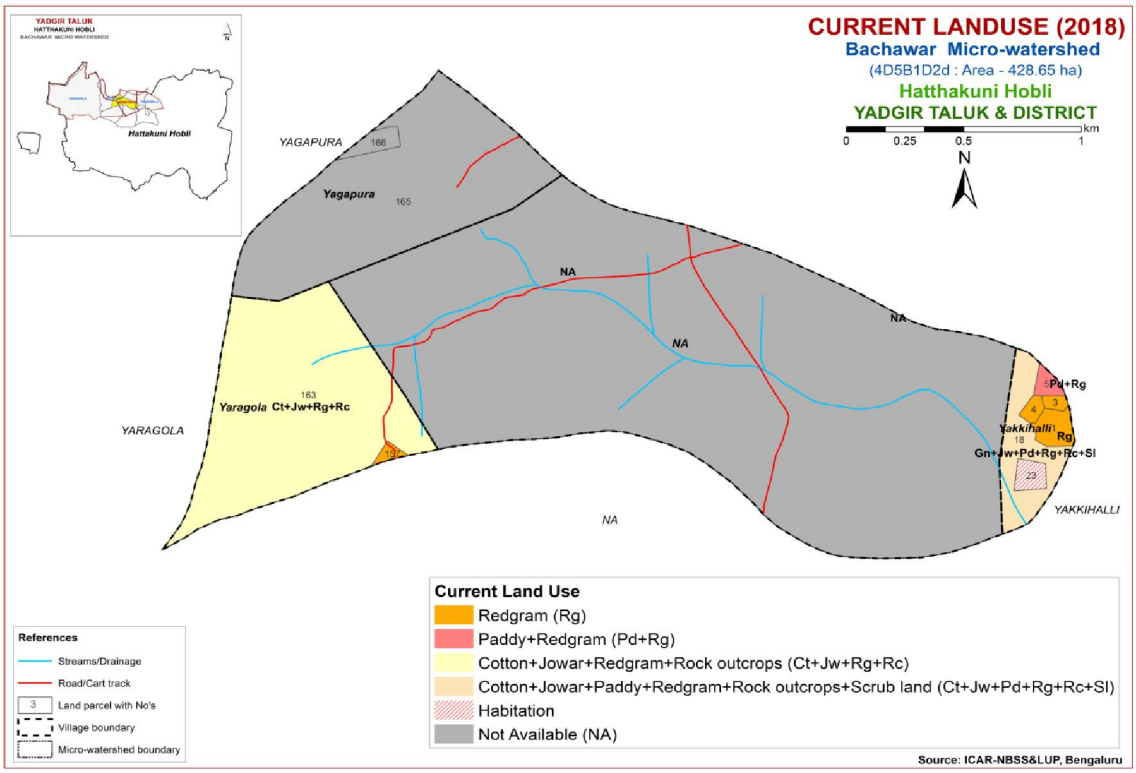


Fig.2.5 Current Land Use map of Bachawar Microwatershed

Fig. 2.6 Different Crops and Cropping Systems in Bachawar Microwatershed

Chapter 3

SURVEY METHODOLOGY

The purpose of land resource inventory is to delineate similar areas (soil series and phases), which respond or expected to respond similarly to a given level of management. This was achieved in Bachawar 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.) followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units, and showing the area extent and their geographic distribution on the microwatershed cadastral map. The detailed survey at 1:7920 scale was carried out in an area of 429 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 and IRS satellite imagery as base supplied by KSRSAC. The cadastral map shows field boundaries with their survey numbers, location of tanks, streams and other permanent features of the area (Fig. 3.1). Apart from the cadastral map, remote sensing data products from Cartosat-1 and LISS IV merged at the scale of 1:7920 were used in conjunction with the cadastral map to identify the 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 microwatershed area was visually interpreted using image interpretation elements and all the available collateral data with local knowledge. The delineated physiographic boundaries were transferred on to a cadastral map overlaid on satellite imagery. Physiographically, the area has been identified as granite gneiss landscape. It was divided into five landforms, *viz;* ridges and mounds, gently and very gently sloping uplands and lowlands based on slope and image characteristics. They were further subdivided into physiographic/image interpretation units based on image characteristics. The image interpretation legend for physiography is given below.

Image Interpretation Legend for Physiography

G- Granite Gneiss Landscape

G1			Hills/ Ridges/ Mounds
	G11		Summits
	G12		Side slopes
		G121	Side slopes with dark grey tones
G2			Uplands
	G21		Summits
	G22		Gently sloping uplands
		G221	Gently sloping uplands, yellowish green (eroded)
		G222	Gently sloping uplands, yellowish white (severely eroded)
	G23		Very gently sloping uplands
		G231	Very gently sloping uplands, yellowish green
		G232	Very gently sloping uplands, medium green and pink
		G233	Very gently sloping uplands, pink and green (scrub land)
		G234	Very gently sloping uplands, medium greenish grey
		G235	Very gently sloping uplands, yellowish white (eroded)
		G236	Very gently sloping uplands, dark green
		G237	Very gently sloping uplands, medium pink (coconut garden)
		G238	Very gently sloping uplands, pink and bluish white (eroded)
	G24		Valleys/ lowlands
		G241	Valleys, pink tones
		G242	Valleys gray mixed with pink tones

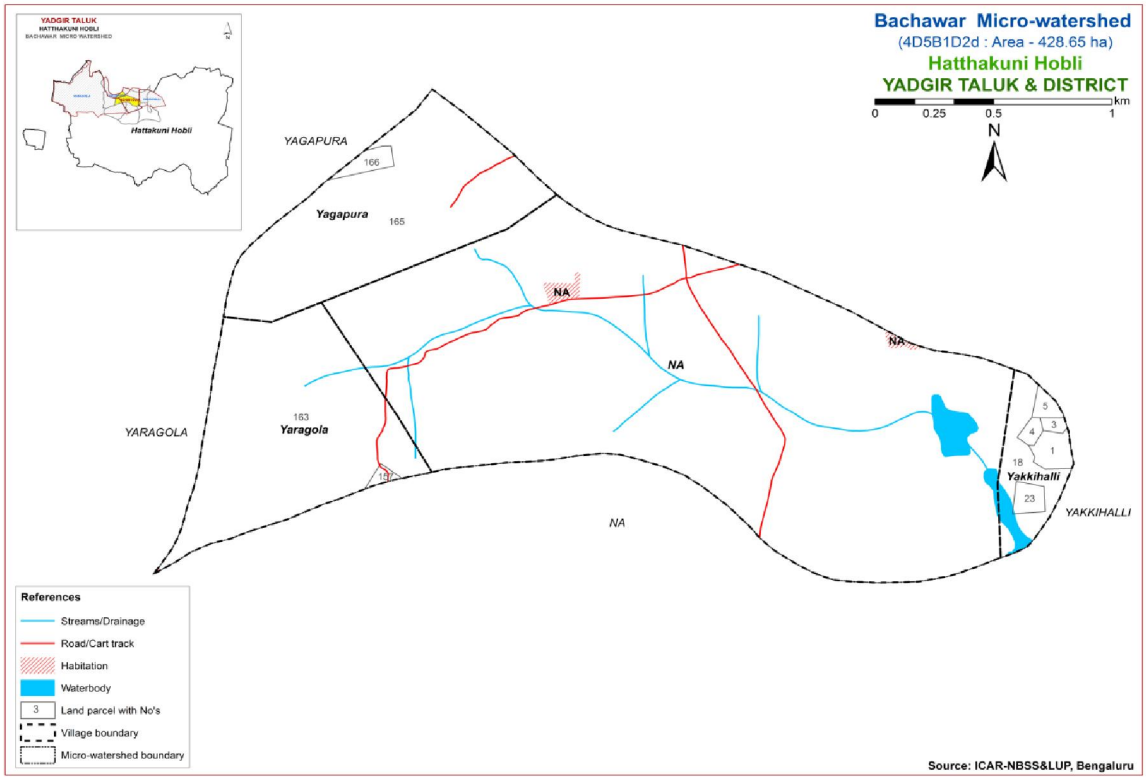


Fig 3.1 Scanned and Digitized Cadastral map of Bachawar Microwatershed

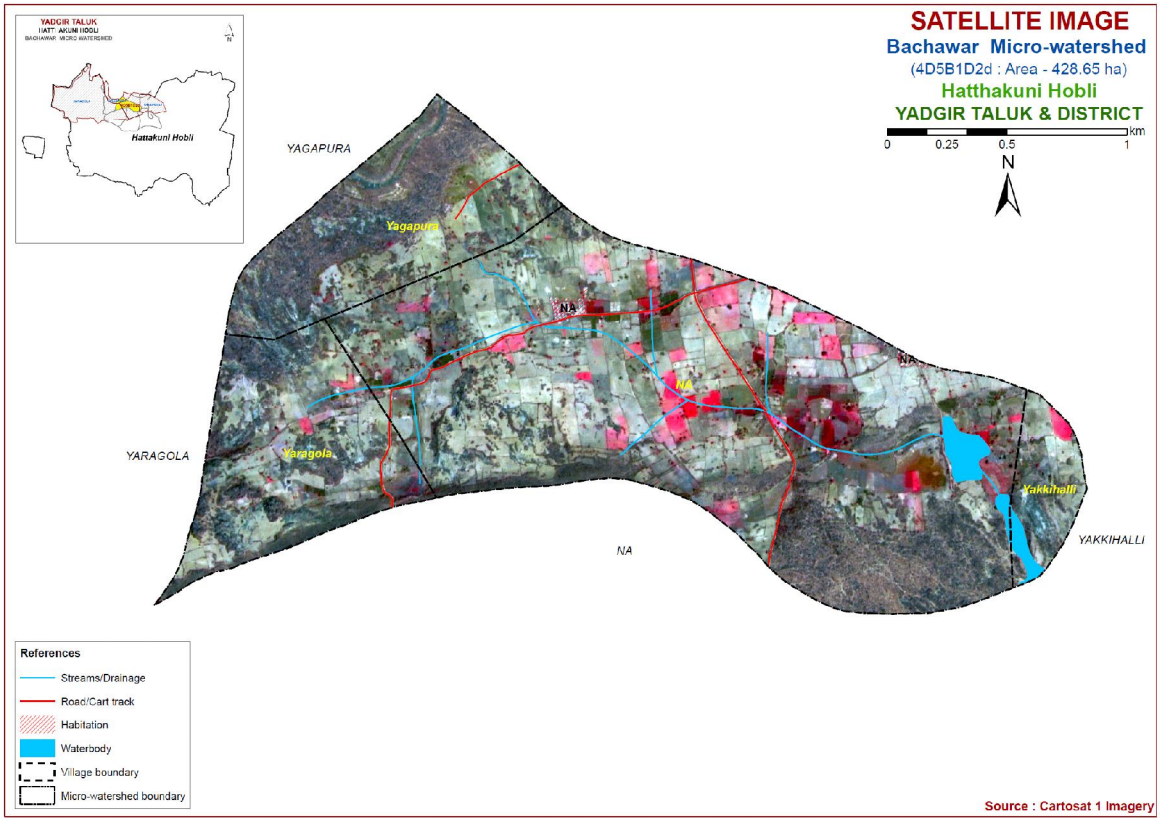


Fig.3.2 Satellite Image of Bachawar Microwatershed

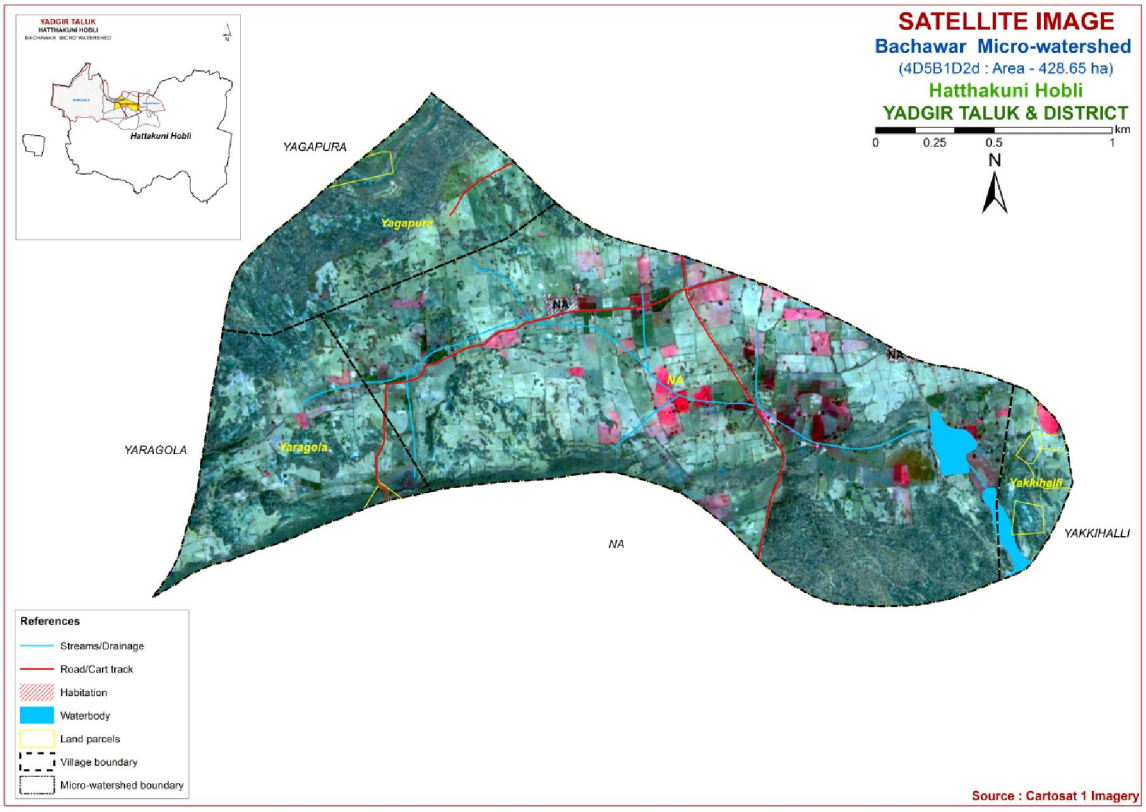


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Bachawar Microwatershed

3.3 Field Investigation

The field boundaries and survey numbers given on the cadastral sheet were located on the ground by following permanent features like roads, cart tracks, *nallas,* streams, tanks etc., and wherever changes were noticed, they were incorporated on the microwatershed cadastral map. Preliminary traverse of the microwatershed was carried out with the help of cadastral map, imagery and toposheets. While traversing, landforms and physiographic units identified were checked and preliminary soil legend was prepared by studying soils at few selected places. Then, intensive traversing of each physiographic unit like hills, ridges, uplands and valleys 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).

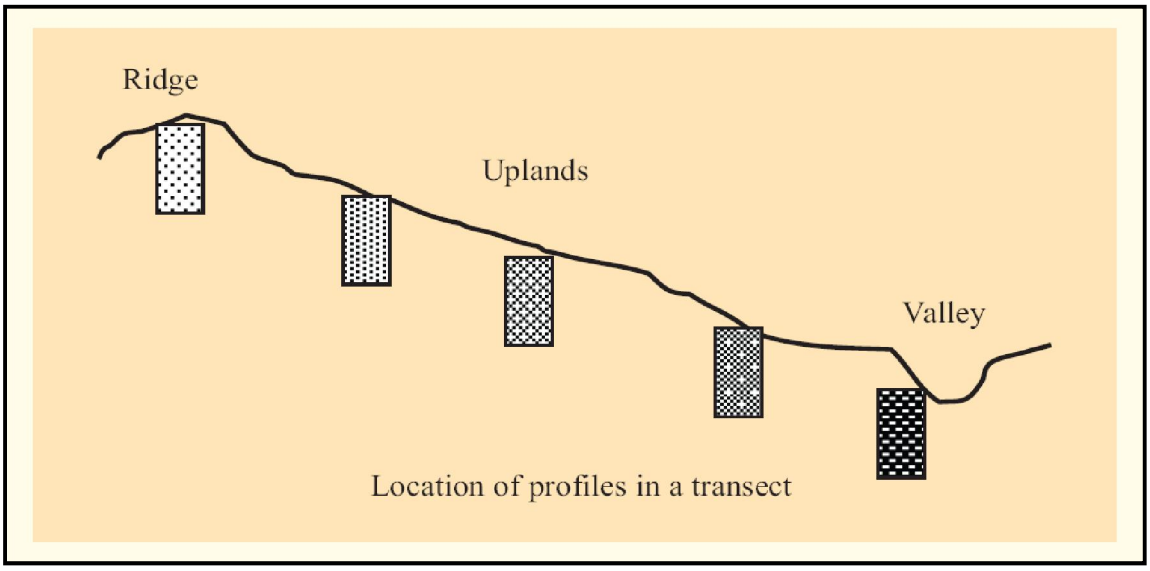


Fig: 3.4. Location of profiles in a transect

In the selected transect, soil profiles were located (Fig. 3.4) 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 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, calcareousness, amount and nature of gravel present, nature of substratum etc, were used as the major differentiating characteristics for

identifying soil series occurring in the area. The differentiating characteristics used for identifying the soil series are given in Table 3.1. Based on the above characteristics, 3 soil series were identified in the Bachawar microwatershed.

Table 3.1 Differentiating Characteristics used for identifying Soil Series

(Characteristics are of Series Control Section)

Soils of Granite gneiss Landscape							
Sl. no	**Soil Series**	**Depth (cm)**	**Colour (moist)**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcareousness**
1	KKR (Kakalawar)	<25	7.5YR 4/3 10YR 6/3	sl	10-15	Ap-AC	-
2	BDL (Badiyala)	25-50	7.5YR 2.5/3,2.5/2,3/3 10YR 3/4,4/3	sl	-	Ap-Bw	e
5	SBR (Sambra)	50-75	10YR 7/1 7.5YR 7/4	ls	-	Ap-AC	-

3.4 Soil Mapping

The area under each soil series was further separated into soil phases and their boundaries delineated on the cadastral map based on the variations observed in the texture of the surface soil, slope, erosion, presence of gravel, stoniness etc. A soil phase is a subdivision of soil series based mostly on surface features that affect its use and management. The soil mapping units are shown on the map (Fig.3.5) in the form of symbols. During the survey many 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 5 mapping units representing 3 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 5 soil 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.

3.5 Land Management Units

The 5 soil phases identified and mapped in the microwatershed were grouped into 2 Land Management Units (LMU's) for the purpose of preparing a Proposed Crop Plan for sustained development of the microwatershed. The database (soil phases) generated under LRI was utilized for identifying Land Management Units (LMU's) based on the management needs. One or more than one soil site characteristic having influence on the management have been chosen for identification and delineation of LMUs. For Bachawar

microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LMUs. The Land Management Units are expected to behave similarly for a given level of management.

3.6 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 for fertility status (major and micronutrients) at 320 m grid interval in the year 2018 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 Bachawar Microwatershed

*Soil map unit No.	Soil Series	Soil Phase	Mapping Unit Description	Area in ha(%)
Soils of Granite Gneiss Landscape				
	KKR	Kakalawar soils are very shallow (<25 cm), well drained, have dark brown sandy loam soils occurring on very gently sloping uplands under cultivation		**61 (14.27)**
153		KKRbB2g1	Loamy sand surface, slope 1-3%, moderate erosion, gravelly (15-35%)	58 (13.57)
175		KKRcB2	Sandy loam surface, slope 1-3%, moderate erosion	3 (0.7)
	BDL	Badiyala soils are shallow (25-50 cm), well drained, have dark brown to very dark brown and dark yellowish brown, slightly calcareous, sandy loam soils occurring on very gently to gently sloping uplands under cultivation		**60 (13.97)**
162		BDLhB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	58 (13.52)
5		BDLiB2	Sandy clay surface, slope 1-3%, moderate erosion	2 (0.45)
	SBR	Sambara soils are moderately shallow (50-75 cm), somewhat excessively drained, have light gray to pink, loamy sand soils occurring on very gently to gently sloping uplands under cultivation		**151 (35.3)**
12		SBRcC3g1	Sandy loam surface, slope 3-5%, severe erosion, gravelly (15-35%)	151 (35.3)
999		Rock outcrops	Rock lands, both massive and bouldery with little or no soil	7 (1.71)
1000		Others	Habitation and water body	151 (35.3)

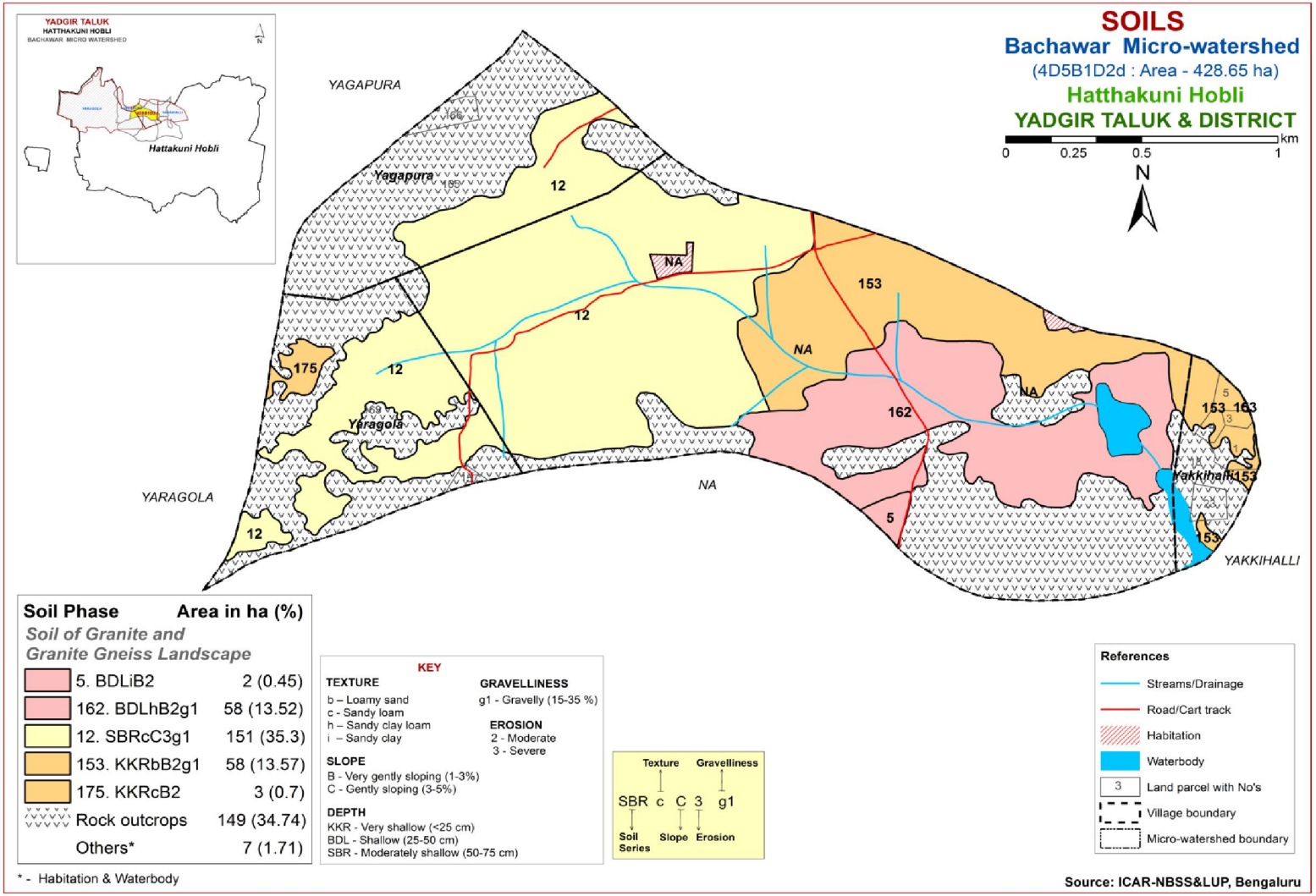


Fig 3.5 Soil Phase or Management Units - Bachawar Microwatershed

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and their distribution of different kinds of soils occurring in Bachawar microwatershed is provided in this chapter. The microwatershed area has been identified as granite and gneiss landscape based on geology. In all, 3 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. In the granite gneiss landscape, it is by parent material, relief and climate.

A brief description of each of the 3 soil series identified followed by 5 soil phases (management units) mapped under each series are furnished below. The physical and chemical characteristics of soil series identified in Bachawar microwatershed are given in Table 4.1 along with soil classification. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristic that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

4.1 Soils of granite gneiss landscape

In this landscape, 3 soil series are identified and mapped. Of these, SBR series occupies maximum area of 151 ha (35%) followed by KKR 61 ha (14%) and BDL 60 ha (14%). Brief description of each series identified and number of soil phases mapped is given below.

4.1.1 Kakalawar (KKR) Series: Kakalawar soils are very shallow (<25cm), well drained, have dark brown to light brown, sandy loam soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands under cultivation. The Kakalawar series has been classified as a member of the mixed, isohyperthermic family of Lithic Ustipsamments.

The thickness of the soil is less than 25 cm. Its colour is in 10 YR and 7.5 YR hue with value 4 to 6 and chroma 3 to 4. The texture varies from loamy sand to sand. The available water capacity is very low (<50 mm/m).

Landscape and Soil Profile characteristics of Kakalawar (KKR) Series

4.1.2 Badiyala (BDL) Series: Badiyala soils are shallow (25-50 cm), well drained, have very dark brown to dark yellow brown and dark brown, slightly calcareous sandy loam soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands under cultivation. The Badiyala series has been classified as a member of the coarse-loamy, mixed, isohyperthermic family of Fluventic Haplustepts.

The thickness of the solum ranges from 28 to 50 cm. The thickness of A horizon ranges from 4 to 12 cm. Its colour is in 10YR hue with value 3 to 4 and chroma 3 to 4. The texture is loamy sand, sandy clay loam and sandy clay. The thickness of B horizon ranges from 27 to 45 cm. Its colour is in 10 YR and 7.5 YR hue with value 2 to 4 and chroma 3 to 4. Its texture is sandy loam to sandy clay loam and is slightly calcareous. The available water capacity is very low (<50mm/m). Only one phase was identified and mapped.

Landscape and Soil Profile characteristics of Badiyala (BDL) Series

4.1.3 Sambara (SBR) Series: Sambara soils are moderately shallow (50-75 cm), somewhat excessively drained, have light grey to reddish yellow, loamy sand soils. They are developed from weathered granite gneiss and occur on very gently to gently sloping uplands under cultivation. The Sambara series has been classified as a member of the mixed, isohyperthermic family of Typic Ustipsamments.

The thickness of the soil ranges from 52-75 cm. Thickness of A horizon ranges from 8 to 23 cm. Its colour is in hue 10 YR and 7.5 YR with value 3 and chroma 1 to 4. The texture varies from loamy sand to sandy loam. The thickness of subsurface horizons ranges from 41 to 66 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 to 5 and chroma 1 to 4. The texture is loamy sand. The available water capacity is very low (<50 mm/m). Only one phase was identified and mapped.

Landscape and Soil Profile characteristics of Sambara (SBR) Series

Table: 4.1 Physical and Chemical Characteristics of Soil Series identified in Bachawar microwatershed

Soil Series: Kakalawar (KKR), Pedon**:** R-7

Location: $16^0$50'25.9"N $77^0$15'97.1"E, Yampada village, Gurumitkal hobli, Yadgir taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bengaluru **Classification:** Mixed, isohyperthermic Lithic Ustipsamments

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-22	Ap	83.81	10.37	5.82	17.31	20.65	17.91	5.67	22.27	10-20	ls	9.77	4.65

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-22	5.85	-	-	0.027	0.19	-	0.72	0.21	0.62	0.03	1.58	2.6	0.45	60.90	1.17

Contd....

Soil Series: Badiyala **(**BDL) **Pedon:** R-5

Location: $16^0$37'10.0"N $77^0$20'21.5", Gudalagunta village, Balichakra hobli, Yadgir taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bengaluru **Classification:** Coarse-loamy, mixed, isohyperthermic, Fluventic Haplustepts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-12	Ap	87.13	7.04	5.83	10.03	24.32	23.61	23.51	5.67	<15	ls	6.27	2.44
12-28	Bw1	64.63	13.30	22.07	6.74	13.07	22.30	17.01	5.50	<15	scl	16.34	7.83
28-50	BC	73.11	12.02	14.87	3.93	16.03	26.89	18.41	7.86	<15	sl	12.94	5.47

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-12	6.20	-	-	0.074	1.00	0.00	2.80	0.98	0.14	0.01	3.92	4.20	0.72	93	0.20
12-28	9.04	-	-	0.253	0.80	3.20	-	-	0.16	0.69	-	16.90	0.77	100	4.09
28-50	9.41	-	-	0.364	1.10	3.60	-	-	0.16	1.39	-	11.10	0.75	100	12.52

Contd...

Soil Series: Sambara (SBR) **Pedon:** R-10

Location: $16^0$42'04.5"N $77^0$14'35.3"E, Jinatera village, Balichakra hobli, Yadgir taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bengaluru **Classification:** Mixed, isohyperthermic Typic Ustipsamments

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-9	Ap	81.90	8.22	9.88	23.76	14.05	23.76	10.62	9.71	-	ls	9.45	2.69
9-17	C1	84.08	6.59	9.33	21.30	20.69	17.65	17.65	6.80	-	ls	7.84	2.65
17-60	C2	86.86	6.17	6.98	11.53	21.54	25.08	23.46	5.26	-	ls	5.48	2.62
60-78	C3	87.27	6.92	5.81	15.05	20.91	26.36	19.29	5.66	-	ls	5.19	2.81

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-9	8.24	-	-	0.145	0.61	0.91	-	-	0.12	0.09	-	7.50	0.76	100	1.15
9-17	8.21	-	-	0.068	0.57	0.39	-	-	0.06	0.12	-	6.70	0.72	100	1.82
17-60	8.47	-	-	0.080	0.38	0.48	-	-	0.03	0.17	-	2.70	0.39	100	6.34
60-78	8.50	-	-	0.081	0.30	0.52	-	-	0.03	0.17	-	2.70	0.46	100	6.43

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

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

The 5 soil map units identified in the Bachawar microwatershed are grouped under 2 land capability classes and 2 subclasses. Entire area in the microwatershed is suitable for agriculture (Fig. 5.1).

Moderately good lands (Class III) cover an area of about 14 per cent and are distributed in the central, southern and eastern part of the microwatershed with moderate problems of soil and erosion. Fairly good lands (Class IV) cover an area of about 50 per cent and are distributed in the major part of the microwatershed with very severe problems of soil and erosion.

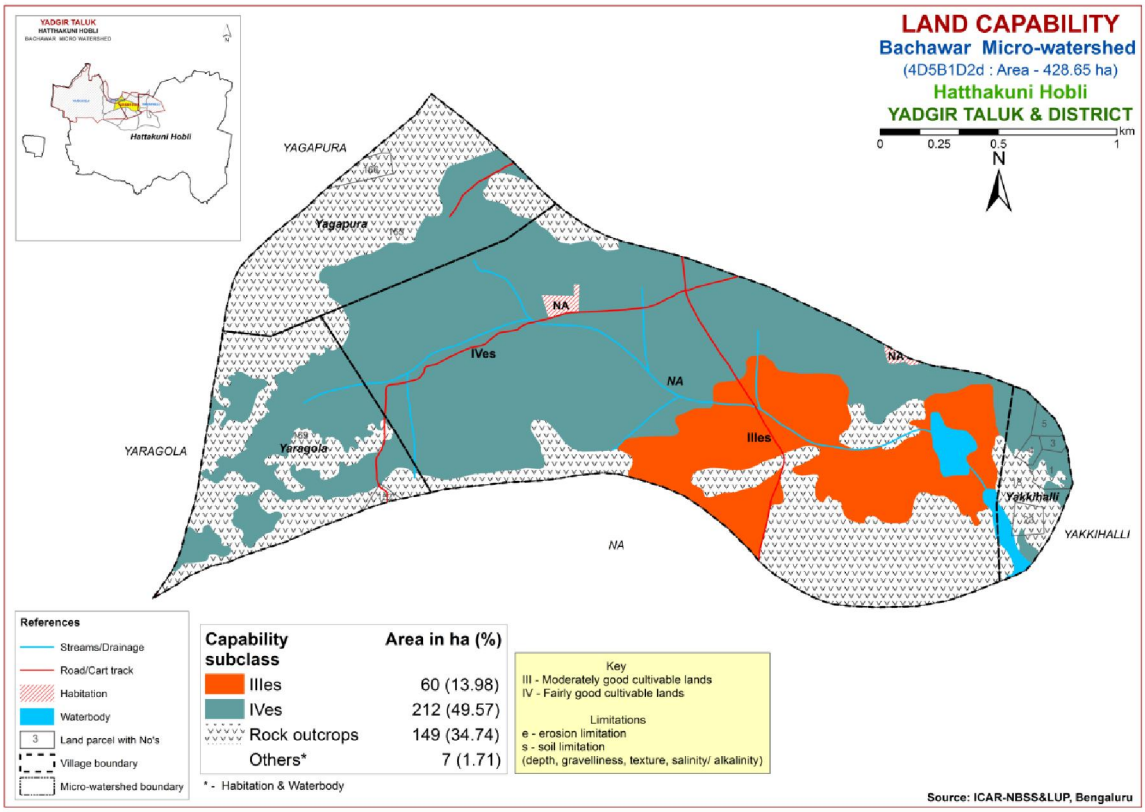


Fig. 5.1 Land Capability map of Bachawar Microwatershed

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 given in Fig. 5.2.

Very shallow (<25 cm) soils occupy an area of about 61 ha (14%) and are distributed in the central, western, eastern and southeastern part of the microwatershed. Shallow (25-50 cm) soils occupy an area of about 60 ha (14%) and are distributed in the central, southern and eastern part of the microwatershed. Moderately shallow (50-75 cm) soils occupy an area of about 151 ha (35%) and are distributed in the major part of the microwatershed.

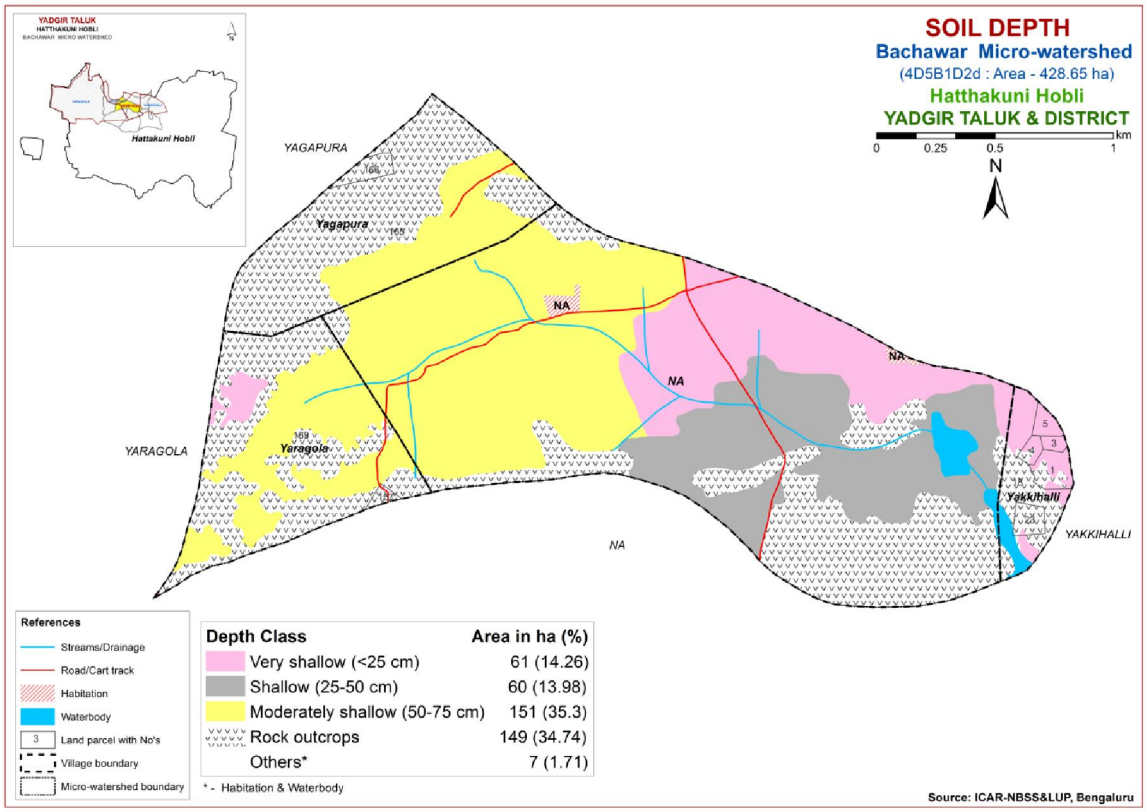


Fig. 5.2 Soil Depth map of Bachawar Microwatershed

Problem soils cover 121 ha (28%), where short or medium duration crops can be grown.

5.3 Surface Soil Texture

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

An area of about 58 ha (14%) is sandy at the surface and are distributed in the central, eastern and southeastern part of the microwatershed. A maximum area of 212 ha (50%) has soils that are loamy and occur in the major part of the microwatershed. An area of about 2 ha (<1%) is clayey and are distributed in the southern part of the microwatershed.

An area of 50% has most productive lands with respect to surface soil texture. The clayey soils (<1%) and loamy soils (50%) have high potential for soil-water retention

and availability, and nutrient retention and availability, but clayey soils have more problems of drainage, infiltration, workability and other physical problems. The other problematic soils are sandy (14%) which have major limitations of moisture and nutrient retention capacity, hence require frequent irrigation with balanced fertilizer application.

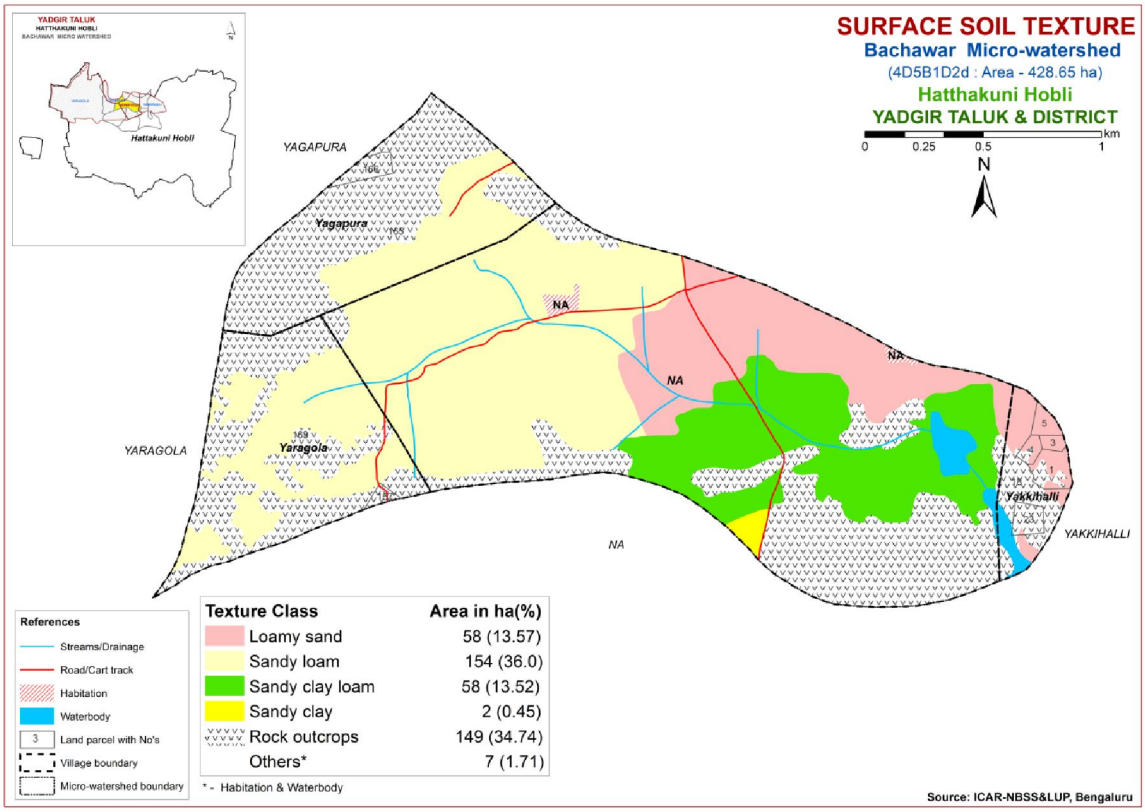


Fig. 5.3 Surface Soil Texture map of Bachawar Microwatershed

5.4 Soil Gravelliness

Gravel is the term used for describing coarse fragments between 2 mm and 7.5 cm diameter and stones for those between 7.5 cm and 25 cm. The presence of gravel and stones in soil reduces the volume of soil responsible for moisture and nutrient storage, drainage, infiltration and runoff, and hinders plant growth by impeding root growth and seedling emergence, intercultural operations and farm mechanization. The gravelliness classes used in LRI were used to classify the soils and using these classes a gravelliness map was generated. The area extent and their geographic distribution in the microwatershed is shown in Figure 5.4.

Non gravelly (<15%) soils cover an area of 5 ha (1%) and are distributed in the western and southern part of the microwatershed. Gravelly (15-35%) soils cover an area of 267 ha (62%) and are distributed in the major part of the microwatershed.

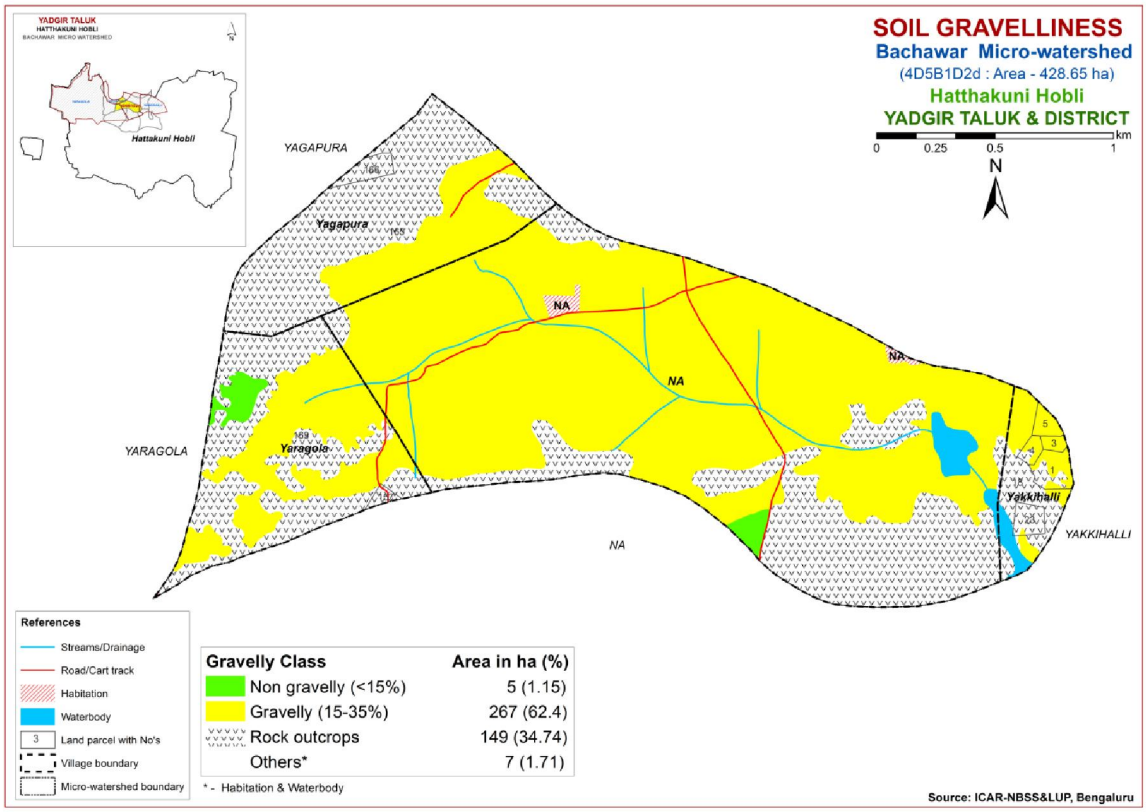


Fig. 5.4 Soil Gravelliness map of Bachawar Microwatershed

The problem soils (62%) which are gravelly (15-35%), where only short or medium duration crops can be grown. The most productive soils (1%) that are non gravelly (<15%) where, all climatically adapted long duration crops can be grown.

5.5 Available Water Capacity

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

Entire cultivated area of about 272 ha (64%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and are distributed in the major part of the microwatershed.

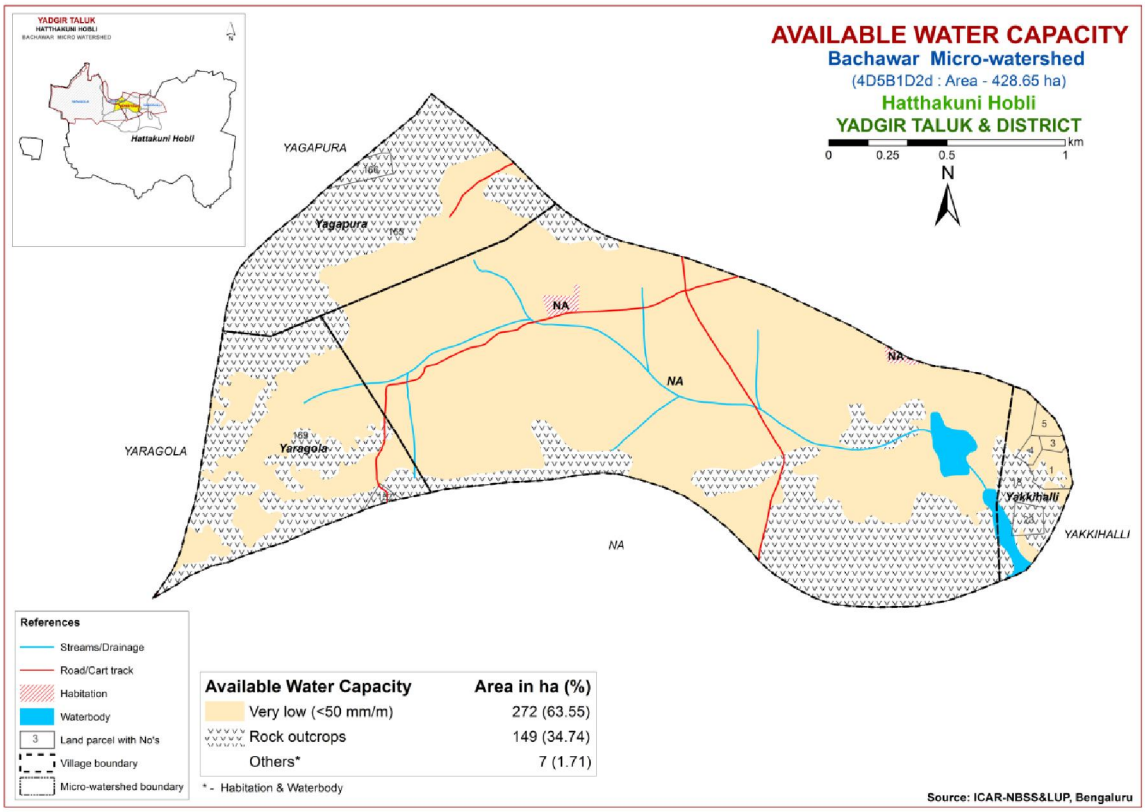


Fig. 5.5 Soil Available Water Capacity map of Bachawar Microwatershed

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

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

An area of about 121 ha (28%) falls under very gently sloping (1-3% slope) lands and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed. An area of about 151 ha (35%) falls under gently sloping (3-5% slope) lands and are distributed in the central, western, northwestern and southwestern part of the microwatershed.

In these areas (1-3% slope), all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development

measures. Soil and water conservation and other land development measures are needed in 35 per cent area where (3-5%) slope occur.

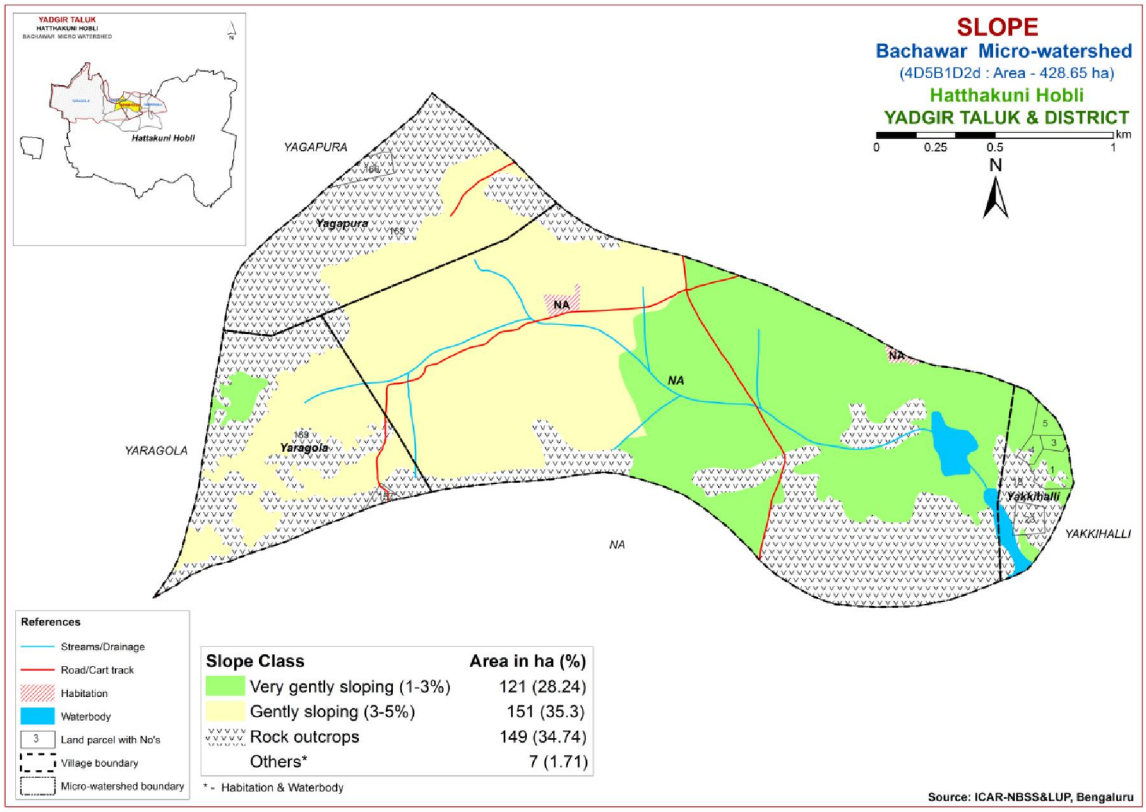


Fig. 5.6 Soil Slope map of Bachawar Microwatershed

5.7 Soil Erosion

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

Moderately eroded (e2 class) soils cover an area of 121 ha (28%) and are distributed in the central, southern, eastern, western and southeastern part of the microwatershed. Severely eroded (e3 class) soils cover an area of 151 ha (35%) and are distributed in the central, western, southwestern and northwestern part of the microwatershed.

Entire cultivated area (64%) in the microwatershed is problematic because of moderate and severe erosion. For these areas, taking up soil and water conservation and other land development measures are needed.

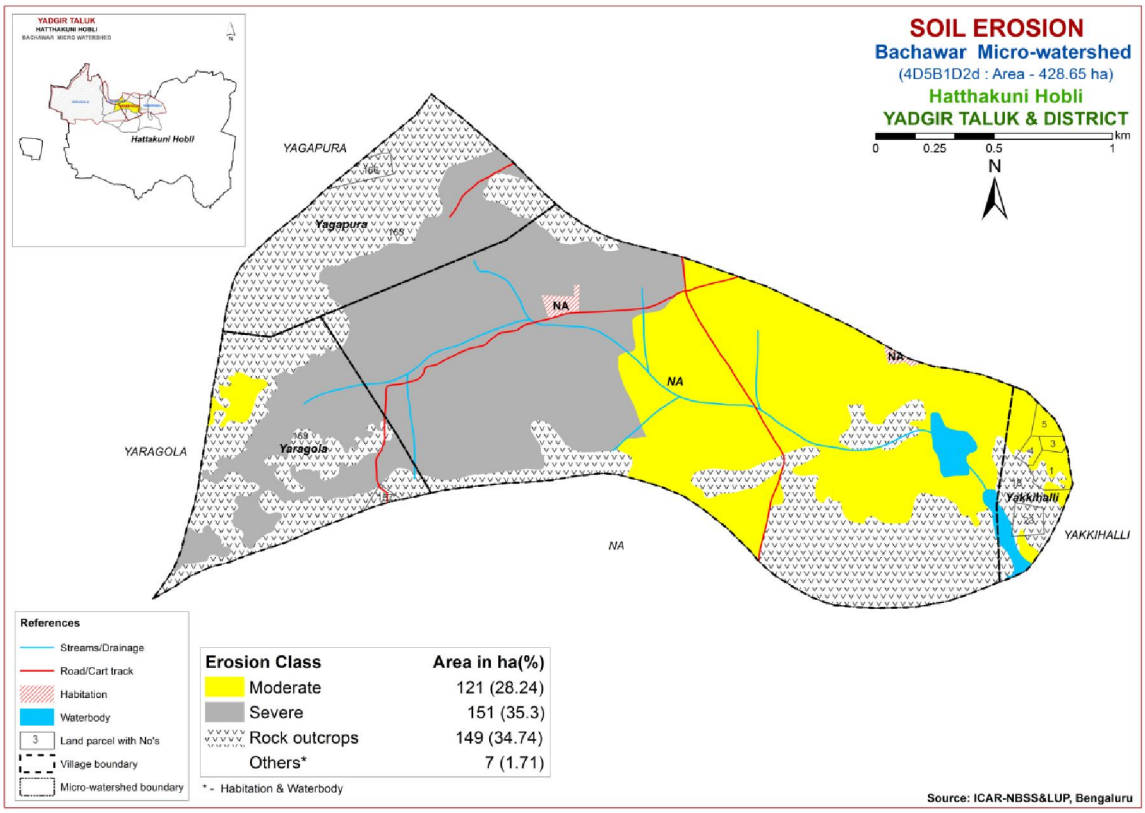


Fig. 5.7 Soil Erosion map of Bachawar Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status as these areas are characterised by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected from the grid points (one soil sample at every 320 m interval) all over the microwatershed through land resource inventory in the year 2018 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 Bachawar microwatershed for soil reaction (pH) showed that an area of about 9 ha (2%) is slightly acid (pH 6.0-6.5) and are distributed in the eastern part of the microwatershed. An area of about 118 ha (28%) is neutral (pH 6.5-7.3) and distributed in the eastern, southeastern and southern part of the microwatershed. Maximum area of 139 ha (32%) is slightly alkaline (pH 7.3-7.8) and distributed in all parts of the microwatershed. Moderately alkaline (pH 7.8-8.4) soils occur in an area of 7 ha (1%) and distributed in the northern part of the microwatershed (Fig.6.2).

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 non-saline.

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 an entire cultivated area of about 272 ha (64%) and are distributed in the major part of the microwatershed (Fig. 6.3).

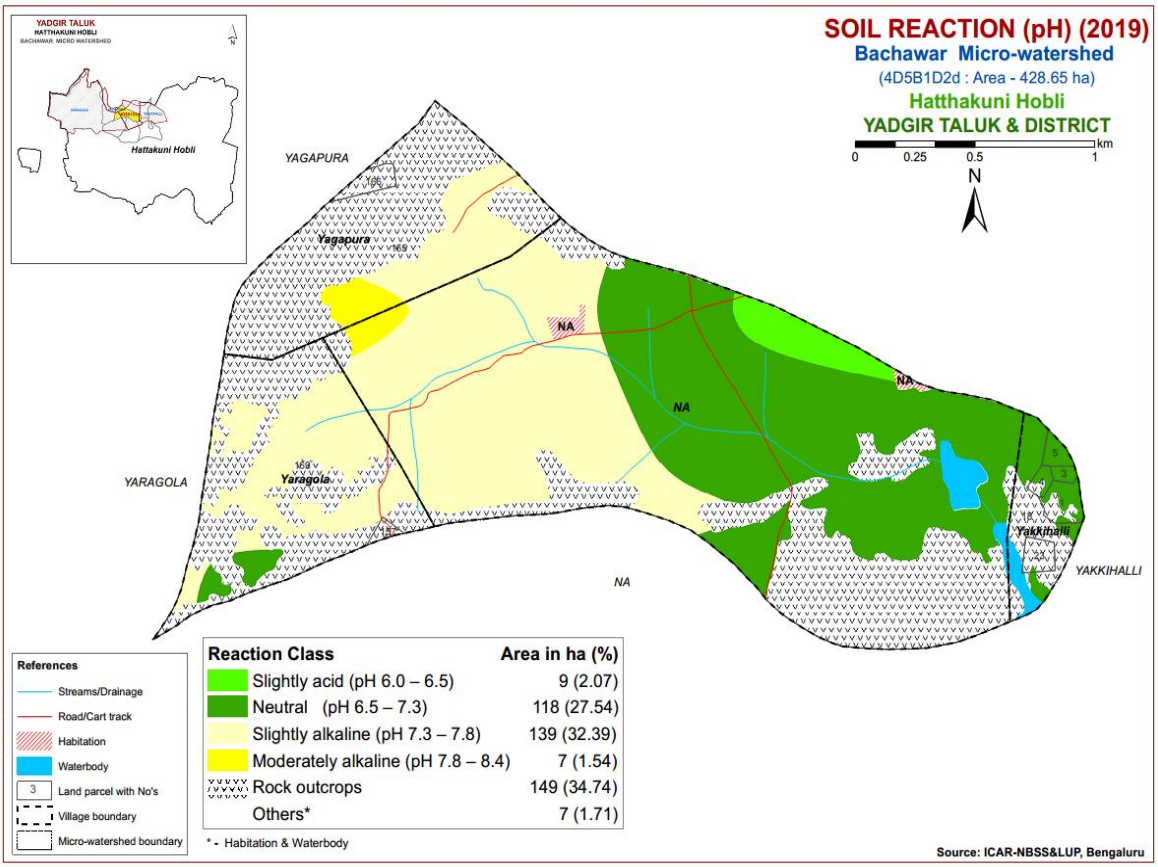


Fig.6.1 Soil Reaction (pH) map of Bachawar Microwatershed

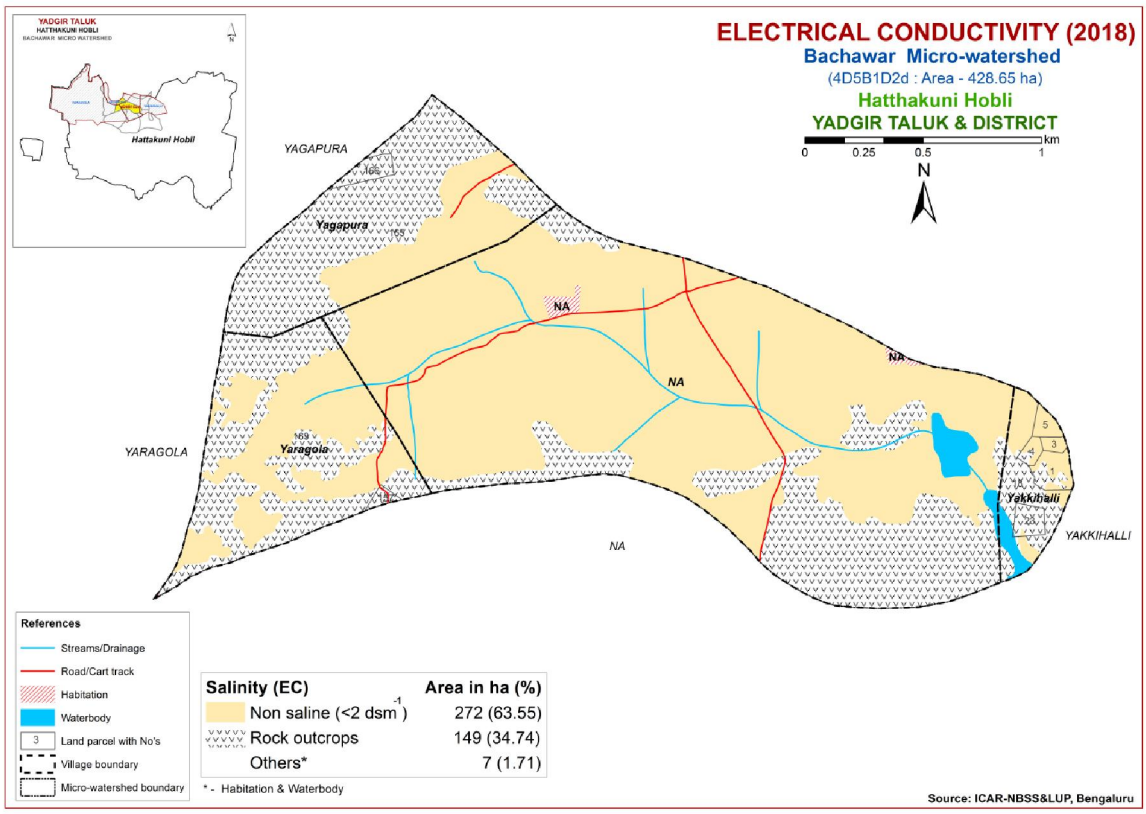


Fig.6.2 Electrical Conductivity (EC) map of Bachawar Microwatershed

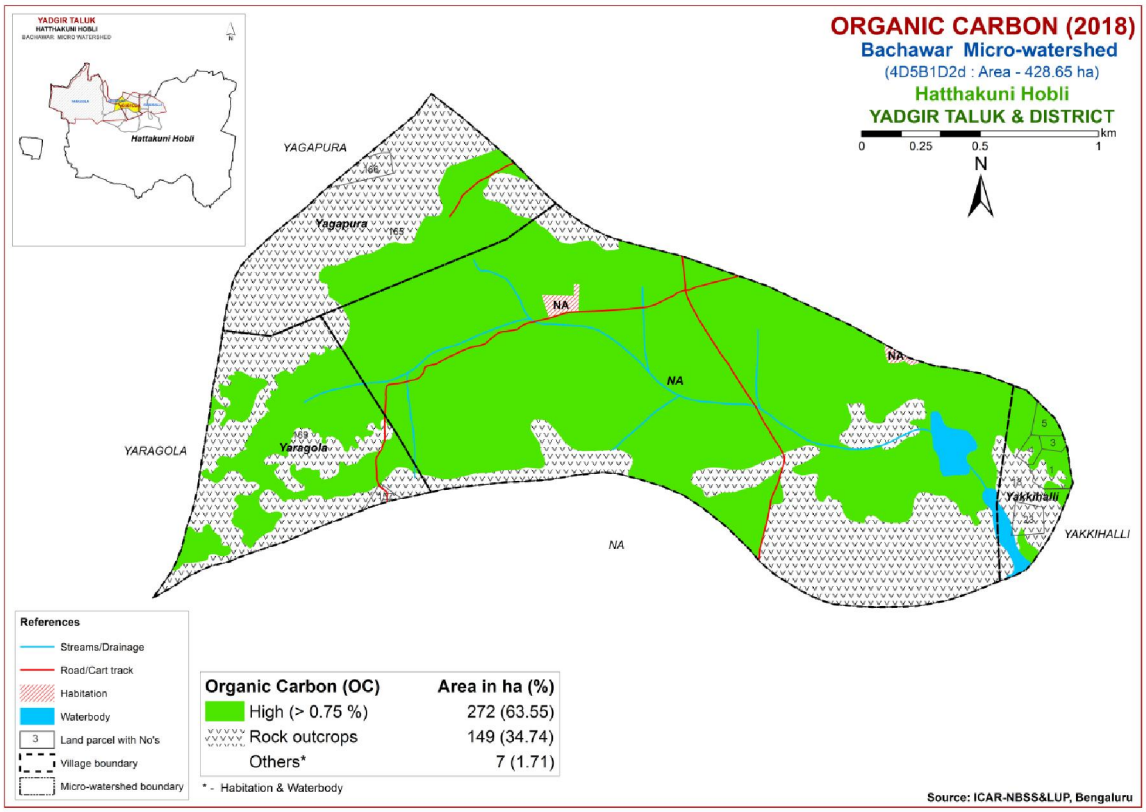


Fig.6.3 Soil Organic Carbon map of Bachawar Microwatershed

6.4 Available Phosphorus

Available phosphorus content is medium (23-57 kg/ha) in an entire cultivated area of 272 ha (64%) and occur in a major area of the microwatershed (Fig. 6.4).

6.5 Available Potassium

Available potassium content is medium (145-337 kg/ha) in an entire cultivated area of 272 ha (64%) and occur in a major area of the microwatershed (Fig. 6.5).

6.6 Available Sulphur

An area of 101 ha (23%) is low (<10 ppm) in available sulphur content and are distributed in the central, southern, eastern and southeastern part of the microwatershed. A maximum area of 132 ha (31%) is medium (10-20 ppm) in available sulphur content and are distributed in the major part of the microwatershed. An area of 40 ha (9%) is high (>20 ppm) in available sulphur content and are distributed in the central and western part of the microwatershed (Fig. 6.6).

6.7 Available Boron

Available boron content is low (<0.5 ppm) in an entire cultivated area of 272 ha (64%) and are distributed in the major part of the microwatershed (Fig. 6.7).

6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in the entire cultivated area of the microwatershed (Fig 6.8).

6.9 Available Manganese

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

6.10 Available Copper

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

6.11 Available Zinc

Available zinc content is deficient (<0.6 ppm) in an area of about 145 ha (34%) and are distributed in the northern, central, western and southwestern part of the microwatershed. An area of 127 ha (30%) is sufficient (>0.6 ppm) in available zinc content and are distributed in the central, southern, eastern and southeastern part of the microwatershed (Fig 6.11).

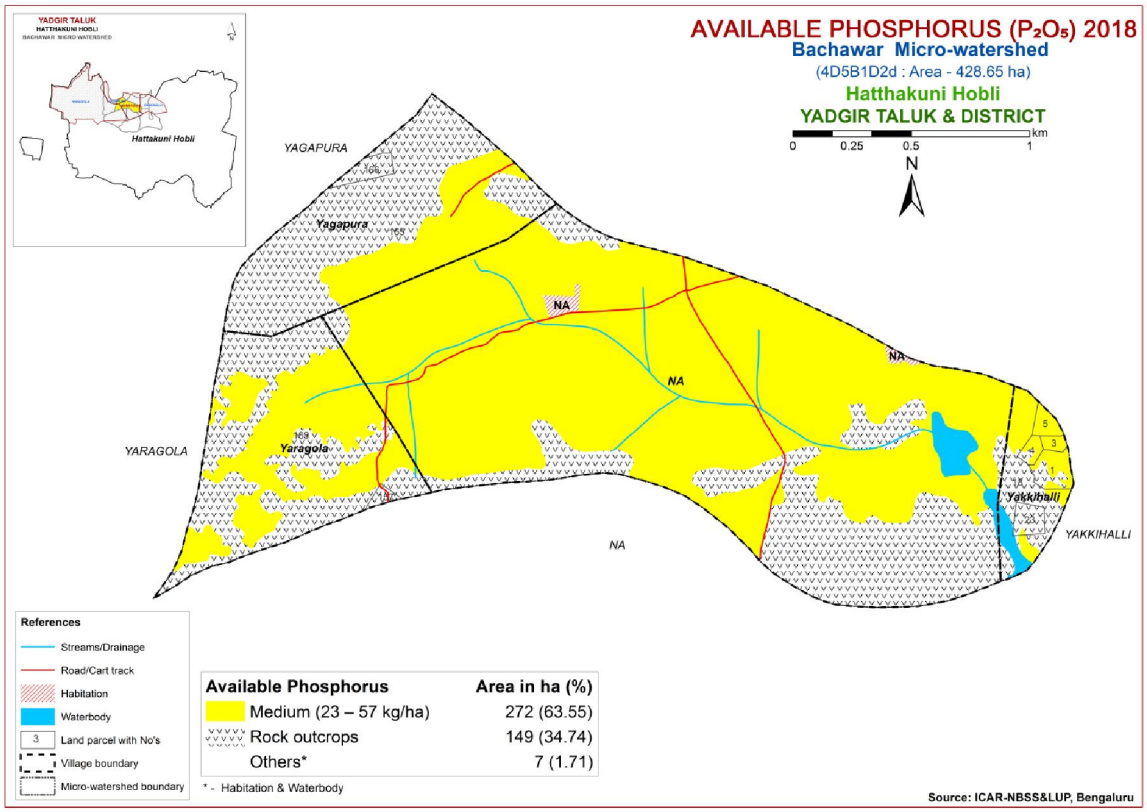


Fig.6.4 Soil Available Phosphorus map of Bachawar Microwatershed

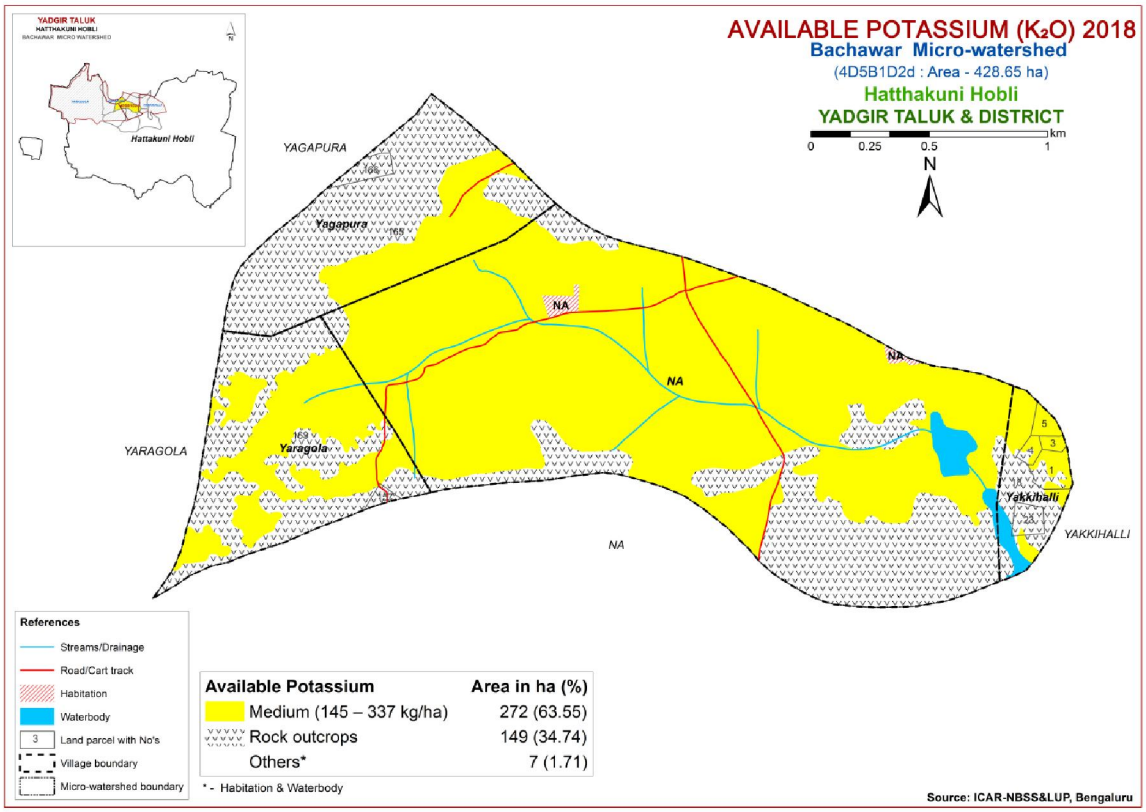


Fig.6.5 Soil Available Potassium map of Bachawar Microwatershed

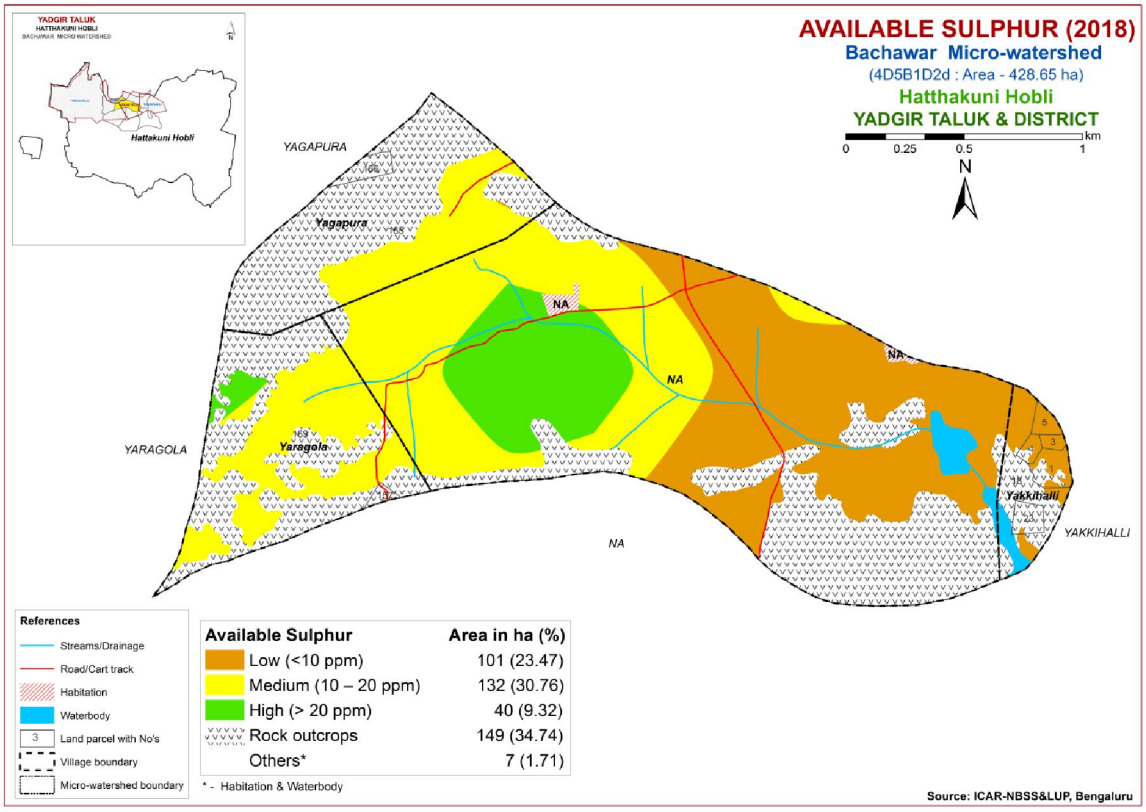


Fig.6.6 Soil Available Sulphur map of Bachawar Microwatershed

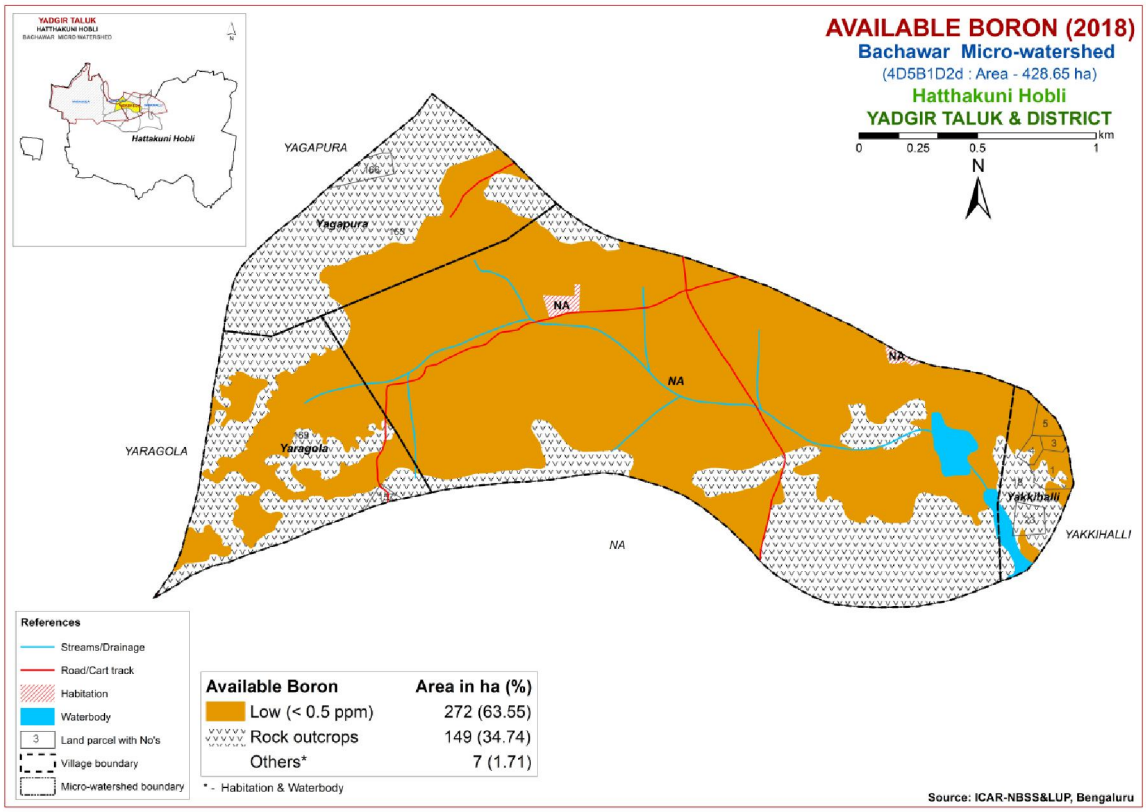


Fig.6.7 Soil Available Boron map of Bachawar Microwatershed

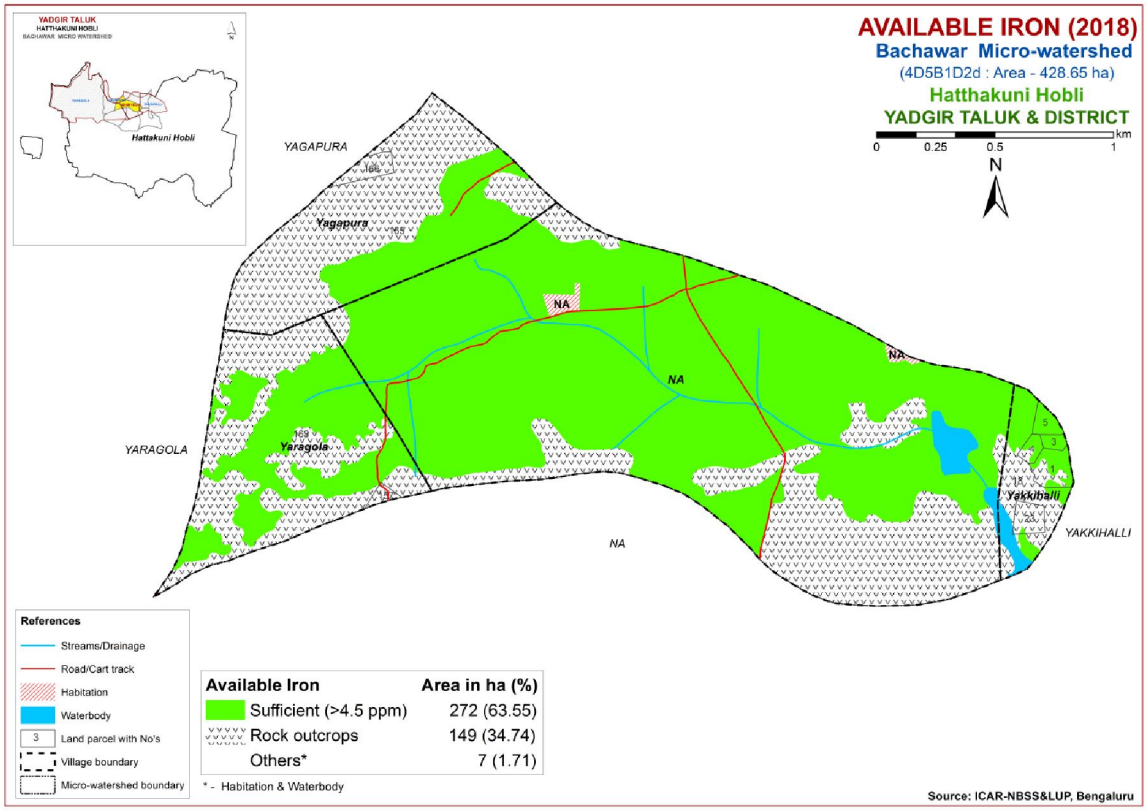


Fig.6.8 Soil Available Iron map of Bachawar Microwatershed

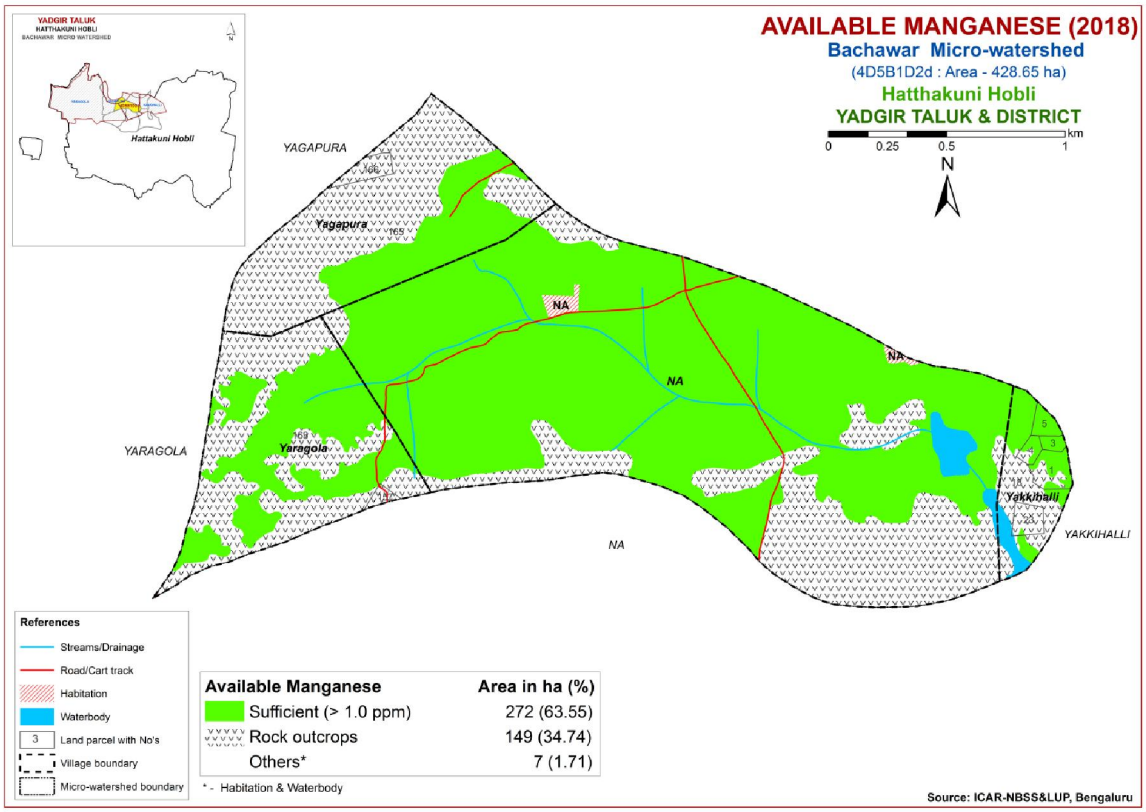


Fig.6.9 Soil Available Manganese map of Bachawar Microwatershed

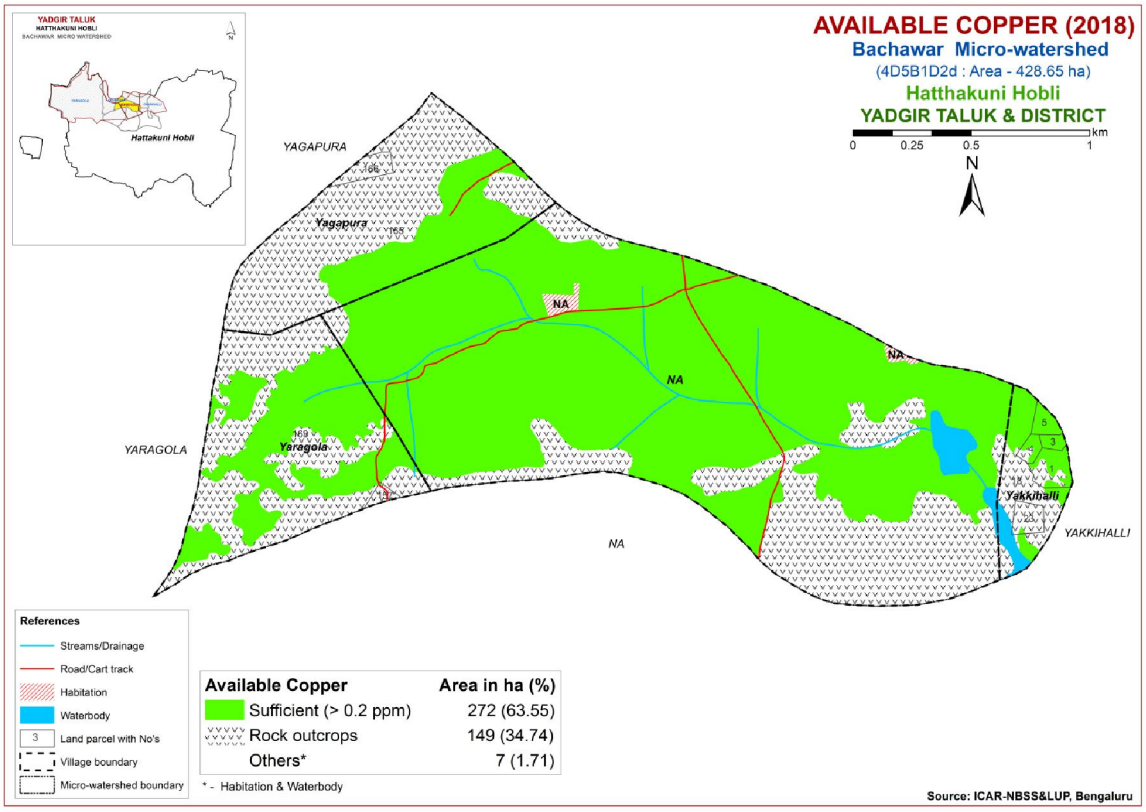


Fig.6.10 Soil Available Copper map of Bachawar Microwatershed

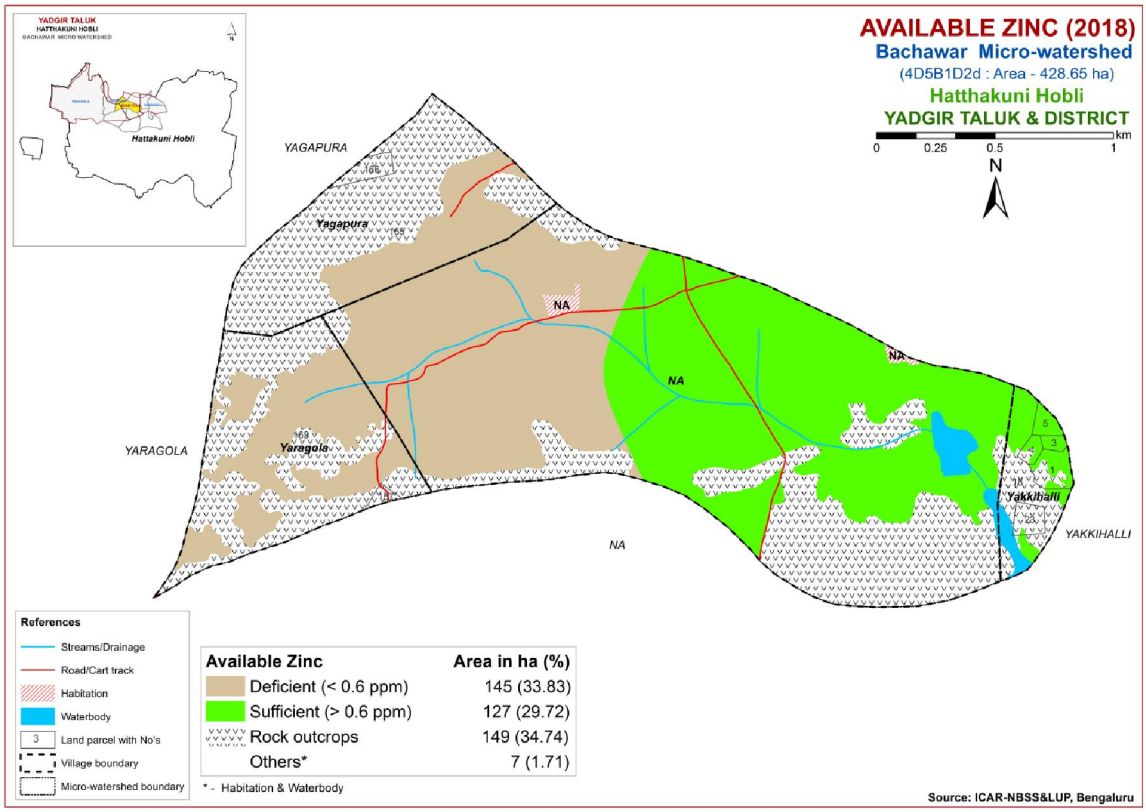


Fig.6.11 Soil Available Zinc map of Bachawar Microwatershed

Chapter 7

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Bachawar 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 soil and land characteristics were matched with the crop requirement to arrive at the crop suitability. The soil and land characteristics table (Table 7.1) and crop requirement tables (Tables 7.2 to Tables 7.30) are given at the end of the chapter. In FAO land suitability classification, two orders are recognized. Order S-Suitable and Order N-Not suitable. The orders have classes, subclasses and units. Order-S has three classes, Class S1-Highly Suitable, Class S2-Moderately Suitable and Class S3- Marginally Suitable. Order N has two classes, N1-Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the Class S1 as they will have very minor or no limitations for crop growth. Classes S2, S3 and N1 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, '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 29 major annual and perennial crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-III.

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

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

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing sorghum and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is

currently not suitable (Class N1) for growing sorghum and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

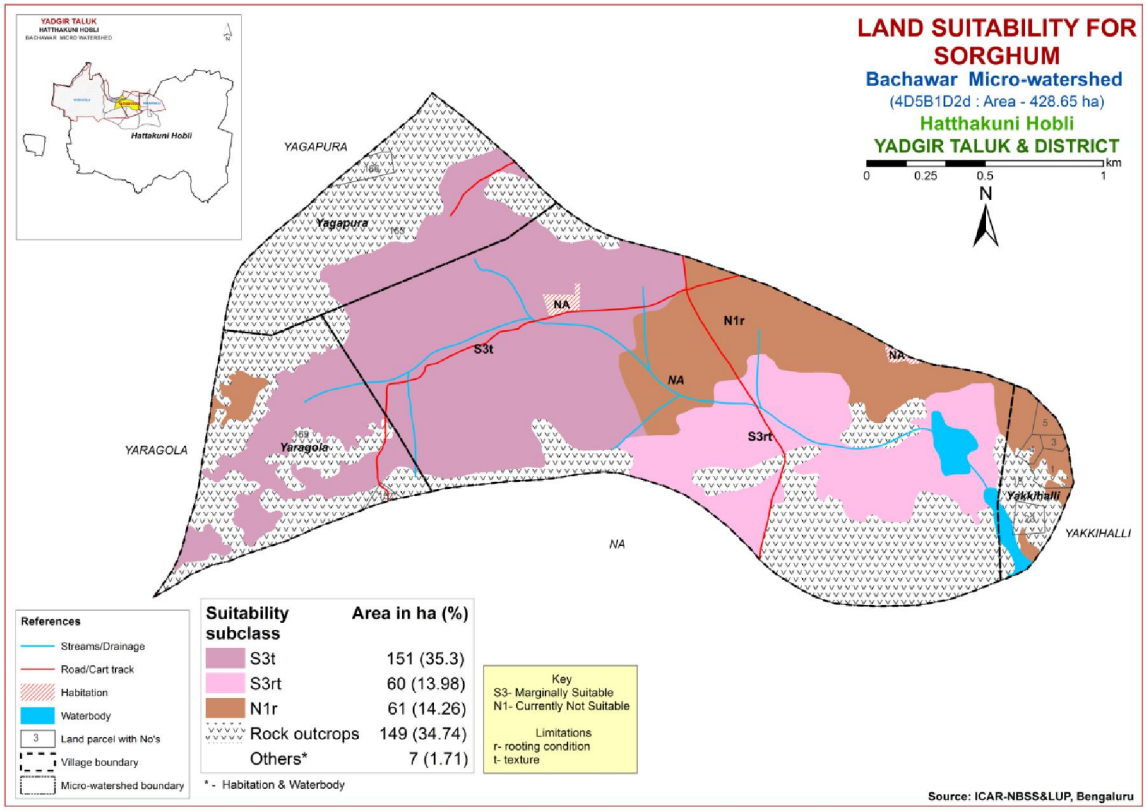


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing maize and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing maize and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

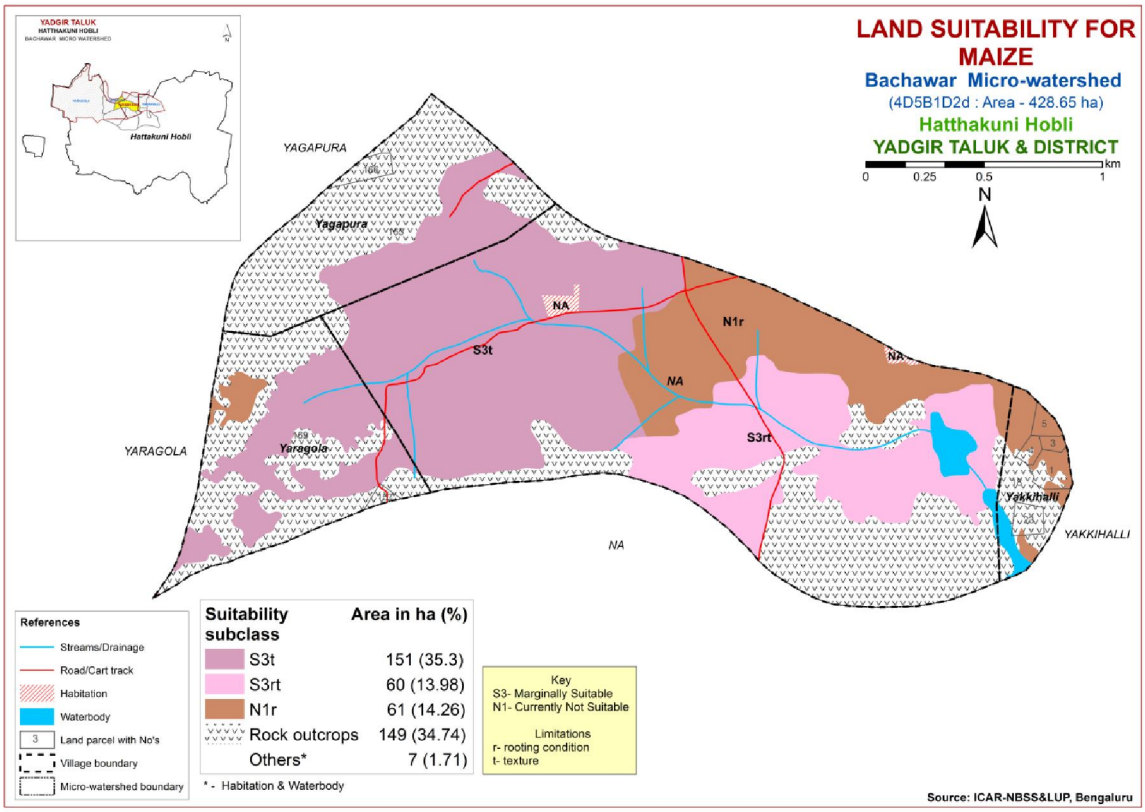


Fig. 7.2 Land Suitability map of Maize

7.3 Land Suitability for Bajra (*Pennisetum glaucum)*

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

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing bajra and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing bajra and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

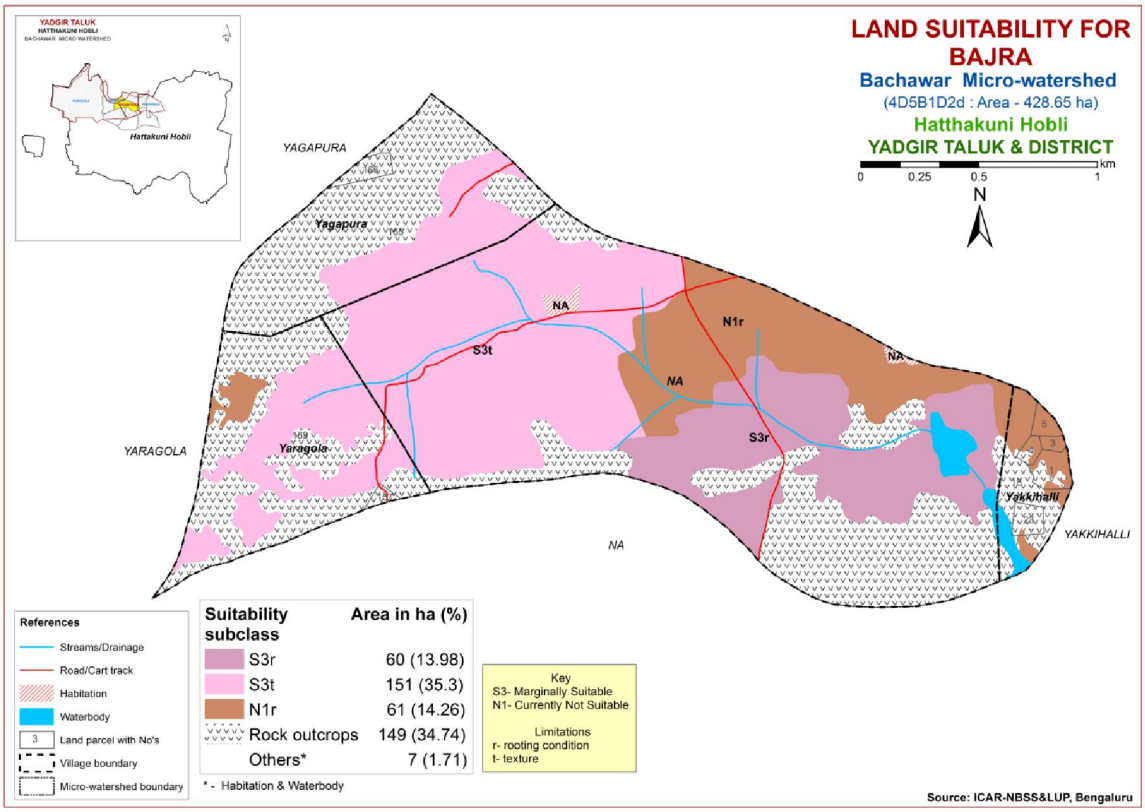


Fig. 7.3 Land Suitability map of Bajra

7.4 Land Suitability for Groundnut (*Arachis hypogaea*)

Groundnut is one of the major oilseed crop grown in an area of 6.54 lakh ha in Karnataka in most of the districts either as rainfed or irrigated crop. The crop requirements for growing groundnut (Table 7.5) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing groundnut was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.4.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing groundnut and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing groundnut and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

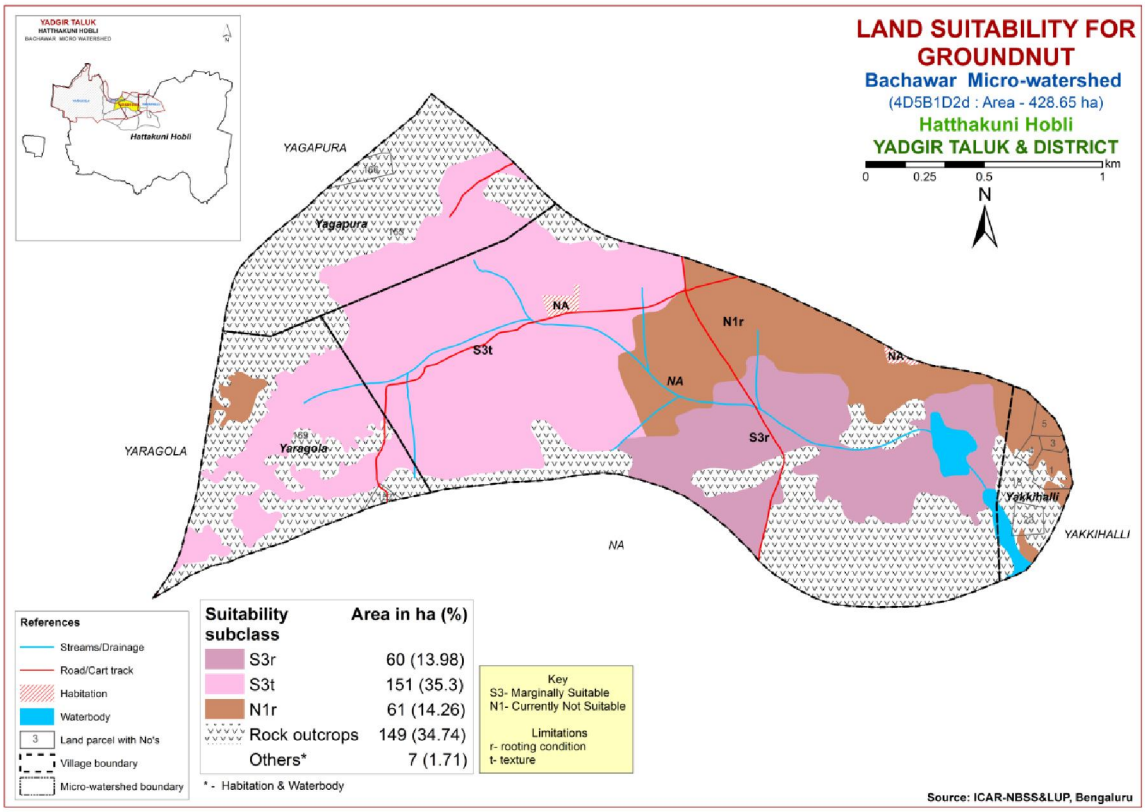


Fig. 7.4 Land Suitability map of Groundnut

7.5 Land Suitability for Sunflower (*Helianthus annus*)

Sunflower is one of the most important oilseed crop grown in an area of 3.56 lakh ha in the State in all the districts. The crop requirements for growing sunflower (Table 7.6) 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 microwatershed is given in Figure 7.5.

Marginally suitable (Class S3) lands for sunflower are found to occur in an area of about 151 ha (35%) with moderate limitations of rooting depth and texture and are distributed in the central, northern, western and southwestern part of the microwatershed. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing sunflower and are distributed in the central, southern, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

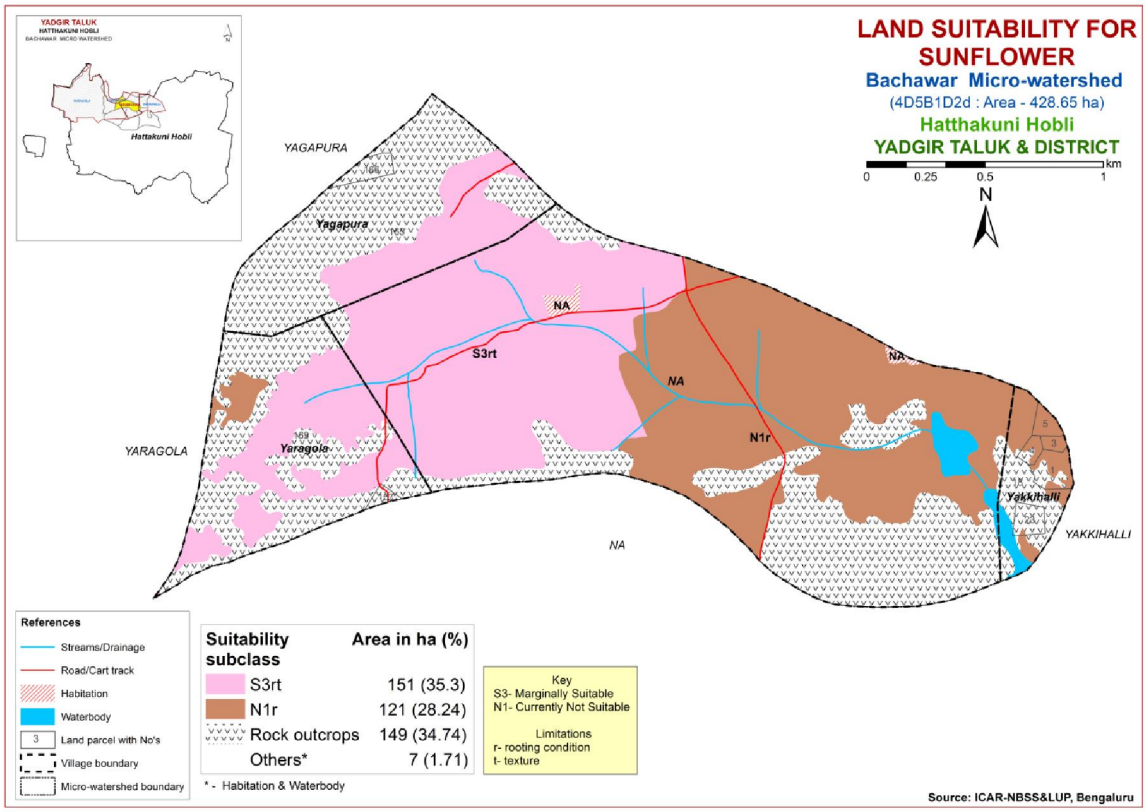


Fig. 7.5 Land Suitability map of Sunflower

7.6 Land Suitability for Red gram (*Cajanus Cajan)*

Redgram is one of the most important pulse crop grown in an area of 7.28 lakh ha in almost all the districts of the State. The crop requirements for growing red gram (Table 7.7) 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 7.6.

Marginally suitable (Class S3) lands for redgram are found to occur in an area of about 151 ha (35%) with moderate limitations of rooting depth and texture and are distributed in the central, northern, western and southwestern part of the microwatershed. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing redgram and are distributed in the central, southern, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

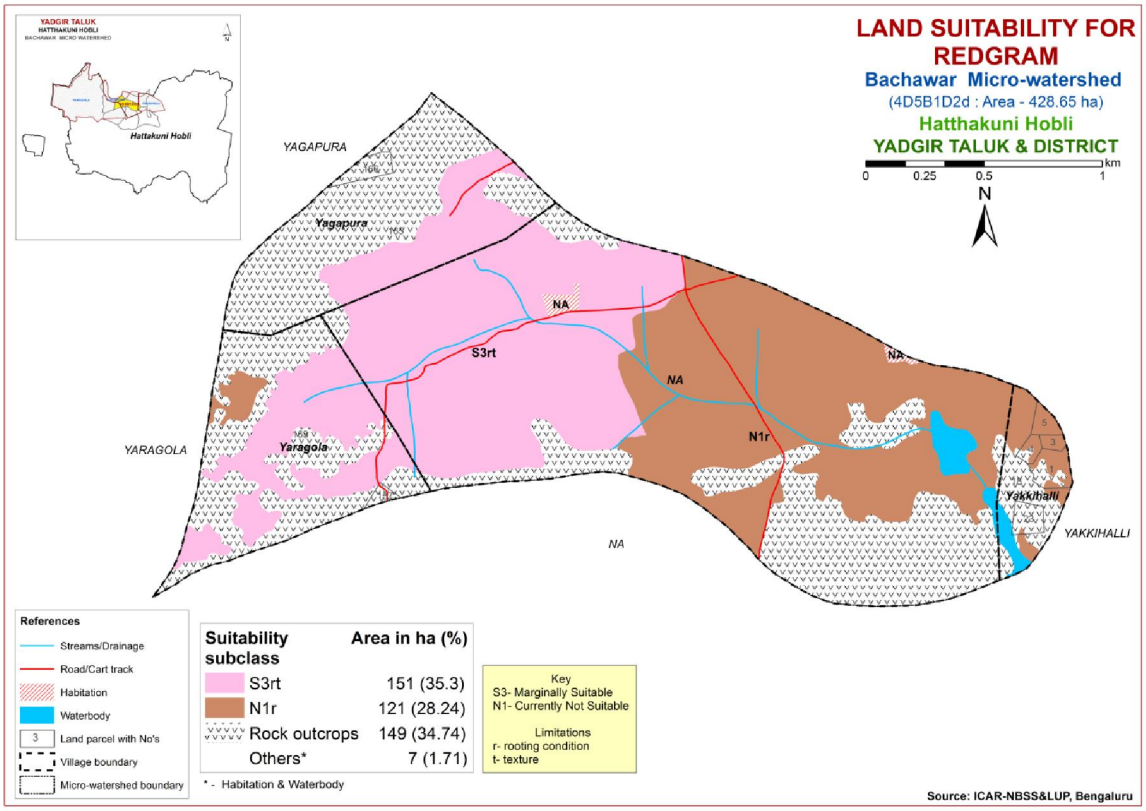


Fig. 7.6 Land Suitability map of Redgram

7.7 Land Suitability for Bengal gram (*Cicer aerativum*)

Bengal gram is one of the most important pulse crop grown in about 9.39 lakh ha area in Bijapur, Raichur, Kalaburgi, Dharwad, Belgaum and Bellary districts. The crop requirements for growing Bengal gram (Table 7.8) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing Bengal gram was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.7.

Entire cultivated area of about 272 ha (64%) is currently not suitable (Class N1) for growing Bengal gram and are distributed in the major part of the microwatershed with severe limitations of texture and rooting depth.

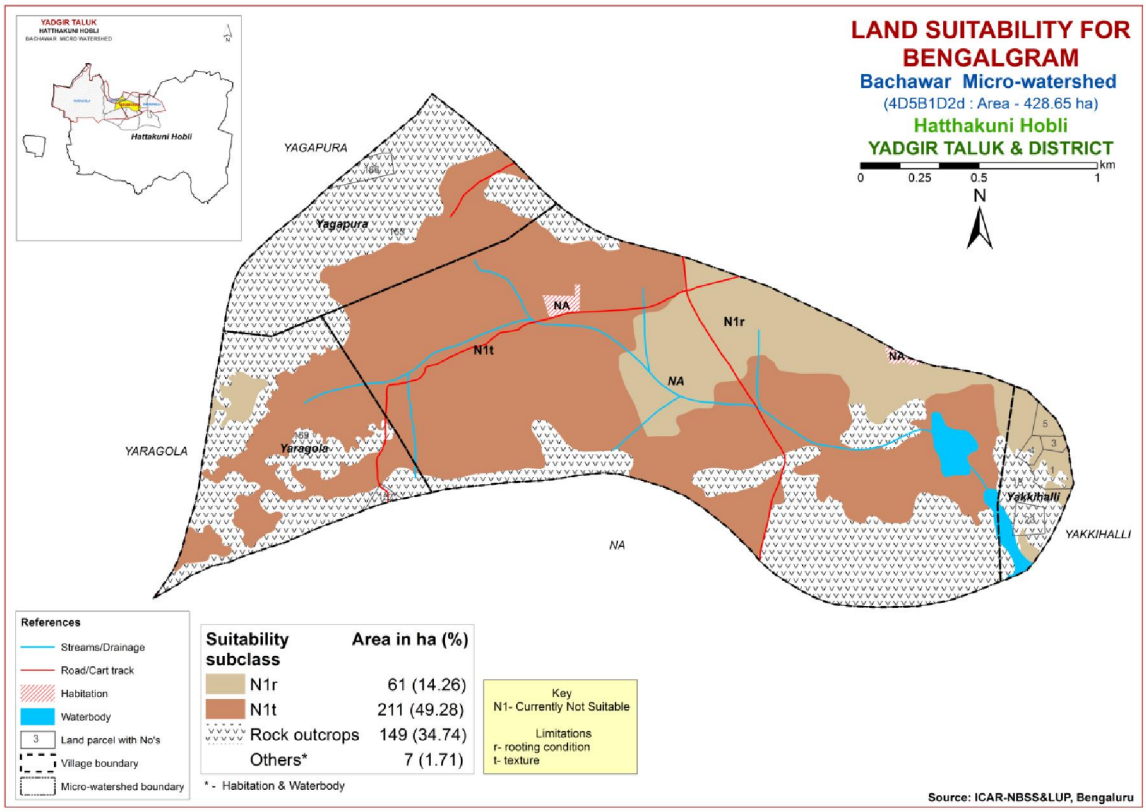


Fig. 7.7 Land Suitability map of Bengal gram.

7.8 Land Suitability for Cotton (*Gossypium hirsutum*)

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

Entire cultivated area of about 272 ha (64%) is currently not suitable (Class N1) for growing cotton and are distributed in the major part of the microwatershed with severe limitations of texture and rooting depth.

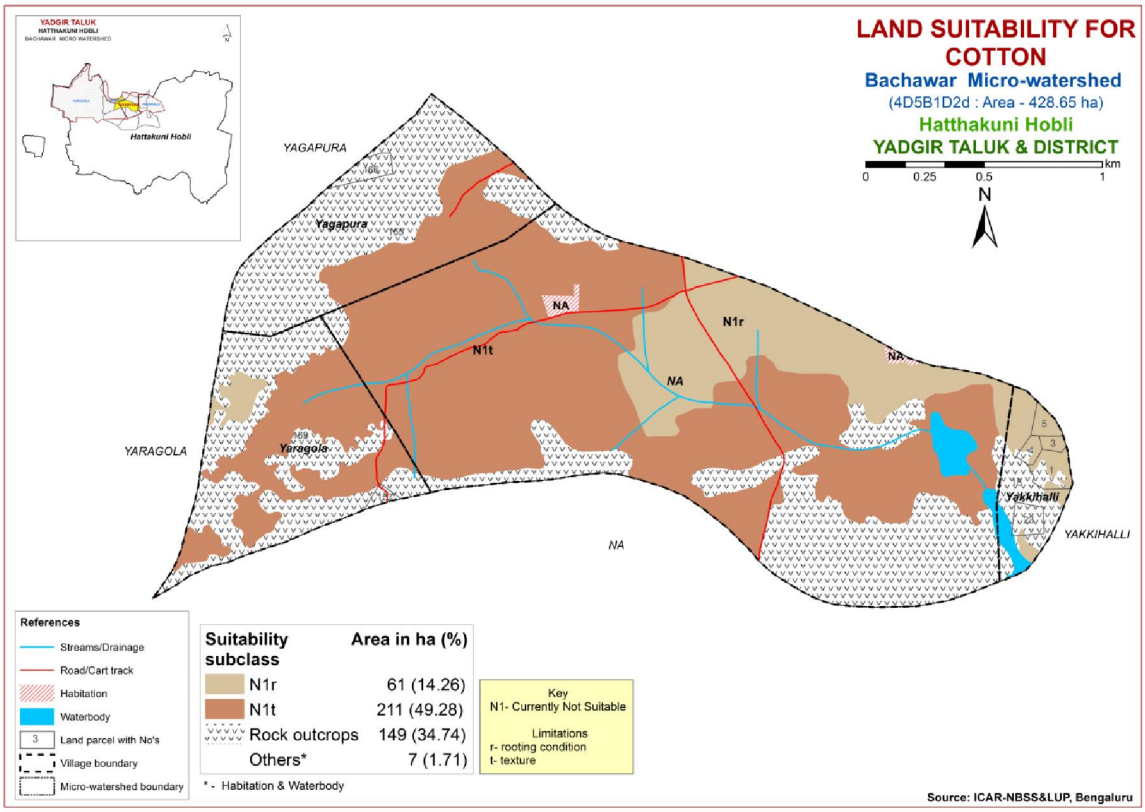


Fig. 7.8 Land Suitability map of Cotton

7.9 Land Suitability for Chilli (*Capsicum annuum)*

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

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing chilli and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing chilli and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

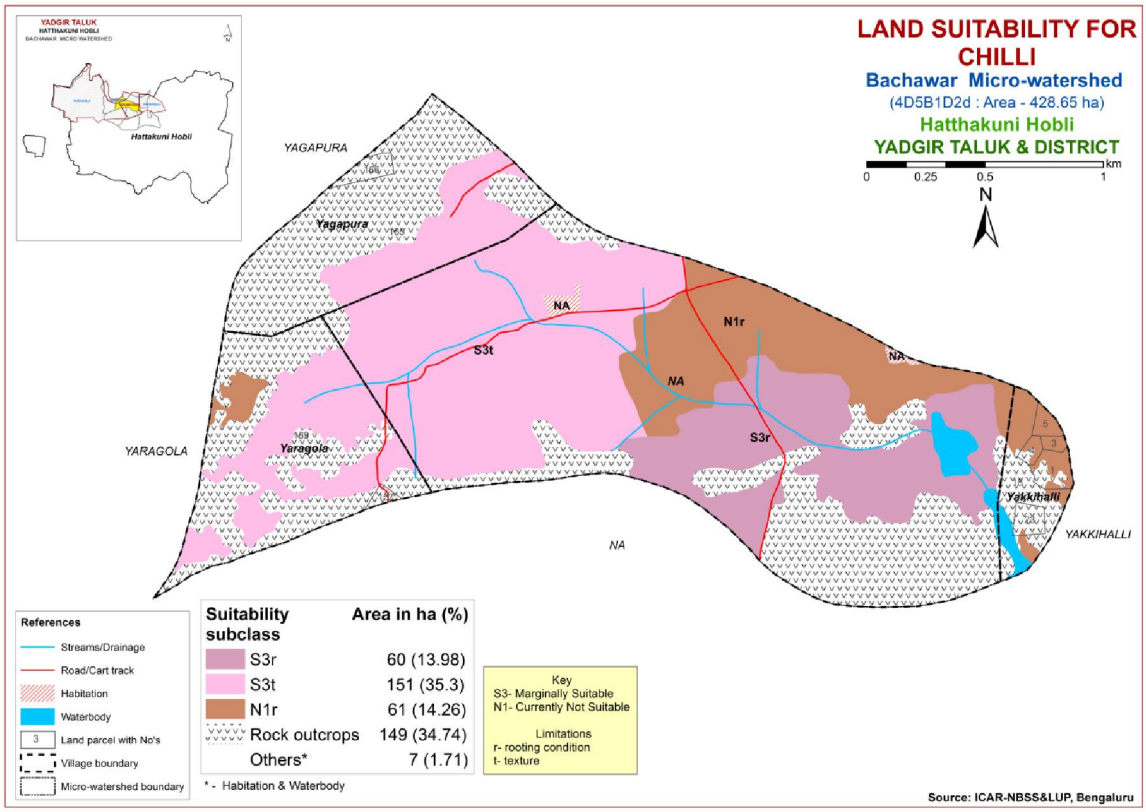


Fig 7.9 Land Suitability map of Chilli

7.10 Land Suitability for Tomato *(Lycopersicon esculentum)*

Tomato is one of the most important vegetable crop grown in about 0.61 lakh ha covering almost all the district of the state. The crop requirements for growing tomato (Table 7.11) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing tomato was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.10.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing tomato and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing tomato and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

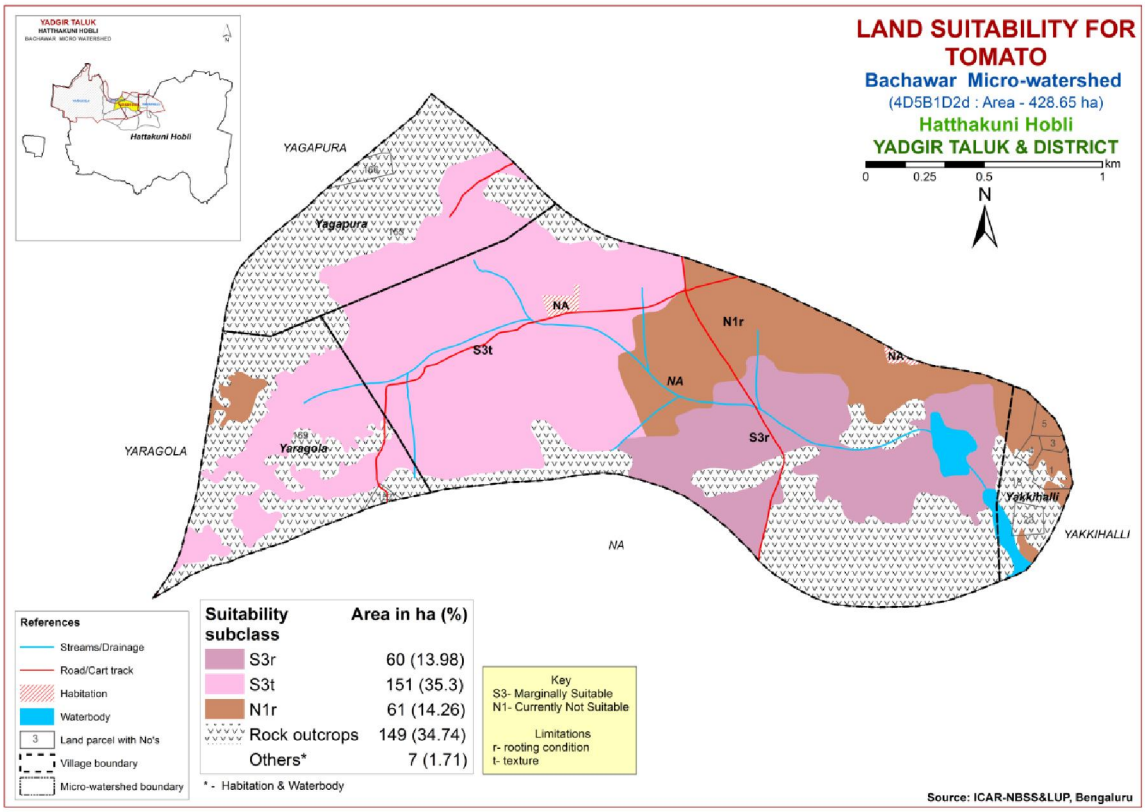


Fig 7.10 Land Suitability map of Tomato

7.11 Land Suitability for Brinjal (*Solanum melongena*)

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

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing Brinjal and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing Brinjal and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

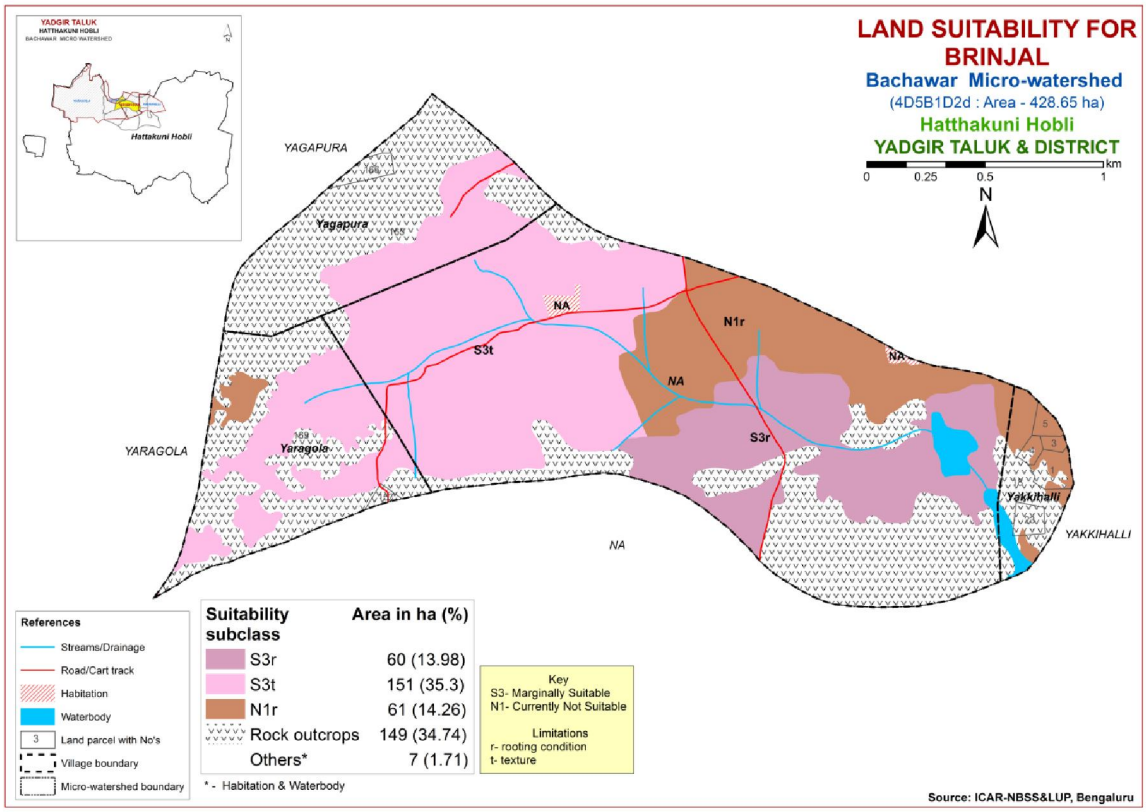


Fig 7.11 Land Suitability map of Brinjal

7.12 Land Suitability for Onion (*Allium cepa L.*,)

Onion is one of the most important vegetable crop grown in the state. The crop requirements for growing onion (Table 7.13) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing onion was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.12.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing onion and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing onion and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

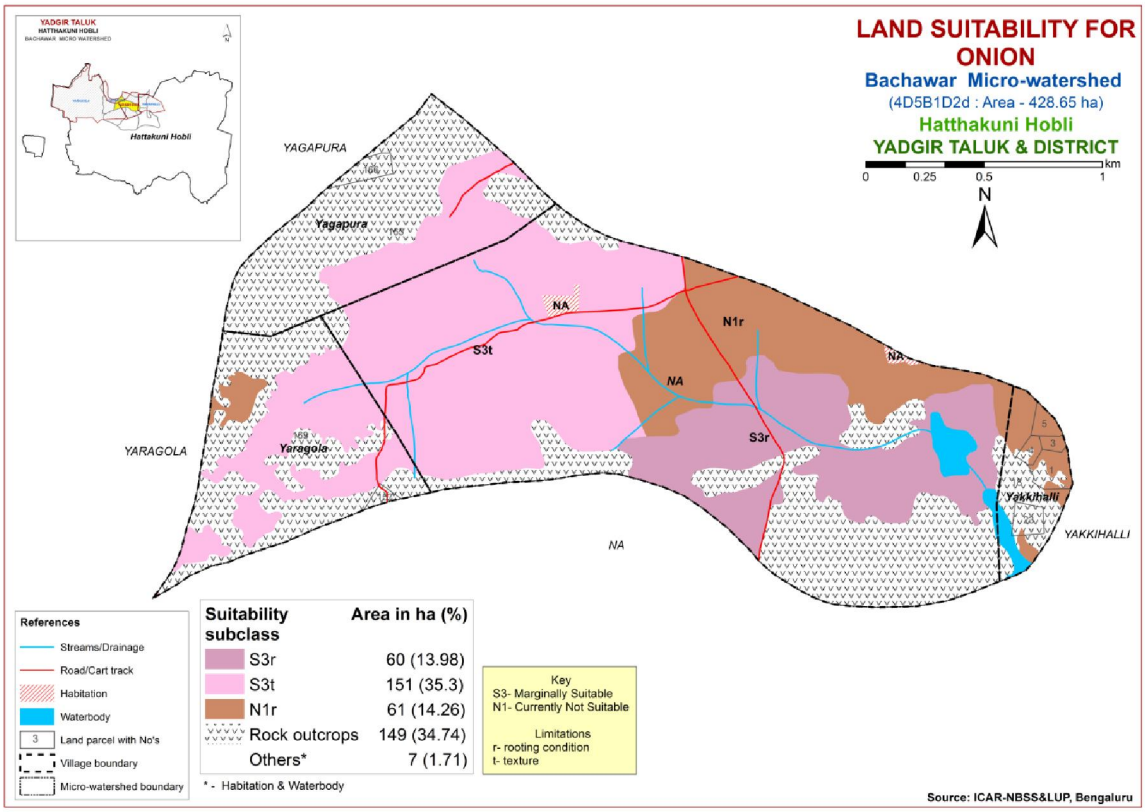


Fig 7.12 Land Suitability map of Onion

7.13 Land Suitability for Bhendi (*Abelmoschus esculentus*)

Bhendi is one of the most important vegetable crop grown in the state. The crop requirements for growing bhendi (Table 7.14) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing bhendi was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.13.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing bhendi and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing bhendi and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

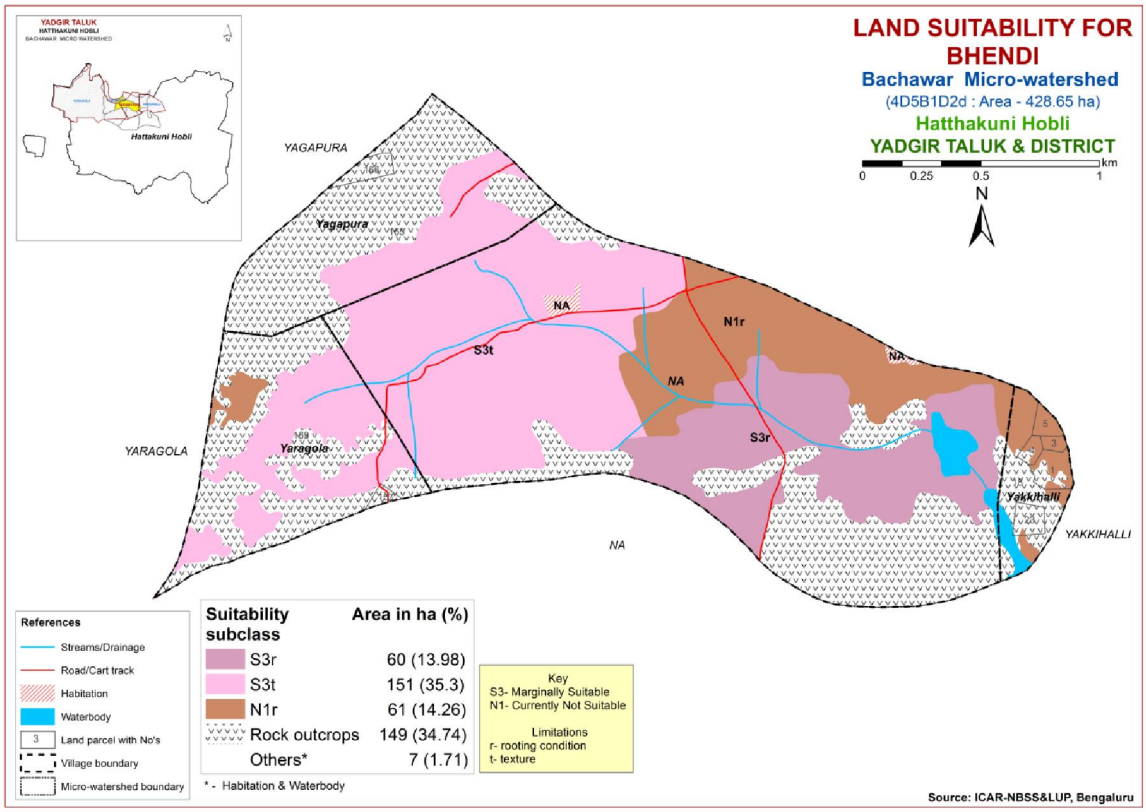


Fig 7.13 Land Suitability map of Bhendi

7.14 Land Suitability for Drumstick (*Moringa oleifera*)

Drumstick is one of the most important vegetable crop grown in about 2403 ha in the state. The crop requirements for growing drumstick (Table 7.15) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing drumstick was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.14.

Marginally suitable lands (Class S3) for growing drumstick occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing drumstick and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

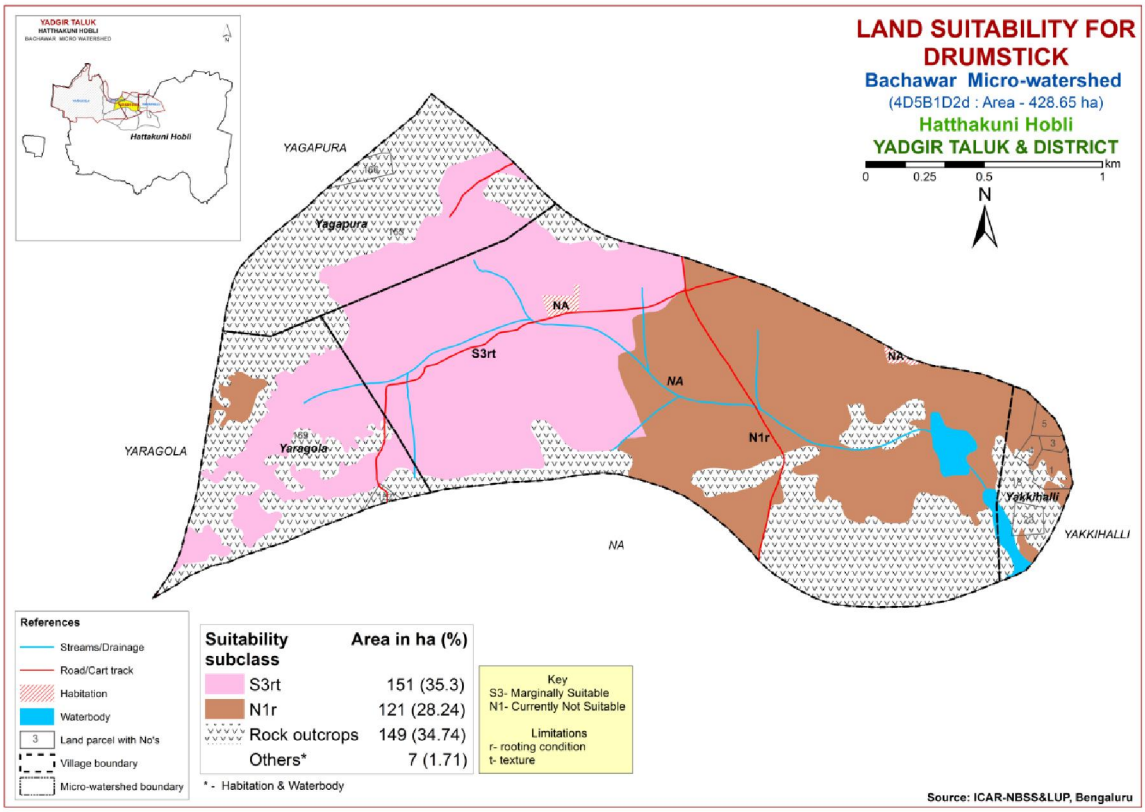


Fig 7.14 Land Suitability map of Drumstick

7.15 Land Suitability for Mango (*Mangifera indica*)

Mango is one of the most important fruit crop grown in an area of 1.73 lakh ha in almost all the districts of the State. The crop requirements (Table 7.16) for growing mango were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mango was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.15.

Entire cultivated area of about 272 ha (64%) is currently not suitable (Class N1) for growing mango and distributed in the major part of the microwatershed. They have severe limitation of rooting depth.

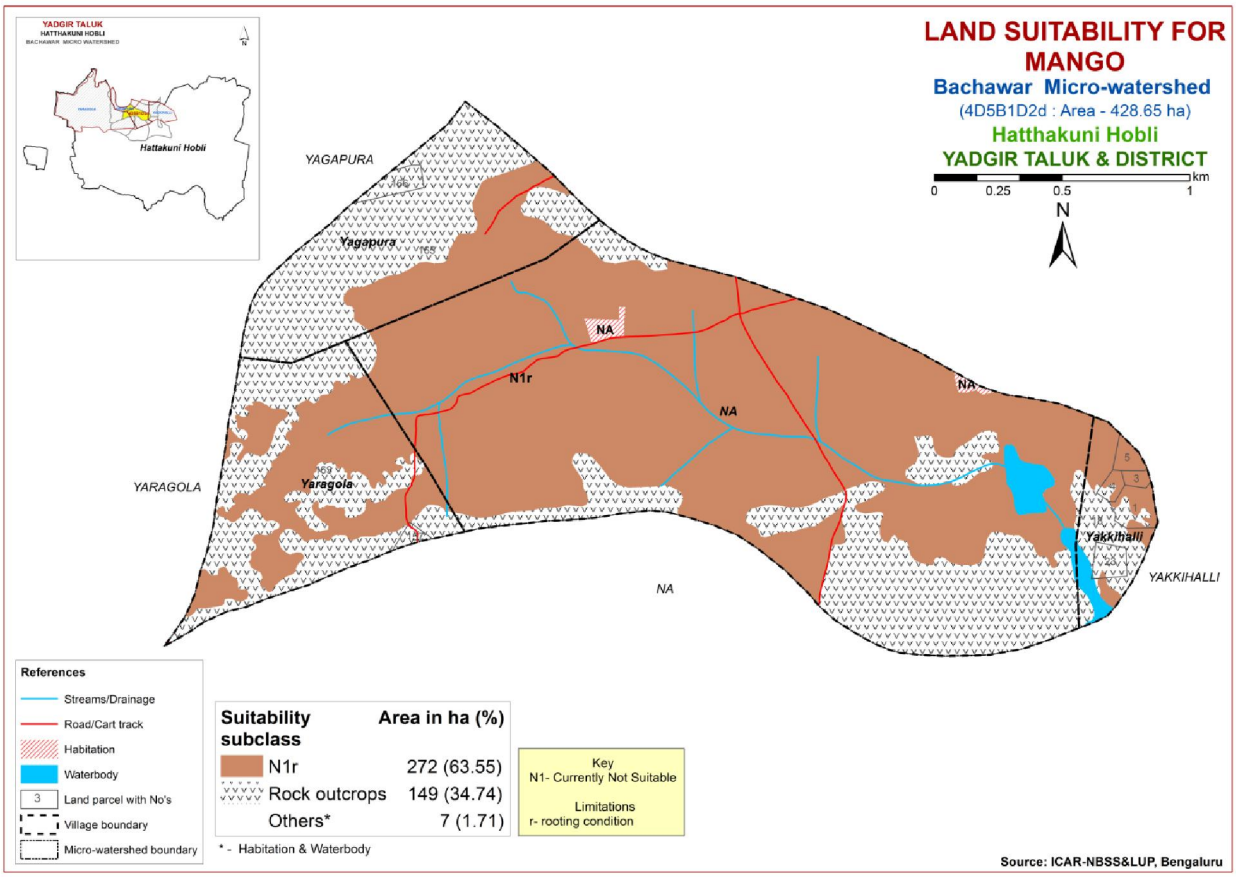


Fig. 7.15 Land Suitability map of Mango

7.16 Land Suitability for Guava (*Psidium guajava*)

Guava is one of the most important fruit crop grown in an area of 0.06 lakh ha in almost all the districts of the State. The crop requirements (Table 7.17) for growing guava were matched with the soil-site characteristics (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 7.16.

Marginally suitable lands (Class S3) for growing guava occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing guava and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

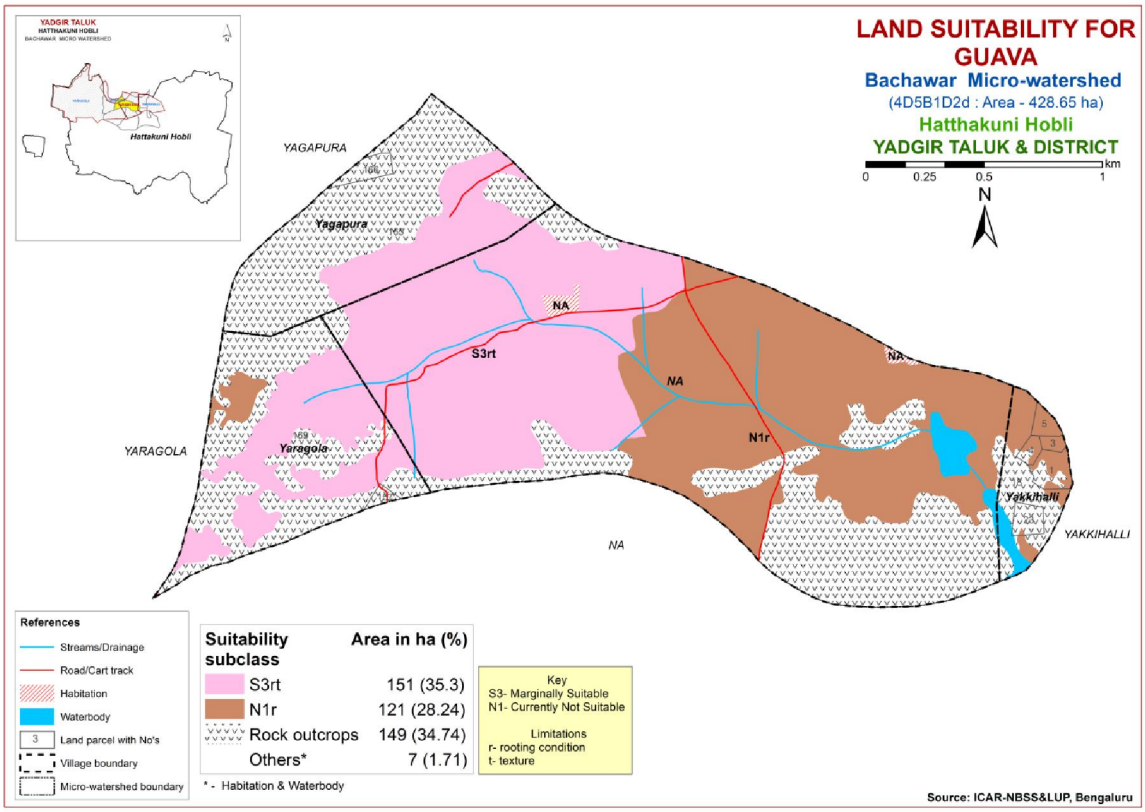


Fig. 7.16 Land Suitability map of Guava

7.17 Land Suitability for Sapota (*Manilkara zapota*)

Sapota is one of the most important fruit crop grown in an area of 29373 ha in almost all the districts of the State. The crop requirements (Table 7.18) 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 are given in Figure 7.17.

Marginally suitable lands (Class S3) for growing sapota occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing sapota and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

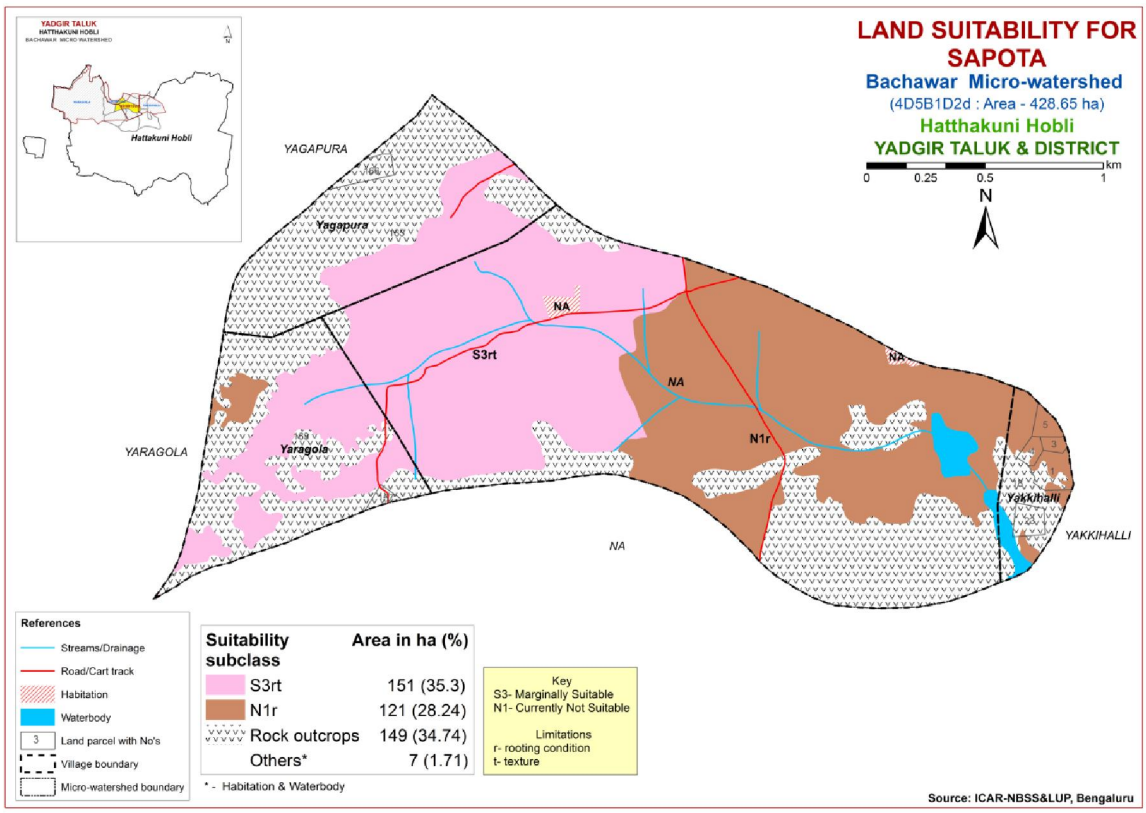


Fig. 7.17 Land Suitability map of Sapota

7.18 Land Suitability for Pomegranate (*Punica granatum*)

Pomegranate is one of the most important fruit crop commercially grown in about 18488 ha in Karnataka, mainly in Bijapur, Bagalkot, Koppal, Gadag and Chitradurga districts. The crop requirements for growing pomegranate (Table 7.19) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing pomegranate was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.18.

Marginally suitable lands (Class S3) for growing pomegranate occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing pomegranate and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

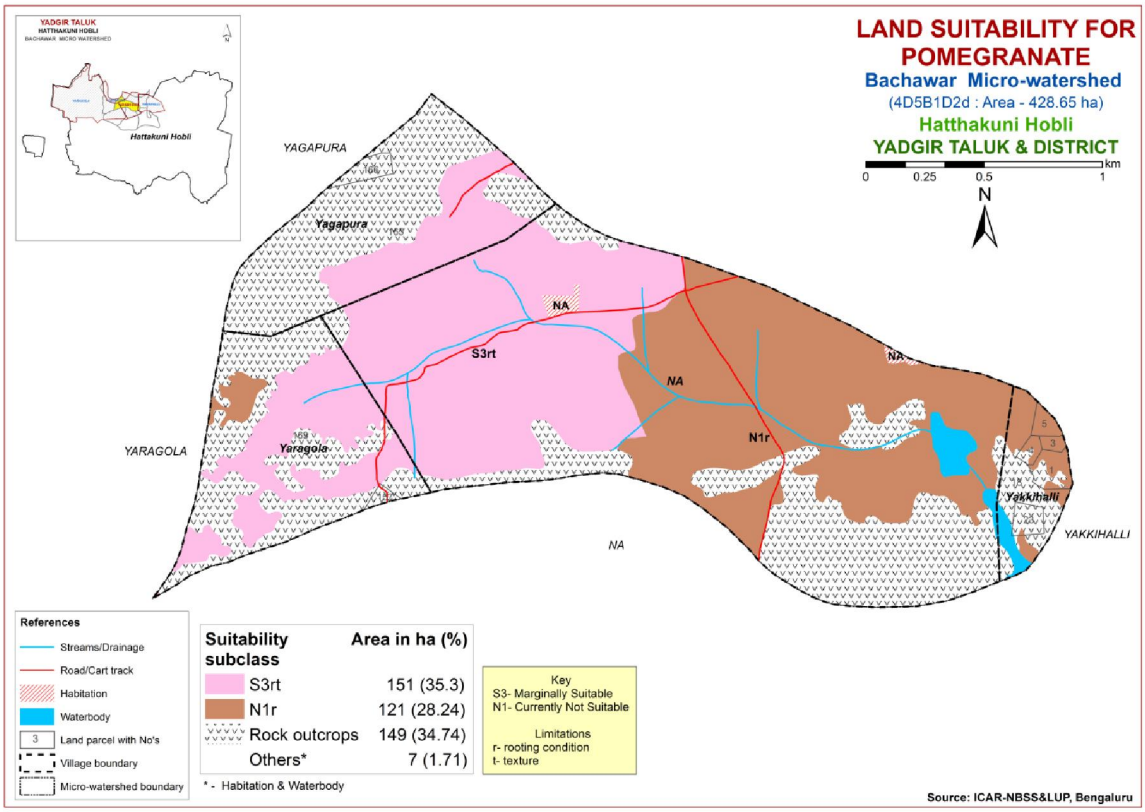


Fig 7.18 Land Suitability map of Pomegranate

7.19 Land Suitability for Musambi (*Citrus limetta*)

Musambi is one of the important fruit crop grown in an area of 3446 ha in almost all the districts of the State. The crop requirements for growing musambi (Table 7.20) 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.19.

Marginally suitable lands (Class S3) for growing musambi occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing musambi and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

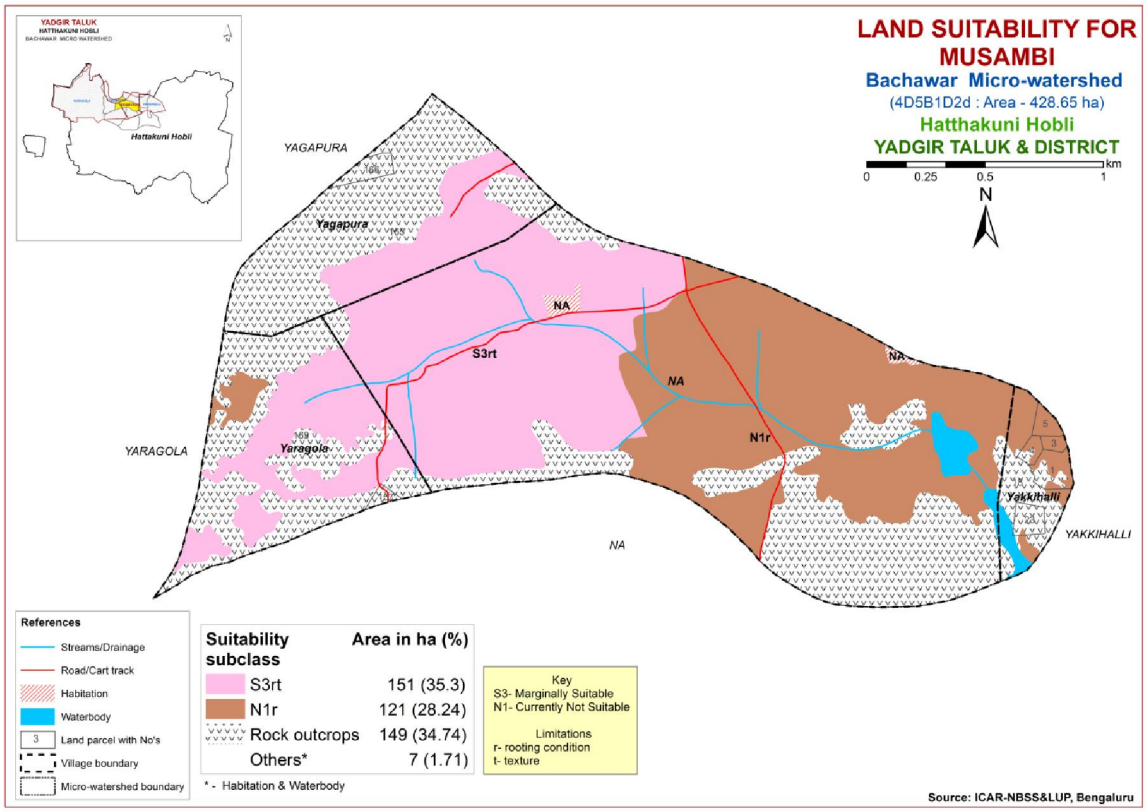


Fig. 7.19 Land Suitability map of Musambi

7.20 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 0.11 lakh ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.21) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7. 20.

Marginally suitable lands (Class S3) for growing lime occupy a maximum area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing lime and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

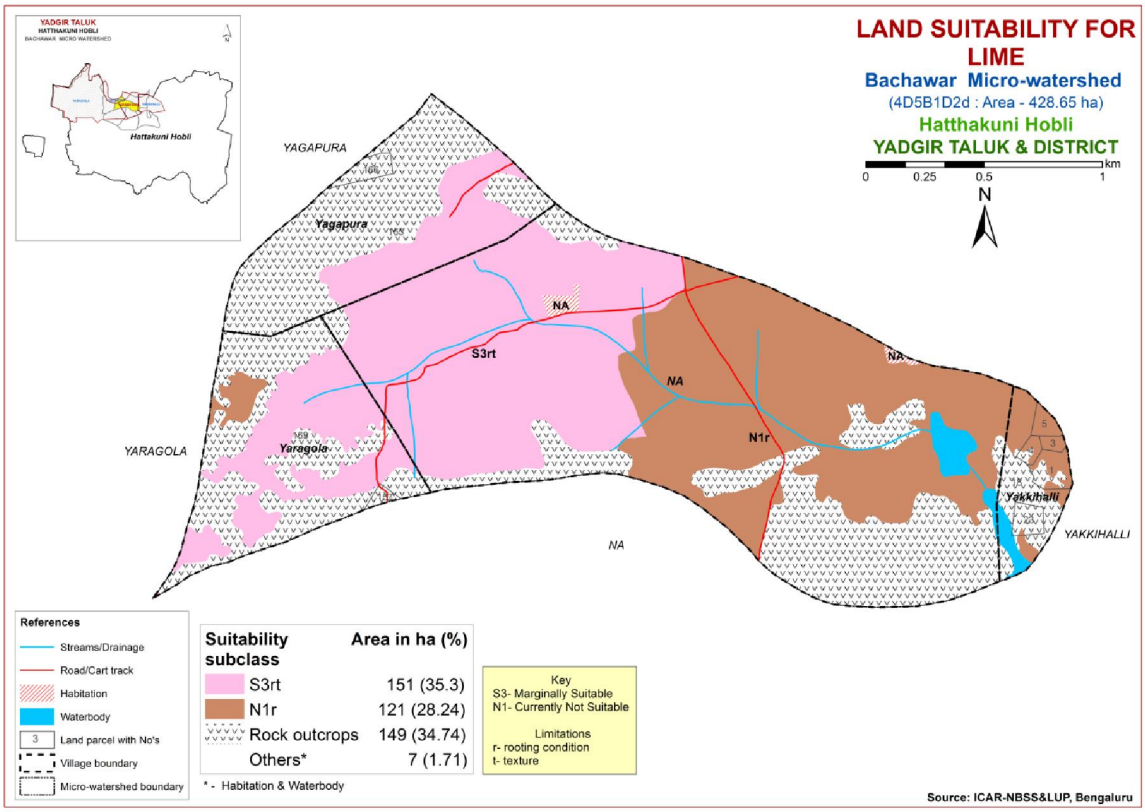


Fig. 7.20 Land Suitability map of Lime

7.21 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the medicinal fruit crop grown in almost all the districts of the State. The crop requirements for growing amla (Table 7.22) 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.21.

An area of about 211 ha (49%) is marginally suitable (Class S3) for growing amla and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing amla and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

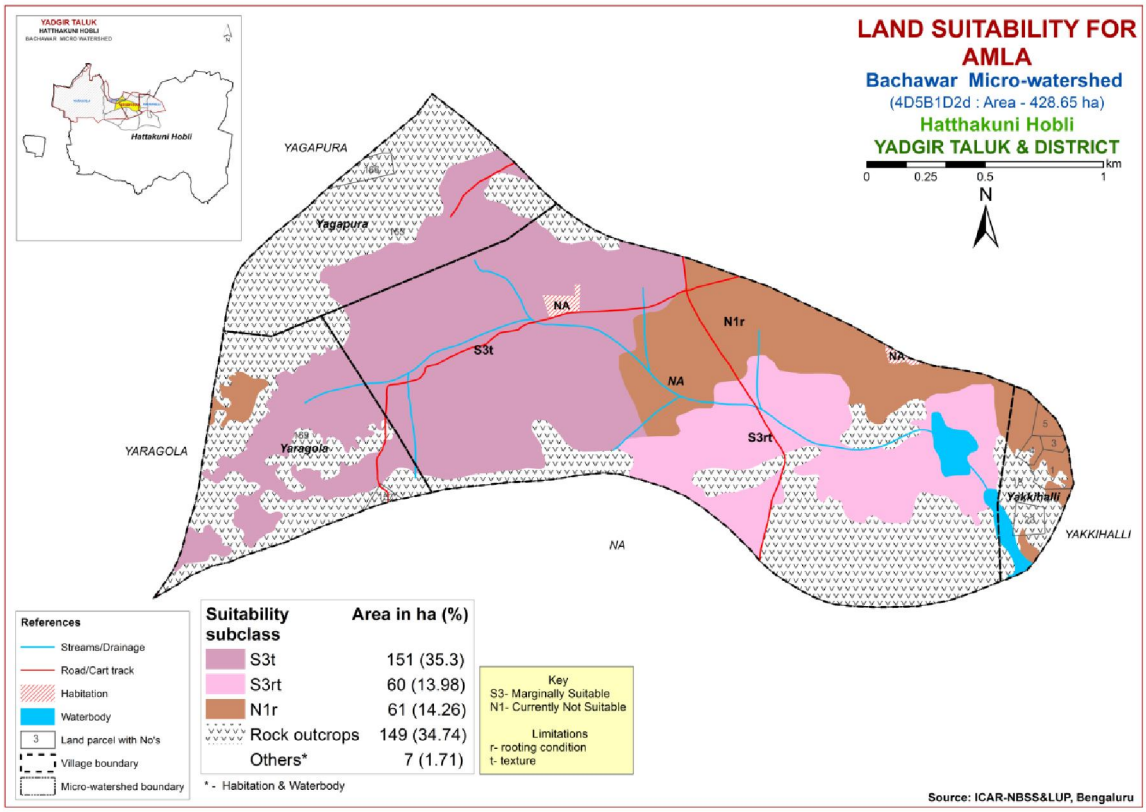


Fig. 7.21 Land Suitability map of Amla

7.22 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important plantation nut crop grown in an area of 0.7 lakh ha in almost all the districts of the State. The crop requirements for growing cashew (Table 7.23) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cashew was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.22.

Entire cultivated area of about 272 ha (64%) is currently not suitable (Class N1) for growing cashew and are distributed in the major part of the microwatershed with severe limitations of rooting depth and nutrient availability.

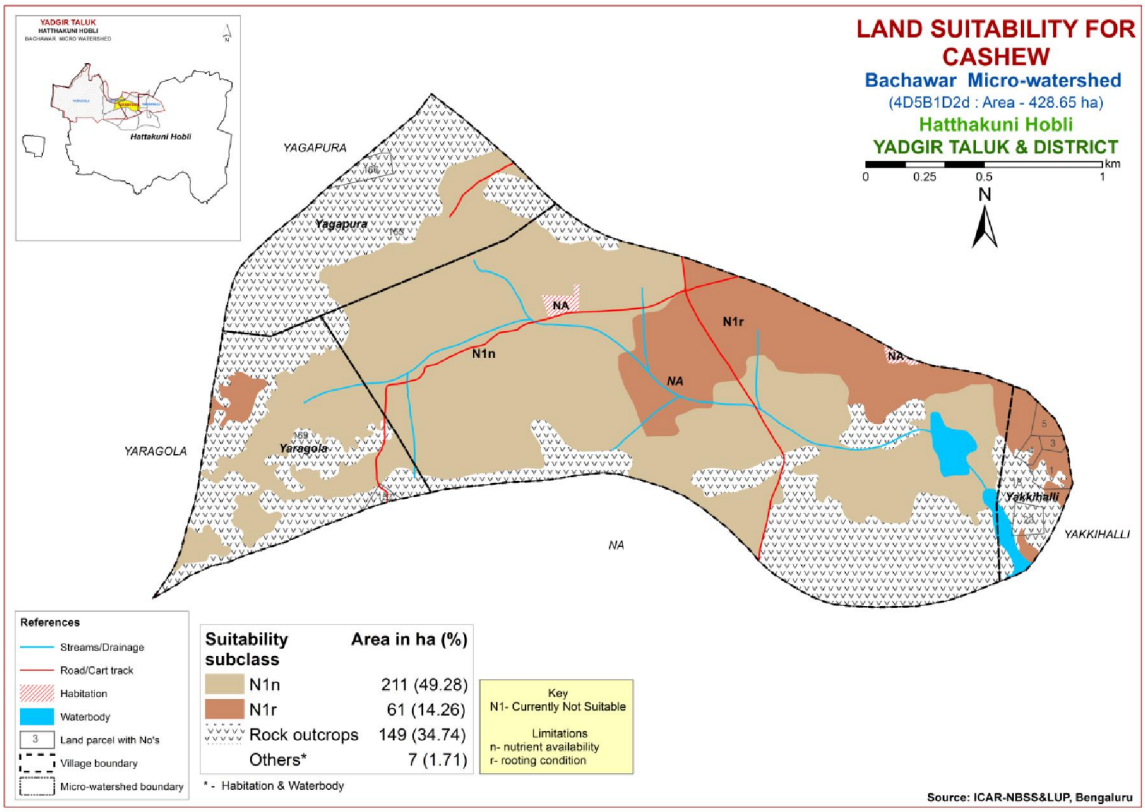


Fig. 7.22 Land Suitability map of Cashew

7. 23 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is one of the most important fruit crop grown in an area of 5368 ha in almost all the districts of the State. The crop requirements for growing jackfruit (Table 7.24) 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 geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.23.

Marginally suitable lands (Class S3) for growing jackfruit occupy an area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing jackfruit and are distributed in the central, western, eastern, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

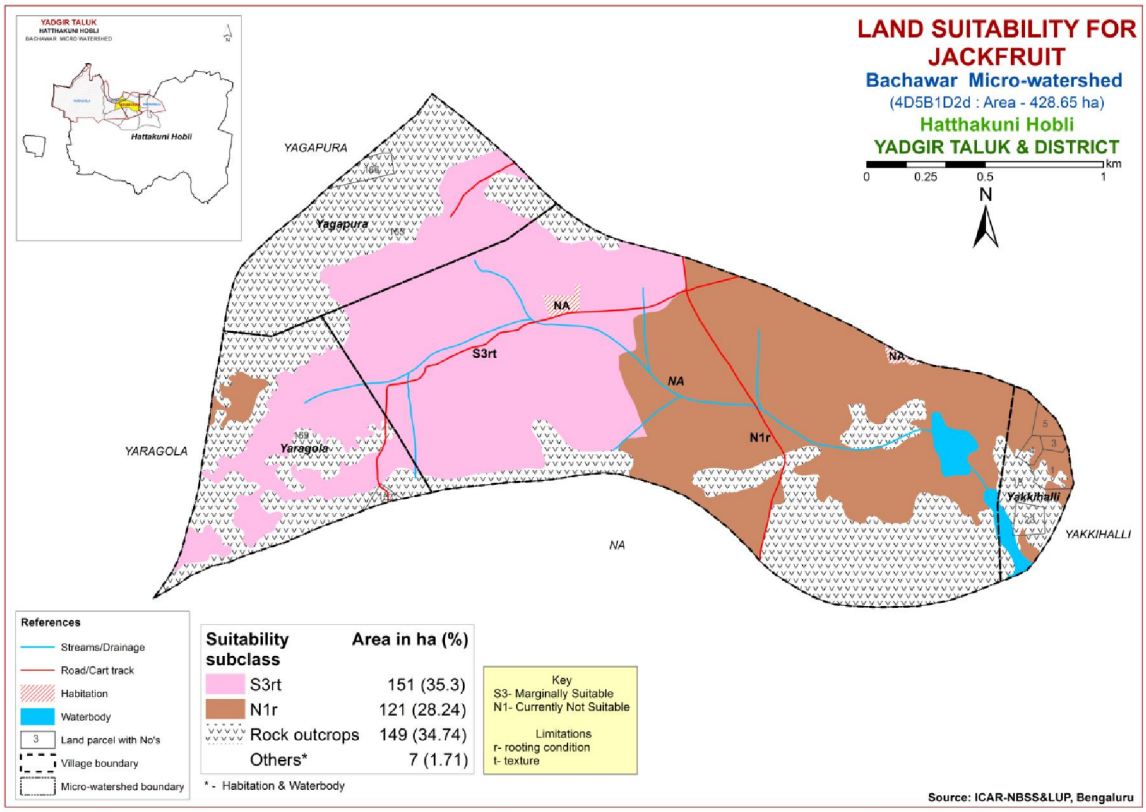


Fig. 7.23 Land Suitability map of Jackfruit

7.24 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 7.25) 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.24.

Marginally suitable lands (Class S3) for growing jamun occupy an area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing jamun and are distributed in the central, western, eastern, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

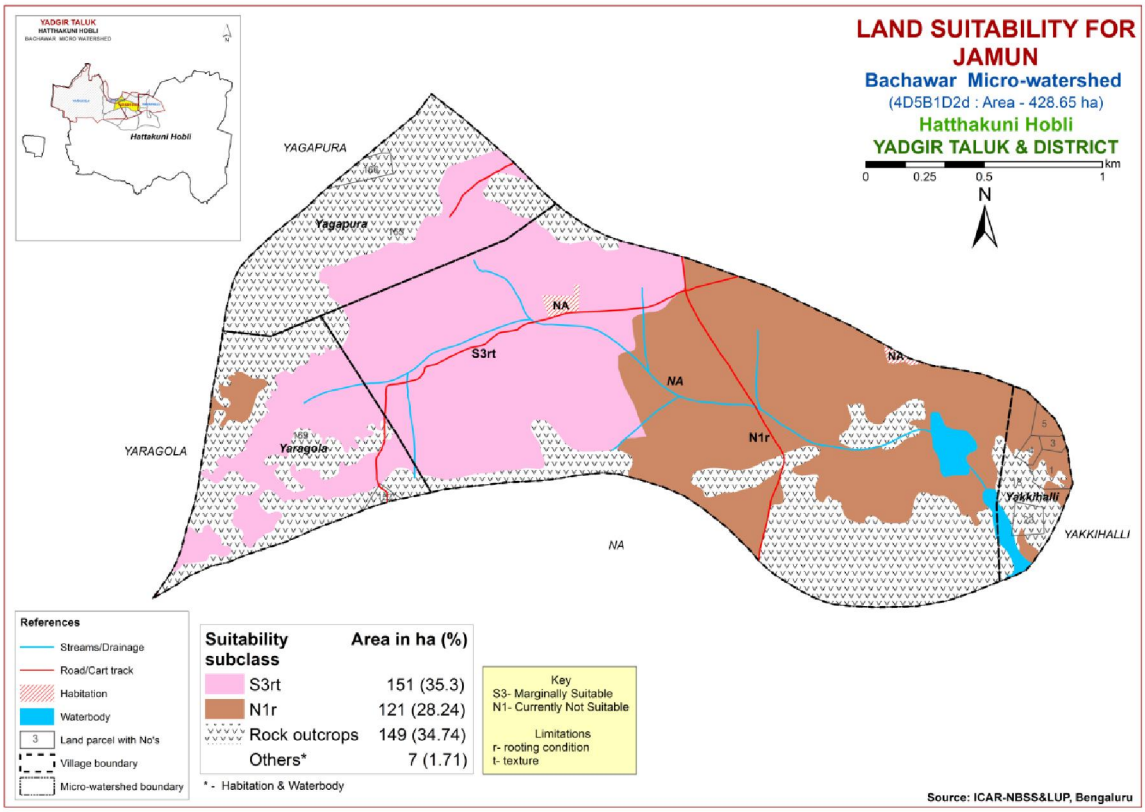


Fig. 7.24 Land Suitability map of Jamun

7.25 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 (Table7.26) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing custard apple was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.25.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing custard apple and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing custard apple and are distributed in the central, eastern, western and southeastern part of the microwatershed with severe limitation of rooting depth.

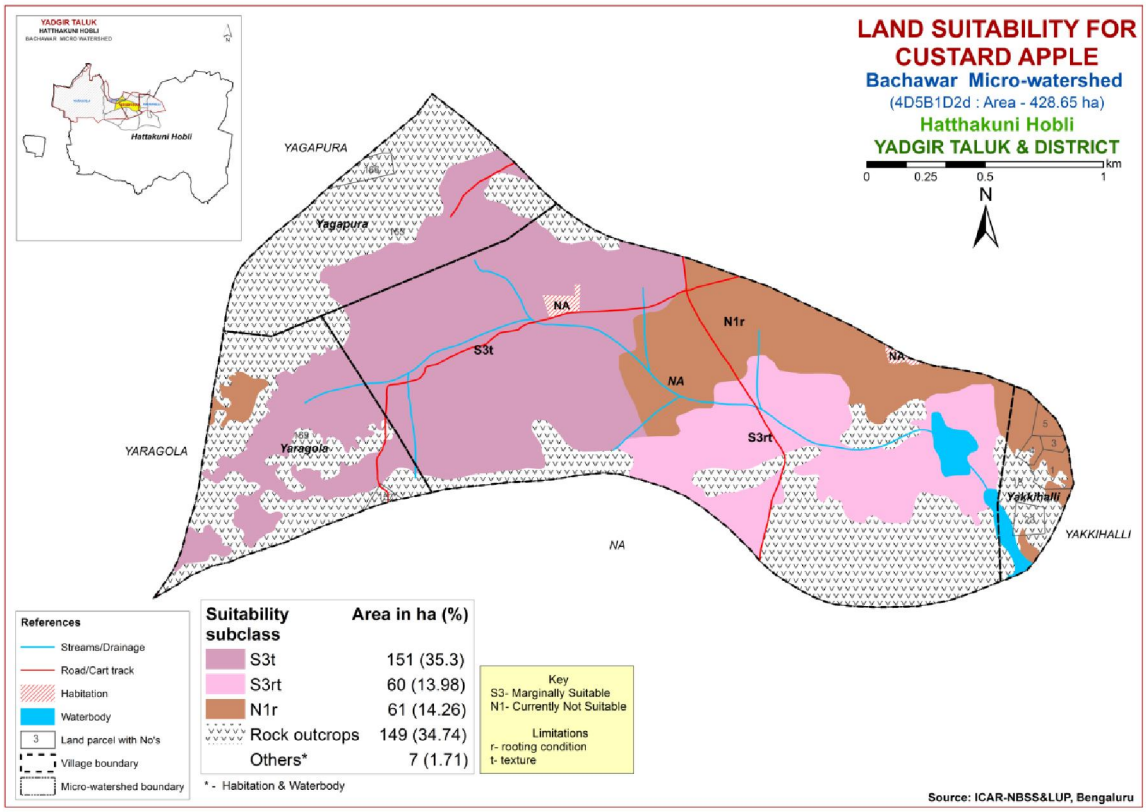


Fig. 7.25 Land Suitability map of Custard Apple

7.26 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is one of the most important spice crop grown in almost all the districts of the state. The crop requirements for growing tamarind (Table 7.27) 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 Fig. 7.26.

Entire cultivated area of about 272 ha (64%) is currently not suitable (Class N1) for growing tamarind and are distributed in the major part of the microwatershed with severe limitation of rooting depth.

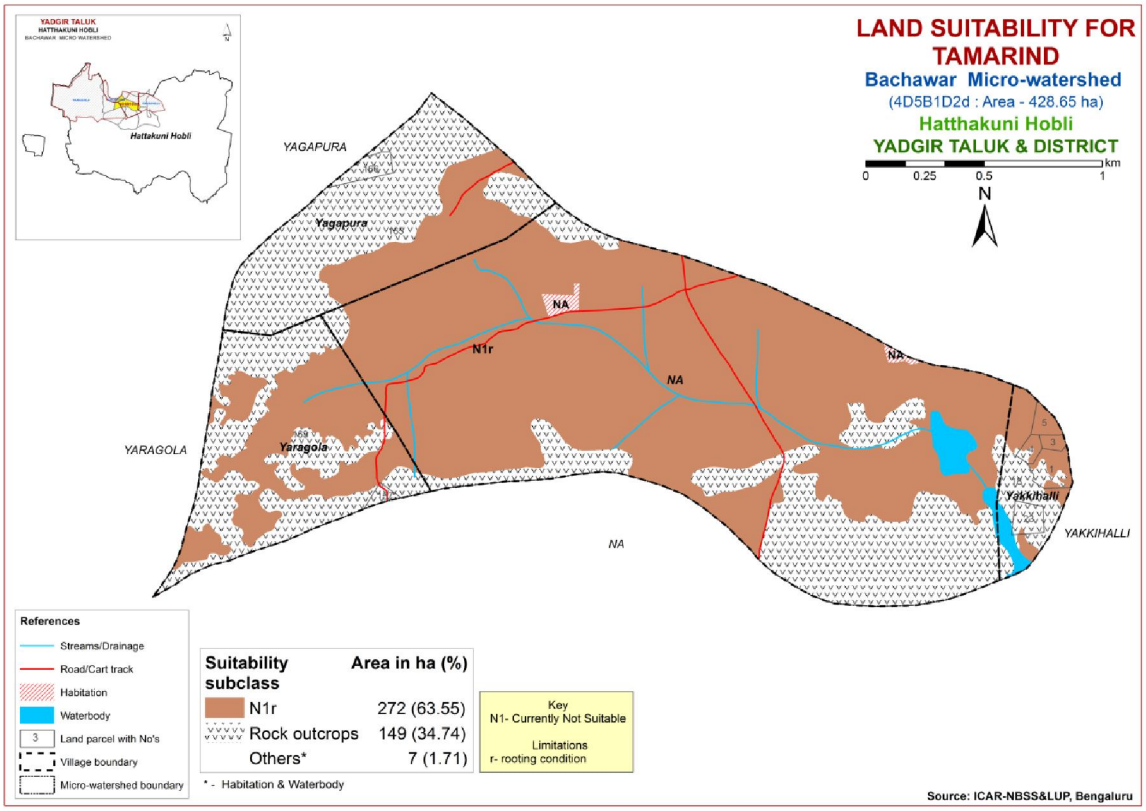


Fig. 7.26 Land Suitability map of Tamarind

7.27 Land Suitability for Mulberry (*Morus nigra*)

Mulberry is an important leaf crop grown for rearing silkworms in about 1.6 lakh ha area in all the districts of the state. The crop requirements for growing mulberry (Table 7.28) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mulberry was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.27.

Marginally suitable lands (Class S3) for growing mulberry occupy an area of about 151 ha (35%) and occur in the major part of the microwatershed. They have moderate limitations of rooting depth and texture. An area of about 121 ha (28%) is currently not suitable (Class N1) for growing mulberry and are distributed in the central, eastern, western, southern and southeastern part of the microwatershed with severe limitation of rooting depth.

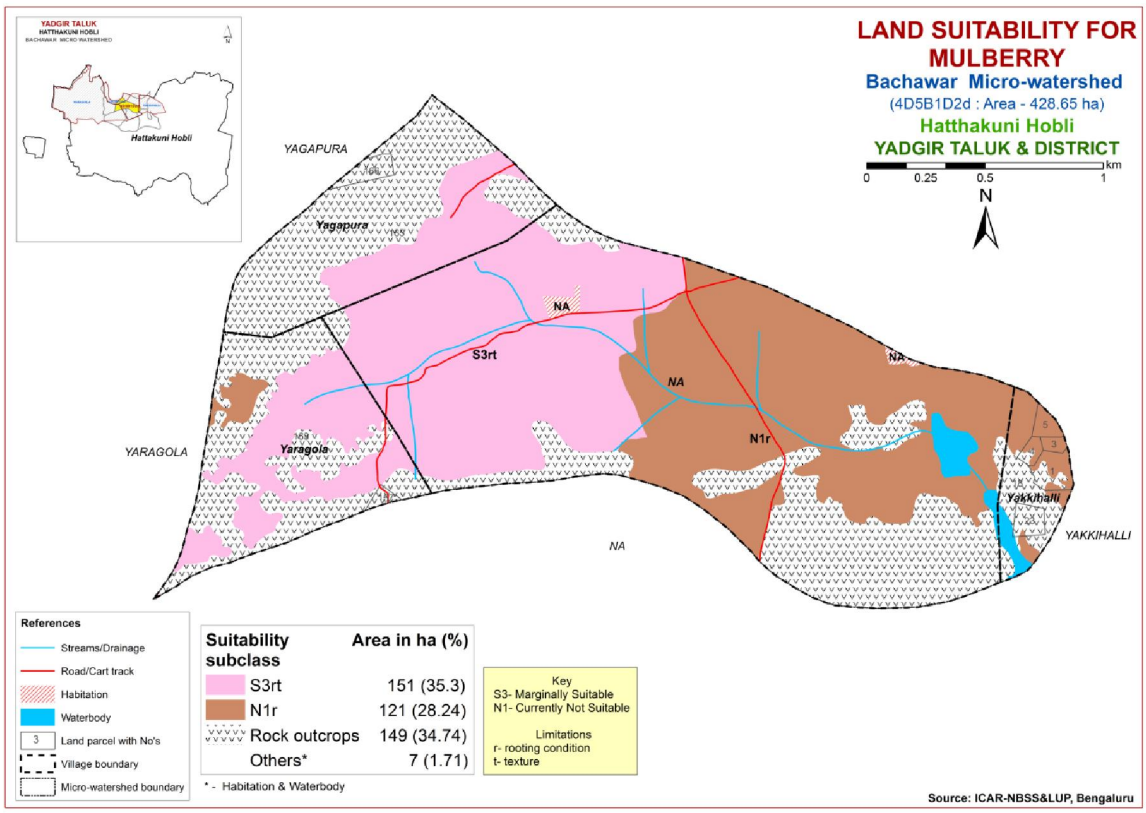


Fig 7.27 Land Suitability map of Mulberry

7.28 Land Suitability for Marigold (*Tagetes sps*.)

Marigold is one of the most important flower crop grown in an area of 9108 ha in almost all the districts of the State. The crop requirements (Table 7.29) for growing marigold were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing marigold was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.28.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing marigold and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing marigold and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

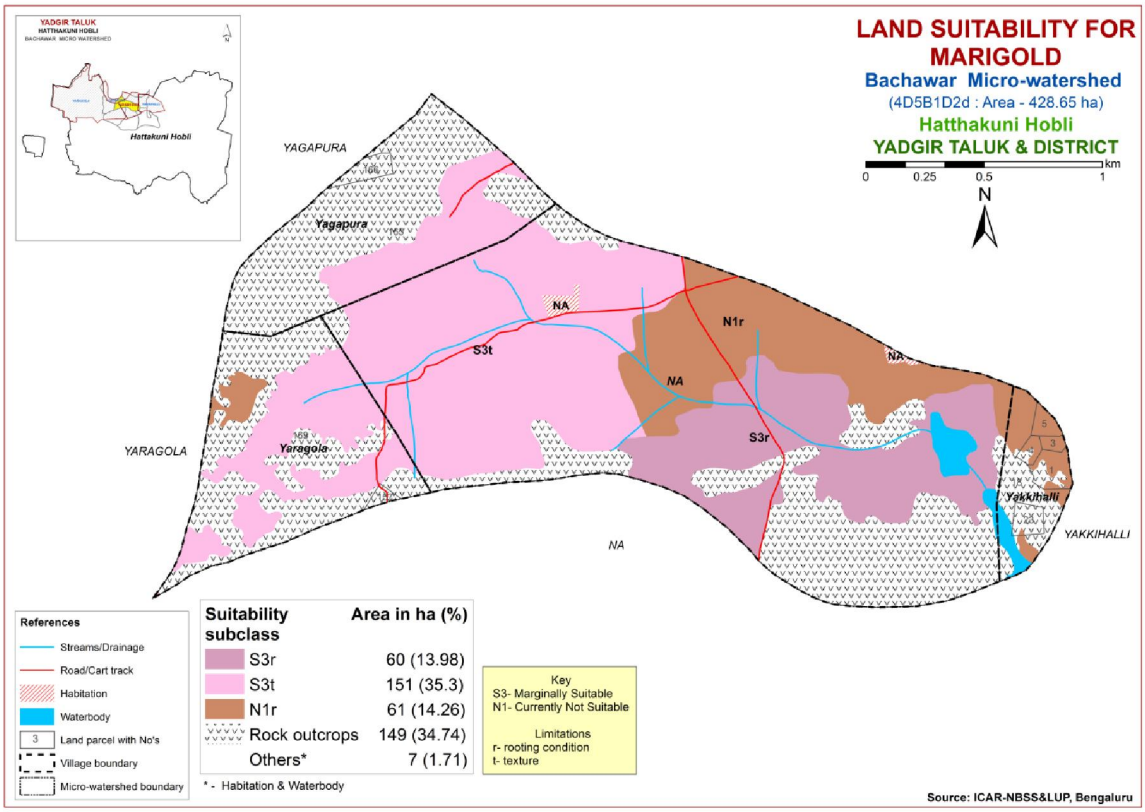


Fig. 7.28 Land Suitability map of Marigold

7.29 Land Suitability for Chrysanthemum (*Dendranthema grandiflora*)

Chrysanthemum is one of the most important flower crop grown in an area of 4978 ha in almost all the districts of the State. The crop requirements (Table 7.30) for growing chrysanthemum were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing chrysanthemum was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.29.

A maximum area of about 211 ha (49%) is marginally suitable (Class S3) for growing chrysanthemum and are distributed in the major part of the microwatershed with moderate limitations of rooting depth and texture. An area of about 61 ha (14%) is currently not suitable (Class N1) for growing chrysanthemum and are distributed in the central, western, eastern and southeastern part of the microwatershed with severe limitation of rooting depth.

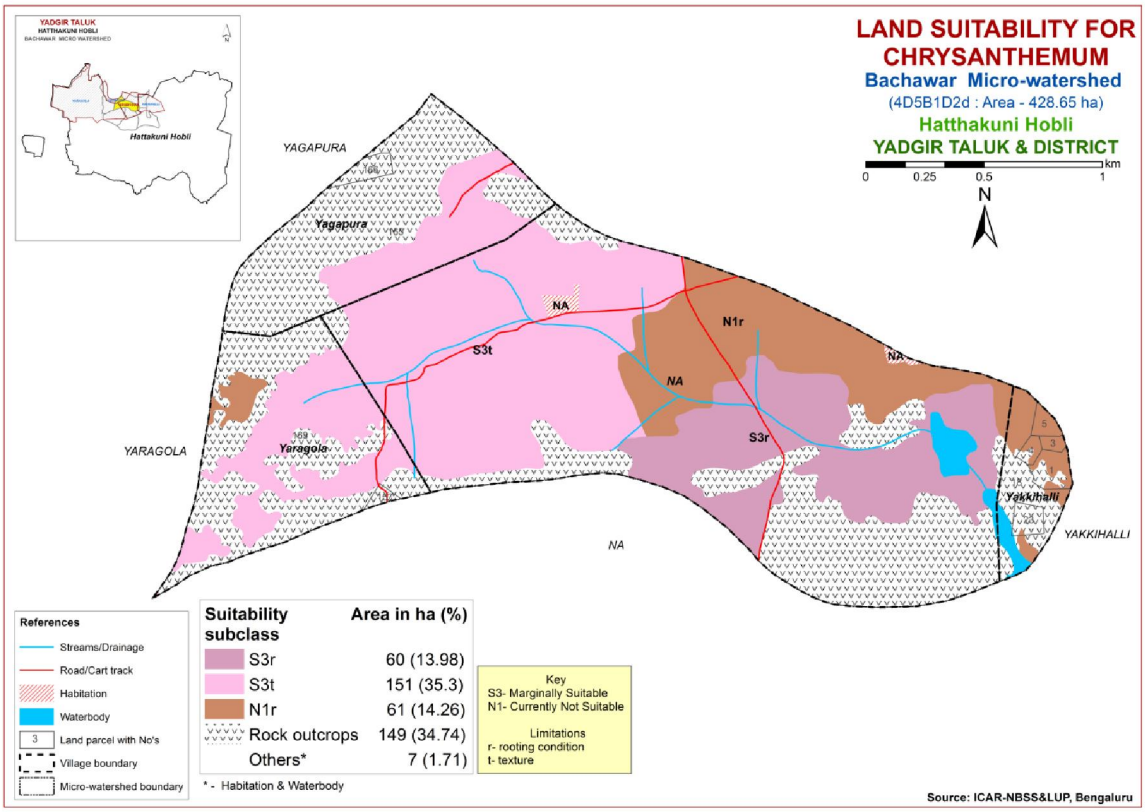


Fig. 7.29 Land Suitability map of Chrysanthemum

Table 7.1 Soil-Site Characteristics of Bachawar Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drain-age Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC (dSm^{-1})	ESP (%)	CEC [Cmol $(p^+)kg^{-1}$]	BS (%)
					Sur-face	Sub-surface	Surface (%)	Sub-surface (%)								
KKRcB2	866	150	WD	<25	sl	sl	<15	10-15	<50	1-3	moderate	-	5.82	-	9.77	0-22
KKRbB2g1	866	150	WD	<25	ls	sl	15-35	10-15	<50	1-3	moderate	-	5.82	-	9.77	0-22
BDLhB2g1	866	150	WD	25-50	sc	sl	15-35	<15	<50	1-3	moderate	6.20	0.074	0.20	4.20	93
BDLiB2	866	150	WD	25-50	sc	sl	<15	<15	<50	1-3	moderate	6.20	0.074	0.20	4.20	93
SBRcC3g1	866	150	sed	50-75	sl	ls	15-35	<15	<50	3-5	severe	8.24	0.145	1.15	7.50	100

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

Table 7.2 Land suitability criteria for Sorghum

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

Table 7.3 Land suitability criteria for Maize

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

Table 7.4 Land suitability criteria for Bajra

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

Table 7.5 Land suitability criteria for Groundnut

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

Table 7.6 Land suitability criteria for Sunflower

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

Table 7.7 Land suitability criteria for Redgram

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

Table 7.8 Land suitability criteria for Bengal gram

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

Table 7.9 Land suitability criteria for Cotton

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

Table 7.10 Land suitability criteria for Chilli

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

Table 7.11 Land suitability criteria for Tomato

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

Table 7.12 Land suitability criteria for Brinjal

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

Table 7.13 Land suitability criteria for Onion

Land use requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N1)**
Climatic regime	Mean temperature in growing season	°C	20-30	30-35	35-40	>40
	Mean max. temp. in growing season	°C				
	Mean min. tempt. in growing season	°C				
	Mean RH in growing season	%				
	Total rainfall	mm				
	Rainfall in growing season	mm				
Land quality	Soil-site characteristic					
Moisture availability	Length of growing period for short duration	Days				
	Length of growing period for long duration					
	AWC	mm/m				
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately /imperfectly	-	Poorly to V poorly drained
	Water logging in growing season	Days				
Nutrient availability	Texture	Class	sl,scl,cl,sc,c (red)	-	c (Black),ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-7.8	7.8-8.4	>8.4
	CEC	C mol (p+)/ Kg				
	BS	%				
	CaCO3 in root zone	%		<5	5-10	>10
	OC	%				
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Stoniness	%				
	Coarse fragments	Vol %	<15	15-35	35-60	60-80
Soil toxicity	Salinity (EC saturation extract)	ds/m	<1.0	1.0-2.0	2.0-4.0	<4
	Sodicity (ESP)	%	<5	5-10	10-15	>15
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 7.14 Land suitability criteria for Bhendi

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

Table 7.15 Land suitability criteria for Drumstick

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

Table 7.16 Land suitability criteria for Mango

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

Table 7.17 Land suitability criteria for Guava

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

Table 7.18 Land suitability criteria for Sapota

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

Table 7.19 Land suitability criteria for Pomegranate

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

Table 7.20 Land suitability criteria for Musambi

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

Table 7.21 Land suitability criteria for Lime

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

Table 7.22 Land suitability criteria for Amla

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

Table 7.23 Land suitability criteria for Cashew

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

Table 7.24 Land suitability criteria for Jackfruit

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

Table 7.25 Land suitability criteria for Jamun

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

Table 7.26 Land suitability criteria for Custard apple

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

Table 7.27 Land suitability criteria for Tamarind

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

Table 7.28 Land suitability criteria for Mulberry

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

Table 7.29 Land suitability criteria for Marigold

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

Table 7.30 Land suitability criteria for Chrysanthemum

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

7.30 Land Management Units (LMUs)

The 5 soil map units identified in Bachawar microwatershed have been grouped into 2 Land Management Units (LMU's) for the purpose of preparing a Proposed Crop Plan. Land Management Units are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land Management Units map (Fig. 7.30) has been generated. These Land Management Units are expected to behave similarly for a given level of management.

The map units that have been grouped into 2 Land Management Units along with brief description of soil and site characteristics are given below.

LMU	Soil map units	Soil and site characteristics
1	12.SBRcC3g1	Moderately shallow (50-75 cm), loamy sand soils, 3-5 % slopes, gravelly (15-35%), severe erosion.
2	162.BDLhB2g1 5.BDLiB2 153.KKRbB2g1 175.KKRcB2	Shallow to very shallow (<25 to 50 cm), sandy loam soils, 1-3 % slopes, non-gravelly to gravelly (<15-35%), moderate erosion.

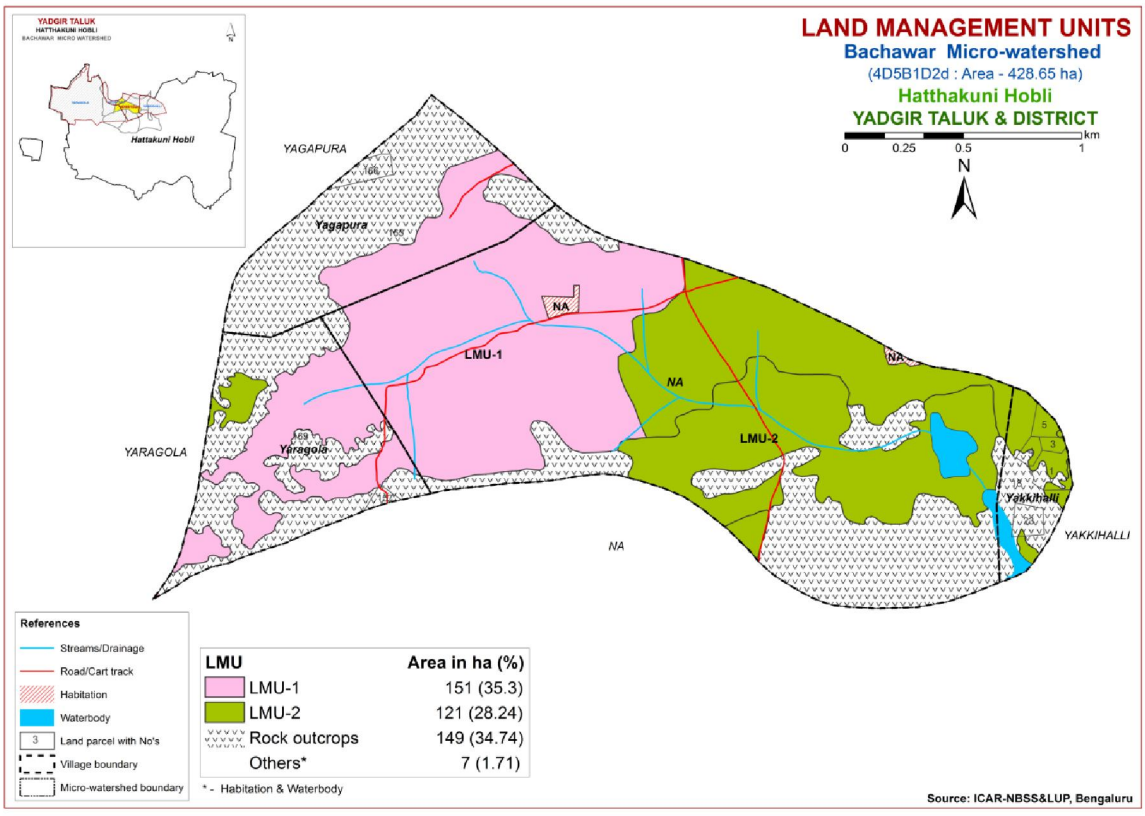


Fig. 7.30 Land Management Units Map- Bachawar Microwatershed

7.31 Proposed Crop Plan for Bachawar Microwatershed

After assessing the land suitability for the 29 crops, the Proposed Crop Plan has been prepared for the 2 identified LMUs by considering only highly (Class S1) and moderately (Class S2) suitable lands for each of the 29 crops. The resultant proposed crop plan is presented below in Table 7.31.

Table 7.31 Proposed Crop Plan for Bachawar Microwatershed

LMU	Soil Map Units	Survey Number	Field Crops/ Commercial crops	Horticulture Crops (Rainfed/Irrigated)	Suitable Interventions
1	12.SBRcC3g1 (Moderately shallow, loamy sand soils)	**Yaragola:**157,163 **Yagapura:**165	-	**Agri-Silvi-Pasture:** Hybrid Napier*, Styloxanthes hamata, Styloxanthes scabra*	Application of FYM, Biofertilizers and micronutrients, drip irrigation, mulching, suitable soil and water conservation practices
2	162.BDLhB2g1 5.BDLiB2 153.KKRbB2g1 175.KKRcB2 (Very shallow to shallow, sandy loam soils)	**Yakkihalli :**1,3,4,5	-	**Agri-Silvi-Pasture:** Hybrid Napier*, Styloxanthes hamata, Styloxanthes scabra*	Use of short duration varieties, sowing across the slope, drip irrigation is recommended

Chapter 8

SOIL HEALTH MANAGEMENT

8.1 Soil Health

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

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

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

The most important characteristics of a healthy soil are

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

Characteristics of Bachawar Microwatershed

- The soil phases identified in the microwatershed belonged to the soil series of KKR 61 ha (14%), BDL 60 ha (14%) and SBR 151 ha (35%).
- As per land capability classification, entire area of the microwatershed falls under arable land category (Class III & IV). The major limitations identified in the arable lands were soil erosion and soil limitation.
- On the basis of soil reaction, 9 ha (2%) is slightly acid (pH 6.0-6.5), 118 ha (28%) is neutral (pH 6.5-7.3), 139 ha (32%) is slightly alkaline (pH 7.3-7.8) and 7 ha (1%) is moderately alkaline (pH 7.8-8.4) in reaction.

Soil Health Management

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

Acid soils

Acid soils occur in an area of 9 ha (2%) in the microwatershed.

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

Liming materials:

1. $CaCO_3$ (Calcium Carbonate).
2. Dolomite [Ca Mg $(Co_3)_2$]
3. Quick lime (Cao)
4. Slaked lime [Ca $(OH)_2$]

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

Neutral soils

Neutral soils cover in an area of 118 ha (28%) in the microwatershed.

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.

Alkaline soils

Alkaline soils occur in an area of 146 ha (33%) in the microwatershed.

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).

Soil Degradation

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 429 ha area in the microwatershed, an area of about 121 ha is suffering moderate and 151 ha from severe erosion. The areas which are in moderate to severe erosion need immediate soil and water conservation and, other land development and land husbandry practices for restoring soil health.

Dissemination of Information and Communication of Benefits

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

Inputs for Net Planning (Saturation Plan) and Interventions needed

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

1. Soil and Water Conservation Plan 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, wetness and soil are the major constraints in Bachawar microwatershed.
- **Organic Carbon:** The OC content (an index of available Nitrogen) is high (>0.75%) in the entire cultivated area of the microwatershed.
- **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.
- **Available Phosphorus**: Available Phosphorus is medium (23-57 kg/ha) in the entire cultivated area of the microwatershed. For all the crops, 25% additional P needs to be applied where available P is medium.
- **Available Potassium:** Available potassium is medium (145-337 kg/ha) in the entire cultivated area of the microwatershed. All the plots, where available potassium is low and medium, for all the crops, additional 25 % potassium may be applied.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. An area of 101 ha (23%) is low (<10 ppm), 132 ha (31%) is medium (10-20 ppm) and 40 ha (9%) is high (>20 ppm) in available sulphur content. Medium and low areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.
- **Available Boron:** Entire cultivated area of the microwatershed is low (<0.5 ppm) in available boron content. For these areas, application of sodium borate @ 10 kg/ha as soil application or 0.2 % borax as foliar spray is recommended.
- **Available Iron:** Entire cultivable area is sufficient (>4.5 ppm) in available iron content of the microwatershed. For the deficient areas, iron sulphate @ 25 kg/ha need to be applied for 2-3 years.
- **Available Copper and Manganese** are sufficient in the entire cultivated area of the microwatershed.
- **Available Zinc:** An area of 145 ha (34%) is deficient (<0.6 ppm) and 127 ha (30%) is sufficient (>0.6 ppm) in available zinc content of the microwatershed. Application of zinc sulphate @25 kg/ha is recommended for the deficient areas.

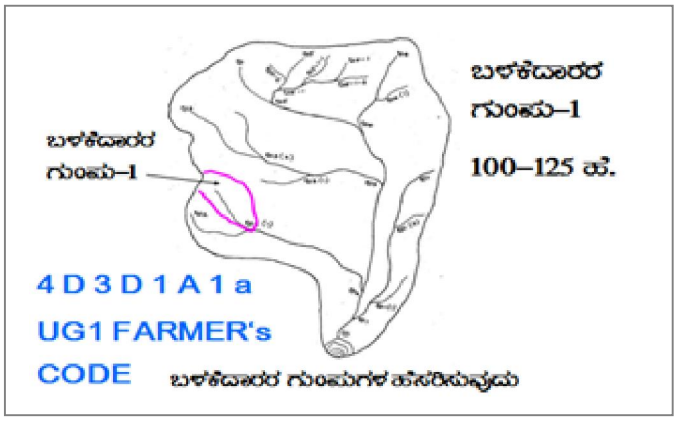
- **Land Suitability for various crops:** Areas that are highly, moderately and marginally suitable for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth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

Chapter 9

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Bachawar 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

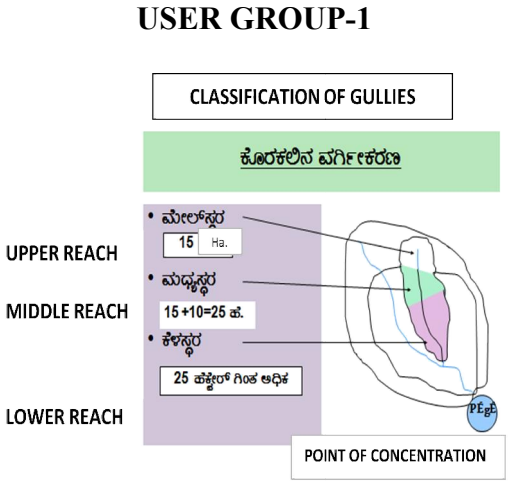
9.1 Treatment Plan

The treatment plan recommended for arable lands is briefly described below

9.1.1 Arable Land Treatment

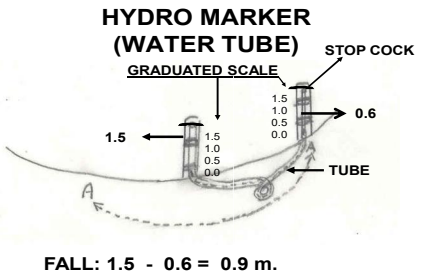
A. BUNDING

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)



Measurement of Land Slope

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



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

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

Note: (i) The above intervals are maximum.

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

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

Section of the Bund

Bund section is decided considering the soil texture class and gravelliness class ($bg_{0...}$ b=loamy sand, g_0 = <15% gravel). The recommended Sections for different soils are given below.

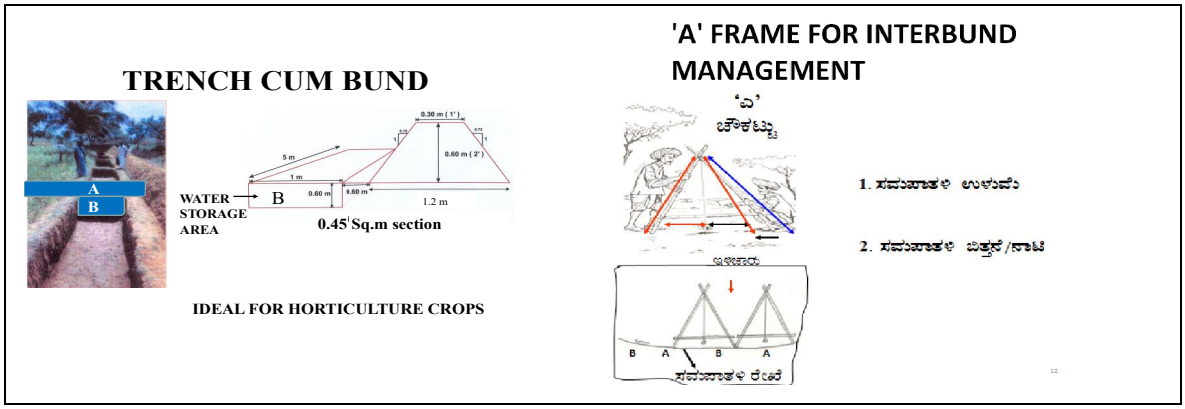
Recommended Bund Section

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

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below:



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

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

B. Water Ways

1. Existing waterways are marked on the cadastral map (1:792 scale) and their dimensions are recorded.
2. Considering the contour plan of the MWS, additional waterways/ modernization of the existing ones can be thought of.
3. The design details are given in the Manual.

C. Farm Ponds

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

D. Diversion Channel

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

9.1.2 Non-Arable Land Treatment

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

9.1.3 Treatment of Natural Water Course/ Drainage Lines

a) The cadastral map has to be updated as regards the network of 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 prepared which shows the spatial distribution and extent of area. Entire cultivated area of about 272 ha (64%) needs Graded Bunding.

The conservation plan prepared may be presented to all the stakeholders including farmers and after considering their suggestions, the conservation plan for the microwatershed may be finalised in a participatory approach.

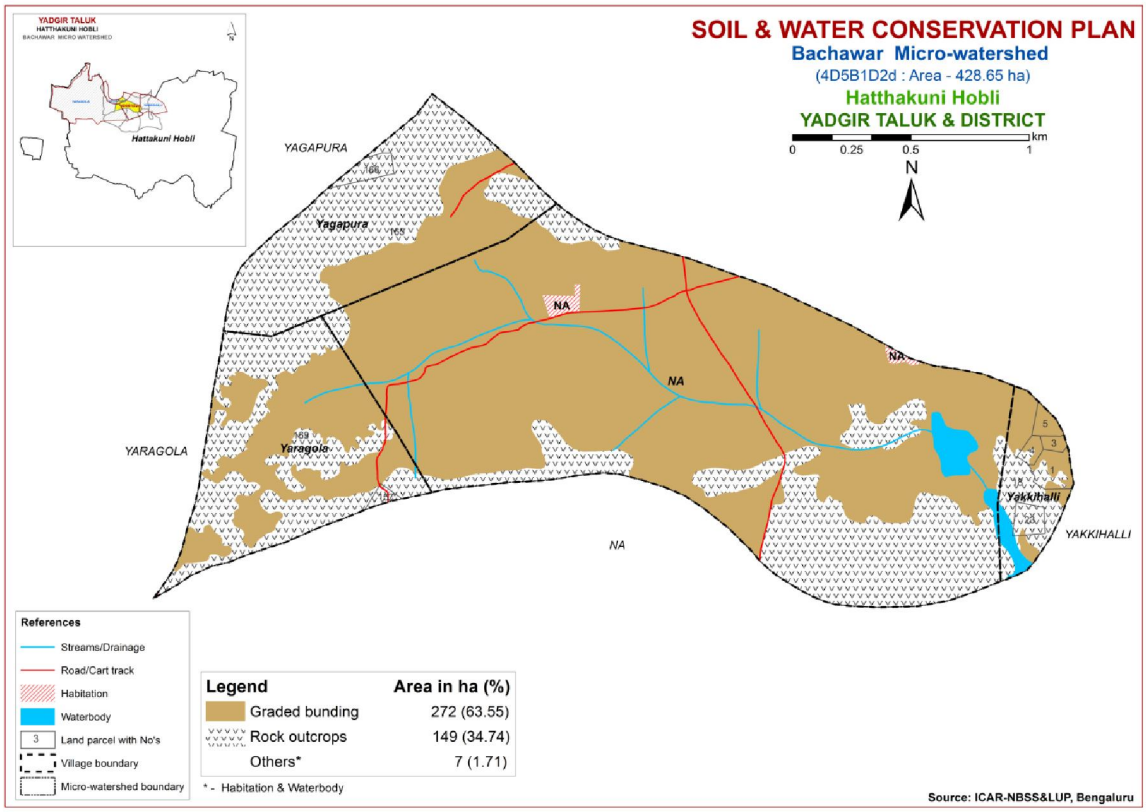


Fig. 9.1 Soil and Water Conservation Plan map of Bachawar Microwatershed

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*.

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

Bachawar (1D2d) Microwatershed

Soil Phase Information

Village	Survey Number	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	Wells	Land Capability	Conservation Plan
Yakkihalli	1	2.45	KKRbB2g1	LMU-2	Very shallow (<25 cm)	Loamy sand	Gravelly (15-35%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVes	Graded bunding
Yakkihalli	3	0.63	KKRbB2g1	LMU-2	Very shallow (<25 cm)	Loamy sand	Gravelly (15-35%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVes	Graded bunding
Yakkihalli	4	0.84	KKRbB2g1	LMU-2	Very shallow (<25 cm)	Loamy sand	Gravelly (15-35%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IVes	Graded bunding
Yakkihalli	5	1.15	KKRbB2g1	LMU-2	Very shallow (<25 cm)	Loamy sand	Gravelly (15-35%)	Very low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Paddy+Redgram (Pd+Rg)	Not Available	IVes	Graded bunding
Yakkihalli	18	10.84	RO	RO	RO	RO	RO	RO	RO	RO	Cotton+Jowar+Paddy+Redgram+RO+Scrub land (Ct+Jw+Pd+Rg+Rc+Sl)	Not Available	RO	RO
Yakkihalli	23	1.63	RO	RO	RO	RO	RO	RO	RO	RO	Habitation	Not Available	RO	RO
Yaragola	157	0.68	RO	RO	RO	RO	RO	RO	RO	RO	Redgram (Rg)	Not Available	RO	RO
Yaragola	163	67.22	RO	RO	RO	RO	RO	RO	RO	RO	Cotton+Jowar+Redgram+RO (Ct+Jw+Rg+Rc)	Not Available	RO	RO
Yagapura	165	63.83	RO	RO	RO	RO	RO	RO	RO	RO	Not Available (NA)	Not Available	RO	RO
Yagapura	166	1.87	RO	RO	RO	RO	RO	RO	RO	RO	Not Available (NA)	Not Available	RO	RO
NA	NA	277.51	SBRcC3g1	LMU-1	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Very low (<50 mm/m)	Gently sloping (3-5%)	Severe	Not Available (NA)	Not Available	IVes	Graded bunding

Appendix II

Bachawar (1D2d) Microwatershed

Soil Fertility Information

Village	Survey NO	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Yakkihalli	1	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Yakkihalli	3	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Yakkihalli	4	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Yakkihalli	5	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Yakkihalli	18	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yakkihalli	23	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yaragola	157	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yaragola	163	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yagapura	165	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yagapura	166	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
NA	NA	Neutral (pH 6.5 – 7.3)	Non saline (<2 dsm)	High (> 0.75 %)	Medium (23 – 57 kg/ha)	Medium (145 – 337 kg/ha)	Low (<10 ppm)	Low (< 0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)

Appendix III

Bachawar (1D2d) Microwatershed

Soil Suitability Information

Village	Survey Number	Mango	Maize	Sapota	Sorghum	Guava	Cotton	Tamarind	Lime	Bengal gram	Sunflower	Red gram	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Brinjal	Bhendi	Drumstick	Mulberry
Yakkihalli	1	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r
Yakkihalli	3	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r
Yakkihalli	4	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r
Yakkihalli	5	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r	N1r
Yakkihalli	18	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yakkihalli	23	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yaragola	157	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yaragola	163	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yagapura	165	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Yagapura	166	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
NA	NA	N1r	S3t	S3rt	S3t	S3rt	N1t	N1r	S3rt	N1t	S3rt	S3rt	S3t	S3rt	S3t	N1n	S3rt	S3rt	S3t	S3t	S3t	S3t	S3t	S3t	S3rt	S3t	S3t	S3t	S3rt	S3rt

Ro-Rock outcrops

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

CONTENTS

LIST OF TABLES

Chapter 1

SALIENT FINDINGS OF THE SURVEY

- *The data indicated that there were 92 (62.16%) men and 56 (37.84%) women among the sampled households.*
- *The average family size of landless farmers' was 3, marginal farmers' was 3.8, small farmers' was 4.1 semi medium farmers' was 4.7 and medium farmers' was 5.*
- *The data indicated that, 6 (45%) people were in 0-15 years of age, 66 (44.59 %) were in 16-35 years of age, 61 (41.22%) were in 36-60 years of age and 15 (10.14%) were above 61 years of age.*
- *The results indicated that Bachawar had 70.95 per cent illiterates, 7.43 per cent of them had primary school, 0.68 per cent of them had middle school and masters, 11.49 per cent of them had high school education and 45 per cent of them had PUC and degree.*
- *The results indicate that, 35.14 per cent of household heads were practicing agriculture, 59.46 per cent of the household heads were agricultural laborers, 2.70 per cent of the households were private services and 5.41 per cent of the households were trade and business.*
- *The results indicate that agriculture was the major occupation for 39.19 per cent of the household members, 48.65 per cent were agricultural labourers, 23 per cent were in Private Service, 2.70 per cent were in trade and business and housewives, 45 per cent were students and 0.68 per cent were children.*
- *The results show that, 100 per cent of the population in the micro watershed has not participated in local institutions.*
- *The results indicate that 2.7 per cent of the households possess Thatched house and 97.3 per cent of the households possess katcha house.*
- *The results show that 72.97 per cent of the households possess TV, 8.11 per cent of the households possess mixer/grinder, 2.7 per cent of the households possess bicycle, 24.32 per cent of the households possess motor cycle and 97.30 per cent of the households possess mobile phones.*
- *The results show that the average value of television was Rs. 9,074, mixer/grinder and bicycle was Rs. 2,000, motor cycle was Rs. 44,000 and mobile phone was Rs. 3,179.*
- *About 8.11 per cent of the households possess bullock cart, 13.51 per cent of them possess plough and chaff cutter, 2.7 per cent of them possess sprayer, harvester and thresher.*
- *The results show that the average value of bullock cart was Rs. 22,000, plough was Rs. 1,166, sprayer was Rs. 4,000, harvester was Rs. 12,000, thresher was Rs. 14,000 and the average value of chaff cutter was Rs. 180.*
- *The results indicate that, 10.81 per cent of the households possess bullocks and local cow.*

- *The results indicate that, average own labour men available in the micro watershed was 23 and average own labour (women) available was 1.5, average hired labour (men) available and average hired labour (women) available was 6.88.*
- *The results indicate that, 91.89 per cent of the households opined that the hired labour was adequate.*
- *The results indicate that, households of the Bachawar micro-watershed possess 23.99 ha (69.53%) of dry land and 10.51 ha (30.47%) of irrigated land. Marginal farmers possess 8.79 ha (90.5%) of dry land and 0.92 ha (9.5 %) of irrigated land. Small farmers possess 7.77 ha (68.83%) of dry land and 3.52 ha (31.17%) of irrigated land. Semi medium farmers possess 7.42 ha (82.9 %) of dry land and 1.62 ha (17.91%) of irrigated land. Medium farmers possess 4.45 ha (100%) of irrigated land.*
- *The results indicate that, the average value of dry land was Rs. 502,083.33 and the average value of irrigated land was Rs. 446,843.72. In case of marginal famers, the average land value was Rs. 801,357.57 for dry land and average land value was Rs. 541,666.65 for irrigated land. In case of small famers, the average land value was Rs. 411,452.37 for dry land and Rs. 596,206.89 for irrigated land. In case of semi medium famers, the average land value was Rs. 242,420.94 for dry land and Rs. 494,000 for irrigated land. In case of medium famers, the average land value was Rs. 291,9099 for irrigated land.*
- *The results indicate that, there were 9 functioning bore wells in the micro watershed.*
- *The results indicate that, bore well was the major irrigation source in the micro water shed for 27.3 per cent of the farmers.*
- *The results indicate that, the depth of bore well was found to be 28.83 meters.*
- *The results indicate that marginal, small and semi medium and medium farmers had an irrigated area of 4.49 ha, 3.52 ha, 1.62 ha and 4.45 ha respectively.*
- *The results indicate that, farmers have grown red gram (14.77 ha), cotton (5.36 ha), groundnut (4.49 ha), sorghum (3.77 ha), green gram (2.15 ha) and paddy (1.3 ha). Marginal farmers have red gram, cotton, groundnut, sorghum, green gram and paddy. Small farmers have grown red gram, cotton, groundnut, sorghum and paddy. Semi medium farmers have grown red gram and groundnut. Medium farmers have grown red gram, cotton and green gram. The results indicate that, the cropping intensity in Bachawar micro-watershed was found to be 92.22 per cent.*
- *The results indicate that, the total cost of cultivation for Cotton was Rs. 30490.20. The gross income realized by the farmers was Rs. 90432.97. The net income from Cotton cultivation was Rs. 59942.76. Thus the benefit cost ratio was found to be 1:2.97.*
- *The total cost of cultivation for Red gram was Rs. 47358.83. The gross income realized by the farmers was Rs. 194677.30. The net income from Red gram cultivation was Rs. 147318.46. Thus the benefit cost ratio was found to be 1:4.11.*

- *The total cost of cultivation for Paddy was Rs. 65147.98. The gross income realized by the farmers was Rs. 123911.66. The net income from Paddy cultivation was Rs. 58763.68. Thus the benefit cost ratio was found to be 1:1.9.*
- *The total cost of cultivation for groundnut was Rs. 43278.49. The gross income realized by the farmers was Rs. 92562.89. The net income from Groundnut cultivation was Rs. 49284.40. Thus the benefit cost ratio was found to be 1:2.14.*
- *The total cost of cultivation for sorghum was Rs. 36132.53. The gross income realized by the farmers was Rs. 31115.61. The net income from sorghum cultivation was Rs. -5016.92. Thus the benefit cost ratio was found to be 1:0.86.*
- *The total cost of cultivation for green gram was Rs. 816769. The gross income realized by the farmers was Rs. 91638.50. The net income from green gram cultivation was Rs. 9962.41. Thus the benefit cost ratio was found to be 1:1.12.*
- *The results indicate that, 18.92 per cent of the households opined that dry fodder and green fodder was adequate.*
- *The results indicate that the annual gross income was Rs. 110,750 for landless farmers, for marginal farmers it was Rs. 106,853.33, for small farmers it was Rs. 110,888.89, semi medium farmers it was Rs. 147,000 and medium farmers it was Rs. 147,500.*
- *The results indicate that the average annual expenditure is Rs. 14,439.67. For landless households it was Rs. 34,375, for marginal farmers it was Rs. 4,237.11, for small farmers it was Rs. 9,222.22, for semi medium farmers it was Rs. 25,625 and medium farmers it was Rs. 67,500.*
- *The results indicate that, households have planted 5 mango and 10 coconut trees in their field and also 2 coconut trees in their backyard.*
- *The results indicate that, households have planted 10 teak, 50 Neem, 2 Banyan and 7 tamarind trees in their field and also 5 neem trees in their backyard.*
- *The results indicated that, households have an average investment capacity of Rs. 1,540.54 for land development and households have an average investment capacity of Rs. 273 for improved crop production.*
- *The results indicated that loan from bank was the source of additional investment for 224.32 per cent each for land development. Own funds was the source of additional investment for 5.41 per cent each for land development and 2.7 per cent for improved crop production.*
- *The results indicated that, cotton was sold to the extent of 100 per cent, green gram was sold to the extent of 87.88 per cent, groundnut to the extent of 93.75 per cent, paddy and sorghum was sold to the extent of 88.89 per cent and red gram was sold to the extent of 93.81 per cent.*
- *The results indicated that, about 2.70 per cent of the farmers sold their produce to agent/ traders, 89.19 per cent of the farmers sold their produce to local/village merchants.*

- *The results indicated that, 88.57 per cent of the households have used tractor as a mode of transportation.*
- *The results indicated that, 62.16 per cent of the households have experienced soil and water erosion problems in the farm.*
- *The results indicated that, 85.71 per cent have shown interest in soil test.*
- *The results indicated that, 91.89 per cent of the households used firewood as a source of fuel and 8.11 per cent of the households used LPG as a source of fuel.*
- *The results indicated that, piped supply was the major source of drinking water for 100 per cent of the households in the micro watershed.*
- *Electricity was the major source of light for 97.3 per cent of the households in micro watershed.*
- *The results indicated that, 67.57 per cent of the households possess sanitary toilet facility.*
- *The results indicated that, 97.3 per cent of the sampled households possessed BPL cards.*
- *The results indicated that, 78.38 per cent of the households participated in NREGA programme.*
- *The results indicated that, cereals were adequate for 100 per cent of the households, pulses were adequate for 81.8 per cent, vegetables were adequate for 31.43 per cent, fruits were adequate for 86.49 per cent, milk, egg and meat were adequate for 97.3 per cent.*
- *The results indicated that, pulses were inadequate for 18.92 per cent, oilseeds were inadequate for 100 per cent, vegetables were inadequate for 13.51 per cent and fruits were inadequate for 91.89 per cent of the households.*
- *The results indicated that, lower fertility status of the soil and high cost of Fertilizers and plant protection chemicals was the constraint experienced by 89.19 per cent of the households, wild animal menace on farm field (48.65%), frequent incidence of pest and diseases (51.35%), Inadequacy of irrigation water and High rate of interest on credit (2.7%), Low price for the agricultural commodities (21.62%) and lack of marketing facilities in the area (5.41%).*

Chapter 2

INTRODUCTION

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

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

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

Scope and importance of survey

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

Chapter 3

METHODOLOGY

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

Description of the study area

Yadgiri District is one of the 30 districts of Karnataka state in southern India. This district was carved out from the erstwhile Gulbarga district as the 30th district of Karnataka on 10 April 2010. Yadgiri town is the administrative headquarters of the district. The district comprises of 3 taluks namely, Shahapur, Yadgirii and Shorapur (There are 16 hoblies, 117 Gram Panchayats, 4 Municipalities,8 Towns/ Urban agglomeration and 487 inhabited & 32 un-inhabited villages The district occupies an area of 5,160.88 km².

Yadgiri district is the second smallest district in the state, area wise is very rich in cultural traditions. The vast stretch of fertile black soil of the district is known for bumper red gram and jowar crops. The district is a "Daal bowl" of the state. The district is also known for cluster of cement industries and a distinct stone popularly known as "Malakheda Stone". Two main rivers, Krishna and Bhima, and a few tributaries flow in this region. Krishna and Bhima Rivers drain the district. They constitute the two major river basins of the district. Kagna and Amarja are the two sub - basins of Bhima River, which occur within the geographical area of the district

According to the 2011 census Yadgiri district has a population of 1, 172,985, roughly equal to the nation of Timor-Lesteor the US state of Rhode Island. This gives it a ranking of 404th in India (out of a total of 640). The district has a population density of 224 inhabitants per square kilometre (580/sq mi). Its population growth rate over the decade 2001-2011 was 22.67%. Yadgiri has a sex ratio of 984 females for every 1000 males, and a literacy rate of 52.36%.

Description of the micro watershed

Bachawar micro-watershed in Yakehalli sub-watershed (Yadgiri taluk and district) is located in between $16^0$54’25.621’’ to 16^0 53’32.901’’North latitudes and 77^0 8’15.673’’ to $77^0$6’041’’East longitudes, covering an area of about 390.61 ha, bounded by Yagapur, Bachawar and Yaragola villages.

Methodology followed in assessing socio-economic status of households

In order to assess the socio-economic condition of the farmers in the watershed a comprehensive questionnaire was prepared. Major components such as demographic conditions, migration details, food consumption and family expenditure pattern, material possession, land holding, land use management, cropping pattern, cost of cultivation of crops, livestock management. The statistical components such as frequency and percentage were used to analyze the data. About 37 households located in the micro-watershed were interviewed for the survey.

Chapter 4

SALIENT FEATURES OF THE SURVEY

Households sampled for socio-economic survey: The data on households sampled for socio economic survey in Bachawar micro-watershed is presented in Table 1 and it indicated that 37 farmers were sampled in Bachawar micro-watershed among them 4 (10.81%) were landless, 18 (48.65%) were marginal farmers, 9 (24.32%) were small farmers, 4 (10.81 %) were semi medium farmers and 2 (5.41%.

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

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Farmers	4	10.81	18	48.65	9	24.32	4	10.81	2	5.41	37	100

Population characteristics: The population characteristics of households sampled for socio-economic survey in Bachawar micro-watershed is presented in Table 2. The data indicated that there were 92 (62.16%) men and 56 (37.84%) women among the sampled households. The average family size of landless farmers' was 3, marginal farmers' was 3.8, small farmers' was 4.1 semi medium farmers' was 4.7 and medium farmers' was 5.

Table 2: Population characteristics of Bachawar micro-watershed

Sl.No.	Particulars	LL (12)		MF (70)		SF (37)		SMF (19)		MDF (10)		All (148)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Men	7	58.33	46	65.71	21	56.76	12	63.16	6	60	92	62.16
2	Women	5	41.67	24	34.29	16	43.24	7	36.84	4	40	56	37.84
Total		12	100	70	100	37	100	19	100	10	100	148	100
Average		3		3.8		4.1		4.7		5		4	

Age wise classification of population: The age wise classification of household members in Bachawar micro-watershed is presented in Table 3. The data indicated that, 6 (45%) people were in 0-15 years of age, 66 (44.59 %) were in 16-35 years of age, 61 (41.22%) were in 36-60 years of age and 15 (10.14%) were above 61 years of age.

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

Sl.No.	Particulars	LL (12)		MF (70)		SF (37)		SMF (19)		MDF (10)		All (148)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	0-15 years of age	0	0	3	4.29	3	8.11	0	0	0	0	6	45
2	16-35 years of age	8	66.67	28	40	17	45.95	8	42.11	5	50	66	44.59
3	36-60 years of age	4	33.33	29	41.43	15	40.54	9	47.37	4	40	61	41.22
4	> 61 years	0	0	10	14.29	2	5.41	2	10.53	1	10	15	10.14
Total		12	100	70	100	37	100	19	100	10	100	148	100

Education level of household members: Education level of household members in Bachawar micro-watershed is presented in Table 4. The results indicated that Bachawar had 70.95 per cent illiterates, 7.43 per cent of them had primary school, 0.68 per cent of

them had middle school and masters, 11.49 per cent of them had high school education and 45 per cent of them had PUC and degree.

Table 4. Education level of household members in Bachawar micro-watershed

Sl.No.	Particulars	LL (12)		MF (70)		SF (37)		SMF (19)		MDF (10)		All (148)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Illiterate	5	41.67	58	82.86	24	64.86	16	84.21	2	20	105	70.95
2	Primary School	3	25	5	7.14	1	2.70	0	0	2	20	11	7.43
3	Middle School	0	0	0	0	1	2.70	0	0	0	0	1	0.68
4	High School	3	25	2	2.86	8	21.62	1	5.26	3	30	17	11.49
5	PUC	1	8.33	2	2.86	2	5.41	1	5.26	0	0	6	45
6	Degree	0	0	1	1.43	1	2.70	1	5.26	3	30	6	45
7	Masters	0	0	1	1.43	0	0	0	0	0	0	1	0.68
8	Others	0	0	1	1.43	0	0	0	0	0	0	1	0.68
Total		12	100	70	100	37	100	19	100	10	100	148	100

Occupation of household heads: The data regarding the occupation of the household heads in Bachawar micro-watershed is presented in Table 5. The results indicate that, 35.14 per cent of household heads were practicing agriculture, 59.46 per cent of the household heads were agricultural laborers, 2.70 per cent of the households were private services and 5.41 per cent of the households were trade and business.

Table 5: Occupation of household heads in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Agriculture	0	0	9	50	2	22.22	1	25	1	50	13	35.14
2	Agricultural Labour	4	100	7	38.89	8	88.89	2	50	1	50	22	59.46
3	Private Service	0	0	0	0	0	0	1	25	0	0	1	2.70
4	Trade & Business	0	0	2	11.11	0	0	0	0	0	0	2	5.41
Total		4	100	18	100	10	100	4	100	2	100	38	100

Table 6: Occupation of family members in Bachawar micro-watershed

Sl.No.	Particulars	LL (12)		MF (70)		SF (37)		SMF (19)		MDF (10)		All (148)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Agriculture	0	0	37	52.86	12	32.43	8	42.11	1	10	58	39.19
2	Agricultural Labour	12	100	23	32.86	21	56.76	9	47.37	7	70	72	48.65
3	Private Service	0	0	0	0	0	0	1	5.26	2	20	3	23
4	Trade & Business	0	0	4	5.71	0	0	0	0	0	0	4	2.70
5	Student	0	0	2	2.86	4	10.81	0	0	0	0	6	45
6	Housewife	0	0	3	4.29	0	0	1	5.26	0	0	4	2.70
7	Children	0	0	1	1.43	0	0	0	0	0	0	1	0.68
Total		12	100	70	100	37	100	19	100	10	100	148	100

Occupation of the household members: The data regarding the occupation of the household members in Bachawar micro-watershed is presented in Table 6. The results indicate that agriculture was the major occupation for 39.19 per cent of the household members, 48.65 per cent were agricultural labourers, 23 per cent were in Private Service,

2.70 per cent were in trade and business and housewives, 45 per cent were students and 0.68 per cent were children.

Institutional participation of the household members: The data regarding the institutional participation of the household members in Bachawar micro-watershed is presented in Table 7. The results show that, 100 per cent of the population in the micro watershed has not participated in local institutions.

Table 7. Institutional Participation of household members in Bachawar micro-watershed

Sl.No.	Particulars	LL (12)		MF (70)		SF (37)		SMF (19)		MDF (10)		All (148)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	No Participation	12	100	70	100	37	100	19	100	10	100	148	100
Total		12	100	70	100	37	100	19	100	10	100	148	100

Type of house owned: The data regarding the type of house owned by the households in Bachawar micro-watershed is presented in Table 8. The results indicate that 2.7 per cent of the households possess Thatched house and 97.3 per cent of the households possess katcha house.

Table 8. Type of house owned by households in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Thatched	0	0	1	5.56	0	0	0	0	0	0	1	2.70
2	Katcha	4	100	17	94.44	9	100	4	100	2	100	36	97.30
Total		4	100	18	100	9	100	4	100	2	100	37	100

Durable Assets owned by the households: The data regarding the Durable Assets owned by the households in Bachawar micro-watershed is presented in Table 9. The results show that 72.97 per cent of the households possess TV, 8.11 per cent of the households possess mixer/grinder, 2.7 per cent of the households possess bicycle, 24.32 per cent of the households possess motor cycle and 97.30 per cent of the households possess mobile phones.

Table 9. Durable Assets owned by households in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Television	4	100	14	77.78	4	44.44	3	75	2	100	27	72.97
2	Mixer/Grinder	0	0	1	5.56	1	11.11	1	25	0	0	3	8.11
3	Bicycle	1	25	0	0	0	0	0	0	0	0	1	2.70
4	Motor Cycle	0	0	7	38.89	1	11.11	0	0	1	50	9	24.32
5	Mobile Phone	4	100	17	94.44	9	100	4	100	2	100	36	97.30

Average value of durable assets: The data regarding the average value of durable assets owned by the households in Bachawar micro-watershed is presented in Table 10. The results show that the average value of television was Rs. 9,074, mixer/grinder and bicycle was Rs. 2,000, motor cycle was Rs. 44,000 and mobile phone was Rs. 3,179.

Table 10. Average value of durable assets owned by households in Bachawar micro-watershed

Average value (Rs.)

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Television	9,000	9,071	9,250	9,000	9,000	9,074
2	Mixer/Grinder	0	2,000	2,000	2,000	0	2,000
3	Bicycle	2,000	0	0	0	0	2,000
4	Motor Cycle	0	43,750	45,000	0	45,000	44,000
5	Mobile Phone	3,200	3,500	3,111	2,750	2,000	3,179

Farm Implements owned: The data regarding the farm implements owned by the households in Bachawar micro-watershed is presented in Table 11. About 8.11 per cent of the households possess bullock cart, 13.51 per cent of them possess plough and chaff cutter, and 2.7 per cent of them possess sprayer, harvester and thresher.

Table 11. Farm Implements owned by households in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Bullock Cart	0	0	0	0	3	33.33	0	0	0	0	3	8.11
2	Plough	0	0	1	5.56	3	33.33	1	25	0	0	5	13.51
3	Sprayer	0	0	0	0	1	11.11	0	0	0	0	1	2.70
4	Harvester	0	0	1	5.56	0	0	0	0	0	0	1	2.70
5	Thresher	0	0	1	5.56	0	0	0	0	0	0	1	2.70
6	Chaff Cutter	0	0	2	11.11	2	22.22	1	25	0	0	5	13.51
7	Blank	4	100	15	83.33	6	66.67	3	75	2	100	30	818

Average value of farm implements: The data regarding the average value of farm Implements owned by the households in Bachawar micro-watershed is presented in Table 12. The results show that the average value of bullock cart was Rs. 22,000, plough was Rs. 1,166, sprayer was Rs. 4,000, harvester was Rs. 12,000, thresher was Rs. 14,000 and the average value of chaff cutter was Rs. 180.

Table 12. Average value of farm implements owned by households in Bachawar micro-watershed

Average Value (Rs.)

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Bullock Cart	0	0	22,000	0	0	22,000
2	Plough	0	1,500	1,000	1,500	0	1,166
3	Sprayer	0	0	4,000	0	0	4,000
4	Harvester	0	12,000	0	0	0	12,000
5	Thresher	0	14,000	0	0	0	14,000
6	Chaff Cutter	0	180	180	180	0	180

Table 13. Livestock possession by households in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Bullock	0	0	0	0	3	33.33	1	25	0	0	4	10.81
2	Local cow	0	0	3	16.67	1	11.11	0	0	0	0	4	10.81
3	blank	4	100	15	83.33	6	66.67	3	75	2	100	30	818

Livestock possession by the households: The data regarding the Livestock possession by the households in Bachawar micro-watershed is presented in Table 13. The results indicate that, 10.81 per cent of the households possess bullocks and local cow.

Average Labour availability: The data regarding the average labour availability in Bachawar micro-watershed is presented in Table 14. The results indicate that, average own labour men available in the micro watershed was 23 and average own labour (women) available was 1.5, average hired labour (men) available and average hired labour (women) available was 6.88.

In case of marginal farmers, average own labour men available was 1.94, average own labour (women) was 1.5, average hired labour (men) and average hired labour (women) available was 6.47. In case of small farmers, average own labour men available was 2 and average own labour (women) was 1.6, average hired labour (men) and average hired labour (women) available was 6.67. In case of semi medium farmers, average own labour men available was 2.75, average own labour (women) was 1.5, average hired labour (men) and average hired labour (women) available was 6.25. In case of medium farmers, average own labour men available was 1.50, average own labour (women) was 1, average hired labour (men) and average hired labour (women) available was 12.5.

Table 14. Average Labour availability in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Hired labour Female	0	6.47	6.67	6.25	12.50	6.88
2	Own Labour Female	0	1.50	1.60	1.50	1	1.50
3	Own labour Male	0	1.94	2	2.75	1.50	23
4	Hired labour Male	0	6.47	6.67	6.25	12.50	6.88

Adequacy of Hired Labour: The data regarding the adequacy of hired labour in Bachawar micro-watershed is presented in Table 15. The results indicate that, 91.89 per cent of the households opined that the hired labour was adequate.

Table 15. Adequacy of Hired Labour in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Adequate	0	0	18	100	10	111.11	4	100	2	100	34	91.89

Table 16. Distribution of land (Ha) in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
1	Dry	0	0	8.79	90.50	7.77	68.83	7.42	82.9	0	0	23.99	69.53
2	Irrigated	0	0	0.92	9.50	3.52	31.17	1.62	17.91	4.45	100	10.51	30.47
Total		0	100	9.72	100	11.30	100	94	100	4.45	100	34.50	100

Distribution of land (ha): The data regarding the distribution of land (ha) in Bachawar micro-watershed is presented in Table 16. The results indicate that, households of the Bachawar micro-watershed possess 23.99 ha (69.53%) of dry land and 10.51 ha (30.47%) of irrigated land. Marginal farmers possess 8.79 ha (90.5%) of dry land and 0.92 ha (9.5

%) of irrigated land. Small farmers possess 7.77 ha (68.83%) of dry land and 3.52 ha (31.17%) of irrigated land. Semi medium farmers possess 7.42 ha (82.9 %) of dry land and 1.62 ha (17.91%) of irrigated land. Medium farmers possess 4.45 ha (100%) of irrigated land.

Average land value (Rs./ha): The data regarding the average land value (Rs./ha) in Bachawar micro-watershed is presented in Table 17. The results indicate that, the average value of dry land was Rs. 502,083.33 and the average value of irrigated land was Rs. 446,843.72. In case of marginal famers, the average land value was Rs. 801,357.57 for dry land and average land value was Rs. 541,666.65 for irrigated land. In case of small famers, the average land value was Rs. 411,452.37 for dry land and Rs. 596,206.89 for irrigated land. In case of semi medium famers, the average land value was Rs. 242,420.94 for dry land and Rs. 494,000 for irrigated land. In case of medium famers, the average land value was Rs. 291,9099 for irrigated land.

Table 17. Average land value (Rs./ha) in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Dry	0	801,357.57	411,452.37	242,420.94	0	502,083.33
2	Irrigated	0	541,666.65	596,206.89	494,000	291,9099	446,843.72

Status of bore wells: The data regarding the status of bore wells in Bachawar micro-watershed is presented in Table 18. The results indicate that, there were 9 functioning bore wells in the micro watershed.

Table 18. Status of bore wells in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Functioning	0	2	4	1	2	9

Source of irrigation: The data regarding the source of irrigation in Bachawar micro-watershed is presented in Table 19. The results indicate that, bore well was the major irrigation source in the micro water shed for 27.3 per cent of the farmers.

Table 19. Source of irrigation in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Bore Well	0	0	2	11.11	4	44.44	1	25	3	150	10	27.3

Depth of water (Avg in meters): The data regarding the depth of water in Bachawar micro-watershed is presented in Table 20. The results indicate that, the depth of bore well was found to be 28.83 meters.

Table 20. Depth of water (Avg in meters) in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Bore Well	0	11.85	47.41	26.67	16.02	28.83

Irrigated Area (ha): The data regarding the irrigated area (ha) in Bachawar micro-watershed is presented in Table 21. The results indicate that marginal, small and semi

medium and medium farmers had an irrigated area of 4.49 ha, 3.52 ha, 1.62 ha and 4.45 ha respectively.

Table 21. Irrigated Area (ha) in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Kharif	0	4.49	3.52	1.62	4.45	14.8
Total		0	4.49	3.52	1.62	4.45	14.8

Cropping pattern: The data regarding the cropping pattern in Bachawar micro-watershed is presented in Table 22. The results indicate that, farmers have grown red gram (14.77 ha), cotton (5.36 ha), groundnut (4.49 ha), sorghum (3.77 ha), green gram (2.15 ha) and paddy (1.3 ha). Marginal farmers have red gram, cotton, groundnut, sorghum, green gram and paddy. Small farmers have grown red gram, cotton, groundnut, sorghum and paddy. Semi medium farmers have grown red gram and groundnut. Medium farmers have grown red gram, cotton and green gram.

Table 22. Cropping pattern in Bachawar micro-watershed (Area in ha)

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Kharif - Red gram	0	4.81	2.67	5.26	22	14.77
2	Kharif - Cotton	0	0.91	2.83	0	1.62	5.36
3	Kharif - Groundnut	0	0.44	2.43	1.62	0	4.49
4	Kharif - Sorghum	0	1.21	2.56	0	0	3.77
5	Kharif - Greengram	0	1.34	0	0	0.81	2.15
6	Kharif - Paddy	0	0.49	0.81	0	0	1.3
Total		0	9.2	11.3	6.88	4.45	31.83

Cropping intensity: The data regarding the cropping intensity in Bachawar micro-watershed is presented in Table 23. The results indicate that, the cropping intensity in Bachawar micro-watershed was found to be 92.22 per cent.

Table 23. Cropping intensity (%) in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Cropping Intensity	0	94.63	100	76.10	100	92.22

Cost of cultivation of Cotton: The data regarding the cost of cultivation of Cotton in Bachawar micro-watershed is presented in Table 24. The results indicate that, the total cost of cultivation for Cotton was Rs. 30490.20. The gross income realized by the farmers was Rs. 90432.97. The net income from Cotton cultivation was Rs. 59942.76. Thus the benefit cost ratio was found to be 1:2.97.

Table 24. Cost of Cultivation of Cotton in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	40.31	9938.99	32.60
2	Bullock		Pairs/day	2.20	1318.80	4.33
3	Tractor		Hours	0	0	0
4	Machinery		Hours	0	0	0
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	5.45	5174.87	16.97
7	FYM		Quintal	1.58	316.10	14
8	Fertilizer + micronutrients		Quintal	3.47	27757	9.10
9	Pesticides (PPC)		Kgs / liters	0.79	790.25	2.59
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	184.46	0.60
14	Land revenue and Taxes			0	3.29	01
II	**Cost B1**					
16	Interest on working capital				1086.88	3.56
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				21588.72	70.81
III	**Cost B2**					
18	Rental Value of Land				333.33	19
19	**Cost B2 = (Cost B1 + Rental value)**				219225	71.90
IV	**Cost C1**					
20	Family Human Labour			21.19	5795.31	191
21	**Cost C1 = (Cost B2 + Family Labour)**				27717.37	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				27718.37	90.91
VI	**Cost C3**					
24	Managerial Cost				2771.84	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				30490.20	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		19.47	900473	
		b) Main Crop Sales Price (Rs.)			4625	
	By Product	e) Main Product (q)		1.54	385.94	
		f) Main Crop Sales Price (Rs.)			250	
b.	Gross Income (Rs.)				90432.97	
c.	Net Income (Rs.)				59942.76	
d.	Cost per Quintal (Rs./q.)				15664	
e.	Benefit Cost Ratio (BC Ratio)				1:2.97	

Cost of cultivation of Red gram: The data regarding the cost of cultivation of Red gram in Bachawar micro-watershed is presented in Table 25. The results indicate that, the total cost of cultivation for Red gram was Rs. 47358.83. The gross income realized by the farmers was Rs. 194677.30. The net income from Red gram cultivation was Rs. 147318.46. Thus the benefit cost ratio was found to be 1:4.11.

Table 25. Cost of Cultivation of Red gram in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	919	20402.26	438
2	Bullock		Pairs/day	1.49	895.35	1.89
3	Tractor		Hours	0.62	494	14
4	Machinery		Hours	0	0	0
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	13.49	1618.96	3.42
6	Seed Inter Crop		Kgs.	0	0	0
7	FYM		Quintal	35	610.40	1.29
8	Fertilizer + micronutrients		Quintal	5.84	4687.41	9.90
9	Pesticides (PPC)		Kgs / liters	1.61	1606.23	3.39
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	0.35	0
14	Land revenue and Taxes			0	3.29	01
II	**Cost B1**					
16	Interest on working capital				1022.88	2.16
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				31341.12	66.18
III	**Cost B2**					
18	Rental Value of Land				355.56	0.75
19	**Cost B2 = (Cost B1 + Rental value)**				31696.68	66.93
IV	**Cost C1**					
20	Family Human Labour			43.31	11355.81	23.98
21	**Cost C1 = (Cost B2 + Family Labour)**				43052.49	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				43053.49	90.91
VI	**Cost C3**					
24	Managerial Cost				4305.35	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				47358.83	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		42.21	191360.44	
		b) Main Crop Sales Price (Rs.)			4533.33	
	By Product	e) Main Product (q)		8.29	3316.86	
		f) Main Crop Sales Price (Rs.)			400	
b.	Gross Income (Rs.)				194677.30	
c.	Net Income (Rs.)				147318.46	
d.	Cost per Quintal (Rs./q.)				1121.93	
e.	Benefit Cost Ratio (BC Ratio)				1:4.11	

Cost of Cultivation of Paddy: The data regarding the cost of cultivation of Paddy in Bachawar micro-watershed is presented in Table 26. The results indicate that, the total cost of cultivation for Paddy was Rs. 65147.98. The gross income realized by the farmers was Rs. 123911.66. The net income from Paddy cultivation was Rs. 58763.68. Thus the benefit cost ratio was found to be 1:1.9.

Table 26. Cost of Cultivation of Paddy in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	62.16	14315.71	21.97
2	Bullock		Pairs/day	5.35	3211	4.93
3	Tractor		Hours	8.23	6586.67	10.11
4	Machinery		Hours	0	0	0
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	15.23	9900.58	15.20
6	Seed Inter Crop		Kgs.	0	0	0
7	FYM		Quintal	4.12	823.33	1.26
8	Fertilizer + micronutrients		Quintal	11.94	11254.97	17.28
9	Pesticides (PPC)		Kgs / liters	1.65	1646.67	2.53
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	03	0
14	Land revenue and Taxes			0	3.29	01
II	**Cost B1**					
16	Interest on working capital				2835.19	4.35
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				50577.44	77.63
III	**Cost B2**					
18	Rental Value of Land				166.67	0.26
19	**Cost B2 = (Cost B1 + Rental value)**				50744.10	77.89
IV	**Cost C1**					
20	Family Human Labour			34.58	8480.33	132
21	**Cost C1 = (Cost B2 + Family Labour)**				59224.44	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				59225.44	90.91
VI	**Cost C3**					
24	Managerial Cost				5922.54	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				65147.98	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		76.16	121853.33	
		b) Main Crop Sales Price (Rs.)			1600	
	By Product	e) Main Product (q)		13	2058.33	
		f) Main Crop Sales Price (Rs.)			2000	
b.	Gross Income (Rs.)				123911.66	
c.	Net Income (Rs.)				58763.68	
d.	Cost per Quintal (Rs./q.)				855.43	
e.	Benefit Cost Ratio (BC Ratio)				1:1.9	

Cost of Cultivation of Groundnut: The data regarding the cost of cultivation of Groundnut in Bachawar micro-watershed is presented in Table 27. The results indicate that, the total cost of cultivation for groundnut was Rs. 43278.49. The gross income realized by the farmers was Rs. 92562.89. The net income from Groundnut cultivation was Rs. 49284.40. Thus the benefit cost ratio was found to be 1:2.14.

Table 27. Cost of Cultivation of Groundnut in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	50.44	12815.36	29.61
2	Bullock		Pairs/day	3.60	21591	4.99
3	Tractor		Hours	0	0	0
4	Machinery		Hours	0	0	0
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	63.93	9588.93	22.16
7	FYM		Quintal	2.35	469.60	19
8	Fertilizer + micronutrients		Quintal	4.99	4068.64	9.40
9	Pesticides (PPC)		Kgs / liters	1	996.15	2.30
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	5.20	01
14	Land revenue and Taxes			0	3.29	01
II	**Cost B1**					
16	Interest on working capital				1814.92	4.19
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				31921.11	73.76
III	**Cost B2**					
18	Rental Value of Land				250	0.58
19	**Cost B2 = (Cost B1 + Rental value)**				32171.11	74.34
IV	**Cost C1**					
20	Family Human Labour			24.42	7171.97	16.57
21	**Cost C1 = (Cost B2 + Family Labour)**				393438	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				393448	90.91
VI	**Cost C3**					
24	Managerial Cost				3934.41	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				43278.49	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		18.80	91636.64	
		b) Main Crop Sales Price (Rs.)			4875	
	By Product	e) Main Product (q)		1.85	926.25	
		f) Main Crop Sales Price (Rs.)			500	
b.	Gross Income (Rs.)				92562.89	
c.	Net Income (Rs.)				49284.40	
d.	Cost per Quintal (Rs./q.)				2302.38	
e.	Benefit Cost Ratio (BC Ratio)				1:2.14	

Cost of Cultivation of Sorghum: The data regarding the cost of cultivation of sorghum in Bachawar micro-watershed is presented in Table 28. The results indicate that, the total cost of cultivation for sorghum was Rs. 36132.53. The gross income realized by the farmers was Rs. 31115.61. The net income from sorghum cultivation was Rs. -5016.92. Thus the benefit cost ratio was found to be 1:0.86.

Table 28. Cost of Cultivation of Sorghum in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	55.37	127684	35.34
2	Bullock		Pairs/day	39	1852.50	5.13
3	Tractor		Hours	0.80	638.79	1.77
4	Machinery		Hours	0	0	0
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	10.78	1331.24	3.68
7	FYM		Quintal	2.88	576.33	1.60
8	Fertilizer + micronutrients		Quintal	6	4743.68	13.13
9	Pesticides (PPC)		Kgs / liters	2.47	2470	6.84
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	2.24	01
14	Land revenue and Taxes			0	3.29	01
II	**Cost B1**					
16	Interest on working capital				1094.67	33
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				25480.79	70.52
III	**Cost B2**					
18	Rental Value of Land				333.33	0.92
19	**Cost B2 = (Cost B1 + Rental value)**				25814.12	71.44
IV	**Cost C1**					
20	Family Human Labour			268	7032.63	19.46
21	**Cost C1 = (Cost B2 + Family Labour)**				32846.75	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				32847.75	90.91
VI	**Cost C3**					
24	Managerial Cost				3284.78	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				36132.53	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		11.91	30961.24	
		b) Main Crop Sales Price (Rs.)			2600	
	By Product	e) Main Product (q)		0.62	154.38	
		f) Main Crop Sales Price (Rs.)			250	
b.	Gross Income (Rs.)				31115.61	
c.	Net Income (Rs.)				-5016.92	
d.	Cost per Quintal (Rs./q.)				3034.26	
e.	Benefit Cost Ratio (BC Ratio)				1:0.86	

Cost of Cultivation of Green gram: The data regarding the cost of cultivation of sorghum in Bachawar micro-watershed is presented in Table 29. The results indicate that, the total cost of cultivation for green gram was Rs. 816769. The gross income realized by the farmers was Rs. 91638.50. The net income from green gram cultivation was Rs. 9962.41. Thus the benefit cost ratio was found to be 1:1.12.

Table 29. Cost of Cultivation of green gram in Bachawar micro-watershed

Sl.No	Particulars		Units	Phy Units	Value(Rs.)	% to C3
I	**Cost A1**					
1	Hired Human Labour		Man days	107.99	28156.20	34.47
2	Bullock		Pairs/day	3.71	2223	2.72
3	Tractor		Hours	1.83	1467.61	1.80
4	Machinery		Hours	1.83	1467.61	1.80
5	Seed Main Crop (Establishment and Maintenance)		Kgs (Rs.)	16.58	2051.66	2.51
6	Seed Inter Crop		Kgs.	0	0	0
7	FYM		Quintal	4.92	2960.40	3.62
8	Fertilizer + micronutrients		Quintal	15.40	12235.13	14.98
9	Pesticides (PPC)		Kgs / liters	3.70	36961	4.53
10	Irrigation		Number	0	0	0
11	Repairs			0	0	0
12	Msc. Charges (Marketing costs etc)			0	0	0
13	Depreciation charges			0	339.69	0.42
14	Land revenue and Taxes			0	3.29	0
II	**Cost B1**					
16	Interest on working capital				2513.30	38
17	**Cost B1 = (Cost A1 + sum of 15 and 16)**				57113.91	69.93
III	**Cost B2**					
18	Rental Value of Land				333.33	0.41
19	**Cost B2 = (Cost B1 + Rental value)**				57447.24	70.34
IV	**Cost C1**					
20	Family Human Labour			61.61	16802.74	20.57
21	**Cost C1 = (Cost B2 + Family Labour)**				74249.99	90.91
V	**Cost C2**					
22	Risk Premium				1	0
23	**Cost C2 = (Cost C1 + Risk Premium)**				74250.99	90.91
VI	**Cost C3**					
24	Managerial Cost				7425.10	99
25	**Cost C3 = (Cost C2 + Managerial Cost)**				816769	100
VII	**Economics of the Crop**					
a.	Main Product	a) Main Product (q)		20.25	91638.50	
		b) Main Crop Sales Price (Rs.)			4525	
b.	Gross Income (Rs.)				91638.50	
c.	Net Income (Rs.)				9962.41	
d.	Cost per Quintal (Rs./q.)				40337	
e.	Benefit Cost Ratio (BC Ratio)				1:1.12	

Adequacy of fodder: The data regarding the adequacy of fodder in Bachawar micro-watershed is presented in Table 30. The results indicate that, 18.92 per cent of the households opined that dry fodder and green fodder was adequate.

Table 30. Adequacy of fodder in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Adequate-Dry Fodder	0	0	3	16.67	3	33.33	1	25	0	0	7	18.92
2	Adequate-Green Fodder	0	0	3	16.67	3	33.33	1	25	0	0	7	18.92

Annual gross income: The data regarding the annual gross income in Bachawar micro-watershed is presented in Table 31. The results indicate that the annual gross income was Rs. 110,750 for landless farmers, for marginal farmers it was Rs. 106,853.33, for small farmers it was Rs. 110,888.89, semi medium farmers it was Rs. 147,000 and medium farmers it was Rs. 147,500.

Table 31. Annual gross income in Bachawar micro-watershed (Avg. value in Rs.)

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Service/salary	10,000	0	0	0	0	1,0818
2	Business	20,000	0	0	0	0	2,162.16
3	Wage	80,750	56,277.78	60,666.67	54,500	30,000	58,378.38
4	Agriculture	0	47,633.33	49,111.11	92,500	117,500	51,470.27
5	Dairy Farm	0	2,942.22	1,111.11	0	0	1,701.62
Income(Rs.)		110,750	106,853.33	110,888.89	147,000	147,500	114,793.51

Average annual expenditure: The data regarding the average annual expenditure in Bachawar micro-watershed is presented in Table 32. The results indicate that the average annual expenditure is Rs. 14,439.67. For landless households it was Rs. 34,375, for marginal farmers it was Rs. 4,237.11, for small farmers it was Rs. 9,222.22, for semi medium farmers it was Rs. 25,625 and medium farmers it was Rs. 67,500.

Table 32. Average annual expenditure in Bachawar micro-watershed (Avg value in Rs.)

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Service/salary	20,000	0	0	0	0	540.54
2	Business	65,000	0	0	0	0	1,756.76
3	Wage	52,500	38,823.53	46,000	40,000	45,000	37,918.92
4	Agriculture	0	27,444.44	32,000	62,500	90,000	32,756.76
5	Dairy Farm	0	10,000	5,000	0	0	945.95
Total		137,500	76,267.97	83,000	102,500	135,000	534,267.97
Average		34,375	4,237.11	9,222.22	25,625	67,500	14,439.67

Table 33: Horticulture species grown in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		F	B	F	B	F	B	F	B	F	B	F	B
1	Mango	0	0	0	0	0	0	0	0	5	0	5	0
2	Coconut	0	0	2	1	0	0	0	0	8	1	10	2

***F= Field B=Back Yard**

Horticulture species grown: The data regarding Horticulture species grown in Bachawar micro-watershed is presented in Table 33. The results indicate that, households have planted 5 mango and 10 coconut trees in their field and also 2 coconut trees in their backyard.

Forest species grown: The data regarding forest species grown in Bachawar micro-watershed is presented in Table 34. The results indicate that, households have planted 10 teak, 50 Neem, 2 Banyan and 7 tamarind trees in their field and also 5 neem trees in their backyard.

Table 34: Forest species grown in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		F	B	F	B	F	B	F	B	F	B	F	B
1	Eucalyptus	0	0	0	0	0	0	0	0	10	0	10	0
2	Cashew	0	0	2	1	0	0	2	0	0	0	4	1
3	Teak	0	0	8	4	0	0	8	0	0	0	16	4
4	Neem	0	0	47	2	43	0	5	1	25	0	120	3
5	Tamarind	0	0	2	2	0	0	0	0	0	0	2	2

***F= Field B=Back Yard**

Average Additional investment capacity: The data regarding average additional investment capacity in Bachawar micro-watershed is presented in Table 35. The results indicated that, households have an average investment capacity of Rs. 1,540.54 for land development and households have an average investment capacity of Rs. 273 for improved crop production.

Table 35: Average Additional investment capacity in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)	MF (18)	SF (9)	SMF (4)	MDF (2)	All (37)
1	Land development	0	2,222.22	1,111.11	1,250	1,000	1,540.54
2	Improved crop production	0	0	0	0	500	273

Source of additional investment: The data regarding source of funds for additional investment in Bachawar micro-watershed is presented in Table 36. The results indicated that loan from bank was the source of additional investment for 224.32 per cent each for land development. Own funds was the source of additional investment for 5.41 per cent each for land development and 2.7 per cent for improved crop production.

Table 36: Source of funds for additional investment capacity in Bachawar micro – watershed

Sl.No	Item	Land development		Improved crop production	
		N	%	N	%
1	Loan from bank	9	24.32	0	0
2	Own funds	2	5.41	1	2.7

Marketing of the agricultural produce: The data regarding marketing of the agricultural produce in Bachawar micro-watershed is presented in Table 37. The results indicated that, cotton was sold to the extent of 100 per cent, green gram was sold to the extent of 87.88 per cent, groundnut to the extent of 93.75 per cent, paddy and sorghum

was sold to the extent of 88.89 per cent and red gram was sold to the extent of 93.81 per cent.

Table 37. Marketing of the agricultural produce in Bachawar micro-watershed

Sl.No	Crops	Output obtained (q)	Output retained (q)	Output sold (q)	Output sold (%)	Avg. Price obtained (Rs/q)
1	Cotton	107	0	107	100	4625
2	Greengram	33	4	29	87.88	4525
3	Groundnut	112	7	105	93.75	4800
4	Paddy	90	10	80	88.89	1600
5	Redgram	420	26	394	93.81	4533.33
6	Sorghum	45	5	40	88.89	2600

Marketing Channels used for sale of agricultural produce: The data regarding marketing channels used for sale of agricultural produce in Bachawar micro-watershed is presented in Table 38. The results indicated that, about 2.70 per cent of the farmers sold their produce to agent/ traders, 89.19 per cent of the farmers sold their produce to local/village merchants.

Table 38. Marketing Channels used for sale of agricultural produce in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Agent/Traders	0	0	0	0	0	0	0	0	1	50	1	2.70
2	Local/village Merchant	0	0	18	100	9	100	4	100	2	100	33	89.19

Mode of transport of agricultural produce: The data regarding mode of transport of agricultural produce in Bachawar micro-watershed is presented in Table 39. The results indicated that, 88.57 per cent of the households have used tractor as a mode of transportation.

Table 39. Mode of transport of agricultural produce in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Tractor	0	0	18	100	9	100	4	100	3	150	34	91.89

Incidence of soil and water erosion problems: The data regarding incidence of soil and water erosion problems in Bachawar micro-watershed is presented in Table 40. The results indicated that, 62.16 per cent of the households have experienced soil and water erosion problems in the farm.

Table 40. Incidence of soil and water erosion problems in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Soil and water erosion problems in the farm	0	0	11	61.11	7	77.78	3	75	2	100	23	62.16

Interest shown towards soil testing: The data regarding Interest shown towards soil testing in Bachawar micro-watershed is presented in Table 41. The results indicated that, 85.71 per cent have shown interest in soil test.

Table 41. Interest shown towards soil testing in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Interest in soil test	0	0	17	94.44	8	88.89	4	100	2	100	31	83.78

Usage pattern of fuel for domestic use: The data regarding usage pattern of fuel for domestic use in Bachawar micro-watershed is presented in Table 42. The results indicated that, 91.89 per cent of the households used firewood as a source of fuel and 8.11 per cent of the households used LPG as a source of fuel.

Table 42. Usage pattern of fuel for domestic use in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Fire Wood	3	75	17	94.44	9	100	3	75	2	100	34	91.89
2	LPG	1	25	1	5.56	0	0	1	25	0	0	3	8.11

Source of drinking water: The data regarding source of drinking water in Bachawar micro-watershed is presented in Table 43. The results indicated that, piped supply was the major source of drinking water for 100 per cent of the households in the micro watershed.

Table 43. Source of drinking water in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Piped supply	4	100	18	100	9	100	4	100	2	100	37	100

Source of light: The data regarding source of light in Bachawar micro-watershed is presented in Table 44. The results indicated that, Electricity was the major source of light for 97.3 per cent of the households in micro watershed.

Table 44. Source of light in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Electricity	4	100	17	94.44	9	100	4	100	2	100	36	97.30

Existence of Sanitary toilet facility: The data regarding existence of sanitary toilet facilit**y** in Bachawar micro-watershed is presented in Table 45. The results indicated that, 67.57 per cent of the households possess sanitary toilet facility.

Table 45. Existence of Sanitary toilet facility in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Sanitary toilet facility	2	50	10	55.56	8	88.89	4	100	1	50	25	67.57

Possession of PDS card: The data regarding possession of PDS card in Bachawar micro-watershed is presented in Table 46. The results indicated that, 97.3 per cent of the sampled households possessed BPL cards.

Table 46. Possession of PDS card in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	BPL	4	100	17	94.44	9	100	4	100	2	100	36	97.30

Participation in NREGA program: The data regarding participation in NREGA programme in Bachawar micro-watershed is presented in Table 47. The results indicated that, 78.38 per cent of the households participated in NREGA programme.

Table 47. Participation in NREGA programme in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Participation in NREGA programme	4	100	13	72.22	6	66.67	4	100	2	100	29	78.38

Adequacy of food items: The data regarding adequacy of food items in Bachawar micro-watershed is presented in Table 48. The results indicated that, cereals were adequate for 100 per cent of the households, pulses were adequate for 81.8 per cent, vegetables were adequate for 31.43 per cent, fruits were adequate for 86.49 per cent, milk, egg and meat were adequate for 97.3 per cent.

Table 48. Adequacy of food items in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Cereals	4	100	18	100	9	100	4	100	2	100	37	100
2	Pulses	4	100	15	83.33	6	66.67	3	75	2	100	30	81.8
3	Vegetables	3	75	14	77.78	9	100	4	100	2	100	32	86.49
4	Fruits	1	25	0	0	2	22.22	0	0	0	0	3	8.11
5	Milk	4	100	17	94.44	9	100	4	100	2	100	36	97.30
6	Egg	4	100	17	94.44	9	100	4	100	2	100	36	97.30
7	Meat	4	100	17	94.44	9	100	4	100	2	100	36	97.30

Response on Inadequacy of food items: The data regarding inadequacy of food items in Bachawar micro-watershed is presented in Table 49. The results indicated that, pulses were inadequate for 18.92 per cent, oilseeds were inadequate for 100 per cent, vegetables were inadequate for 13.51 per cent and fruits were inadequate for 91.89 per cent of the households.

Table 49. Response on Inadequacy of food items in Bachawar micro-watershed

Sl.No.	Particulars	LL (4)		MF (18)		SF (9)		SMF (4)		MDF (2)		All (37)	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Pulses	0	0	3	16.67	3	33.33	1	25	0	0	7	18.92
2	Oilseed	4	100	18	100	9	100	4	100	2	100	37	100
3	Vegetables	1	25	4	22.22	0	0	0	0	0	0	5	13.51
4	Fruits	3	75	18	100	7	77.78	4	100	2	100	34	91.89

Farming constraints: The data regarding farming constraints experienced by households in Bachawar micro-watershed is presented in Table 50. The results indicated that, lower fertility status of the soil and high cost of Fertilizers and plant protection chemicals was

the constraint experienced by 89.19 per cent of the households, wild animal menace on farm field (48.65%), frequent incidence of pest and diseases (51.35%), Inadequacy of irrigation water and High rate of interest on credit (2.7%), Low price for the agricultural commodities (21.62%) and lack of marketing facilities in the area (5.41%).

Table 50. Farming constraints Experienced in Bachawar micro-watershed

Sl.No.	Particulars	MF (18)		SF (9)		SMF(4)		MDF(2)		All (37)	
		N	%	N	%	N	%	N	%	N	%
1	Lower fertility status of the soil	18	100	9	100	4	100	2	100	33	89.19
2	Wild animal menace on farm field	8	44.44	6	66.67	3	75	1	50	18	48.65
3	Frequent incidence of pest and diseases	10	55.56	7	77.78	1	25	1	50	19	51.35
4	Inadequacy of irrigation water	0	0	0	0	1	25	0	0	1	2.70
5	High cost of Fertilizers and plant protection chemicals	18	100	9	100	4	100	2	100	33	89.19
6	High rate of interest on credit	0	0	1	11.11	0	0	0	0	1	2.70
7	Low price for the agricultural commodities	6	33.33	1	11.11	0	0	1	50	8	21.62
8	Lack of marketing facilities in the area	1	5.56	0	0	0	0	1	50	2	5.41

Chapter 5

SUMMARY

In order to assess the socio-economic condition of the farmers in the watershed a comprehensive questionnaire was prepared. Major components such as demographic conditions, migration details, food consumption and family expenditure pattern, material possession, land holding, land use management, cropping pattern, cost of cultivation of crops, livestock management. The statistical components such as frequency and percentage were used to analyze the data. About 37 households located in the micro watershed were interviewed for the survey.

The data indicated that there were 92 (62.16%) men and 56 (37.84%) women among the sampled households. The average family size of landless farmers' was 3, marginal farmers' was 3.8, small farmers' was 4.1 semi medium farmers' was 4.7 and medium farmers' was 5. The data indicated that, 6 (45%) people were in 0-15 years of age, 66 (44.59 %) were in 16-35 years of age, 61 (41.22%) were in 36-60 years of age and 15 (10.14%) were above 61 years of age.

The results indicated that Bachawar had 70.95 per cent illiterates, 7.43 per cent of them had primary school, 0.68 per cent of them had middle school and masters, 11.49 per cent of them had high school education and 45 per cent of them had PUC and degree.

The results indicate that, 35.14 per cent of household heads were practicing agriculture, 59.46 per cent of the household heads were agricultural laborers, 2.70 per cent of the households were private services and 5.41 per cent of the households were trade and business. The results indicate that agriculture was the major occupation for 39.19 per cent of the household members, 48.65 per cent were agricultural labourers, 23 per cent were in Private Service, 2.70 per cent were in trade and business and housewives, 45 per cent were students and 0.68 per cent were children.

The results show that, 100 per cent of the population in the micro watershed has not participated in local institutions. The results indicate that 2.7 per cent of the households possess Thatched house and 97.3 per cent of the households possess katcha house.

The results show that 72.97 per cent of the households possess TV, 8.11 per cent of the households possess mixer/grinder, 2.7 per cent of the households possess bicycle, 24.32 per cent of the households possess motor cycle and 97.30 per cent of the households possess mobile phones. The results show that the average value of television was Rs. 9,074, mixer/grinder and bicycle was Rs. 2,000, motor cycle was Rs. 44,000 and mobile phone was Rs. 3,179.

About 8.11 per cent of the households possess bullock cart, 13.51 per cent of them possess plough and chaff cutter, 2.7 per cent of them possess sprayer, harvester and thresher. The results show that the average value of bullock cart was Rs. 22,000, plough

was Rs. 1,166, sprayer was Rs. 4,000, harvester was Rs. 12,000, thresher was Rs. 14,000 and the average value of chaff cutter was Rs. 180. The results indicate that, 10.81 per cent of the households possess bullocks and local cow.

The results indicate that, average own labour men available in the micro watershed was 23 and average own labour (women) available was 1.5, average hired labour (men) available and average hired labour (women) available was 6.88. The results indicate that, 91.89 per cent of the households opined that the hired labour was adequate.

The results indicate that, households of the Bachawar micro-watershed possess 23.99 ha (69.53%) of dry land and 10.51 ha (30.47%) of irrigated land. Marginal farmers possess 8.79 ha (90.5%) of dry land and 0.92 ha (9.5 %) of irrigated land. Small farmers possess 7.77 ha (68.83%) of dry land and 3.52 ha (31.17%) of irrigated land. Semi medium farmers possess 7.42 ha (82.9 %) of dry land and 1.62 ha (17.91%) of irrigated land. Medium farmers possess 4.45 ha (100%) of irrigated land.

The results indicate that, the average value of dry land was Rs. 502,083.33 and the average value of irrigated land was Rs. 446,843.72. In case of marginal famers, the average land value was Rs. 801,357.57 for dry land and average land value was Rs. 541,666.65 for irrigated land. In case of small famers, the average land value was Rs. 411,452.37 for dry land and Rs. 596,206.89 for irrigated land. In case of semi medium famers, the average land value was Rs. 242,420.94 for dry land and Rs. 494,000 for irrigated land. In case of medium famers, the average land value was Rs. 291,9099 for irrigated land.

The results indicate that, there were 9 functioning bore wells in the micro watershed. The results indicate that, bore well was the major irrigation source in the micro water shed for 27.3 per cent of the farmers. The results indicate that, the depth of bore well was found to be 28.83 meters.

The results indicate that marginal, small and semi medium and medium farmers had an irrigated area of 4.49 ha, 3.52 ha, 1.62 ha and 4.45 ha respectively. The results indicate that, farmers have grown red gram (14.77 ha), cotton (5.36 ha), groundnut (4.49 ha), sorghum (3.77 ha), green gram (2.15 ha) and paddy (1.3 ha). Marginal farmers have red gram, cotton, groundnut, sorghum, green gram and paddy. Small farmers have grown red gram, cotton, groundnut, sorghum and paddy. Semi medium farmers have grown red gram and groundnut. Medium farmers have grown red gram, cotton and green gram. The results indicate that, the cropping intensity in Bachawar micro-watershed was found to be 92.22 per cent.

The results indicate that, the total cost of cultivation for Cotton was Rs. 30490.20. The gross income realized by the farmers was Rs. 90432.97. The net income from Cotton cultivation was Rs. 59942.76. Thus the benefit cost ratio was found to be 1:2.97. The total cost of cultivation for Red gram was Rs. 47358.83. The gross income realized by the

farmers was Rs. 194677.30. The net income from Red gram cultivation was Rs. 147318.46. Thus the benefit cost ratio was found to be 1:4.11. The total cost of cultivation for Paddy was Rs. 65147.98. The gross income realized by the farmers was Rs. 123911.66. The net income from Paddy cultivation was Rs. 58763.68. Thus the benefit cost ratio was found to be 1:1.9. The total cost of cultivation for groundnut was Rs. 43278.49. The gross income realized by the farmers was Rs. 92562.89. The net income from Groundnut cultivation was Rs. 49284.40. Thus the benefit cost ratio was found to be 1:2.14. The total cost of cultivation for sorghum was Rs. 36132.53. The gross income realized by the farmers was Rs. 31115.61. The net income from sorghum cultivation was Rs. -5016.92. Thus the benefit cost ratio was found to be 1:0.86. The total cost of cultivation for green gram was Rs. 816769. The gross income realized by the farmers was Rs. 91638.50. The net income from green gram cultivation was Rs. 9962.41. Thus the benefit cost ratio was found to be 1:1.12.

The results indicate that, 18.92 per cent of the households opined that dry fodder and green fodder was adequate.

The results indicate that the annual gross income was Rs. 110,750 for landless farmers, for marginal farmers it was Rs. 106,853.33, for small farmers it was Rs. 110,888.89, semi medium farmers it was Rs. 147,000 and medium farmers it was Rs. 147,500. The results indicate that the average annual expenditure is Rs. 14,439.67. For landless households it was Rs. 34,375, for marginal farmers it was Rs. 4,237.11, for small farmers it was Rs. 9,222.22, for semi medium farmers it was Rs. 25,625 and medium farmers it was Rs. 67,500.

The results indicate that, households have planted 5 mango and 10 coconut trees in their field and also 2 coconut trees in their backyard. The results indicate that, households have planted 10 teak, 50 Neem, 2 Banyan and 7 tamarind trees in their field and also 5 neem trees in their backyard.

The results indicated that, households have an average investment capacity of Rs. 1,540.54 for land development and households have an average investment capacity of Rs. 273 for improved crop production. The results indicated that loan from bank was the source of additional investment for 224.32 per cent each for land development. Own funds was the source of additional investment for 5.41 per cent each for land development and 2.7 per cent for improved crop production.

The results indicated that, cotton was sold to the extent of 100 per cent, green gram was sold to the extent of 87.88 per cent, groundnut to the extent of 93.75 per cent, paddy and sorghum was sold to the extent of 88.89 per cent and red gram was sold to the extent of 93.81 per cent.

The results indicated that, about 2.70 per cent of the farmers sold their produce to agent/ traders, 89.19 per cent of the farmers sold their produce to local/village merchants.

The results indicated that, 88.57 per cent of the households have used tractor as a mode of transportation.

The results indicated that, 62.16 per cent of the households have experienced soil and water erosion problems in the farm. The results indicated that, 85.71 per cent have shown interest in soil test.

The results indicated that, 91.89 per cent of the households used firewood as a source of fuel and 8.11 per cent of the households used LPG as a source of fuel. The results indicated that, piped supply was the major source of drinking water for 100 per cent of the households in the micro watershed.

Electricity was the major source of light for 97.3 per cent of the households in micro watershed. The results indicated that, 67.57 per cent of the households possess sanitary toilet facility. The results indicated that, 97.3 per cent of the sampled households possessed BPL cards. The results indicated that, 78.38 per cent of the households participated in NREGA programme.

The results indicated that, cereals were adequate for 100 per cent of the households, pulses were adequate for 81.8 per cent, vegetables were adequate for 31.43 per cent, fruits were adequate for 86.49 per cent, milk, egg and meat were adequate for 97.3 per cent.

The results indicated that, pulses were inadequate for 18.92 per cent, oilseeds were inadequate for 100 per cent, vegetables were inadequate for 13.51 per cent and fruits were inadequate for 91.89 per cent of the households.

The results indicated that, lower fertility status of the soil and high cost of Fertilizers and plant protection chemicals was the constraint experienced by 89.19 per cent of the households, wild animal menace on farm field (48.65%), frequent incidence of pest and diseases (51.35%), Inadequacy of irrigation water and High rate of interest on credit (2.7%), Low price for the agricultural commodities (21.62%) and lack of marketing facilities in the area (5.41%).